Restoring Drylands : afforestation efforts in arid sites in Northern California

Six Rivers National Forest, Northern California

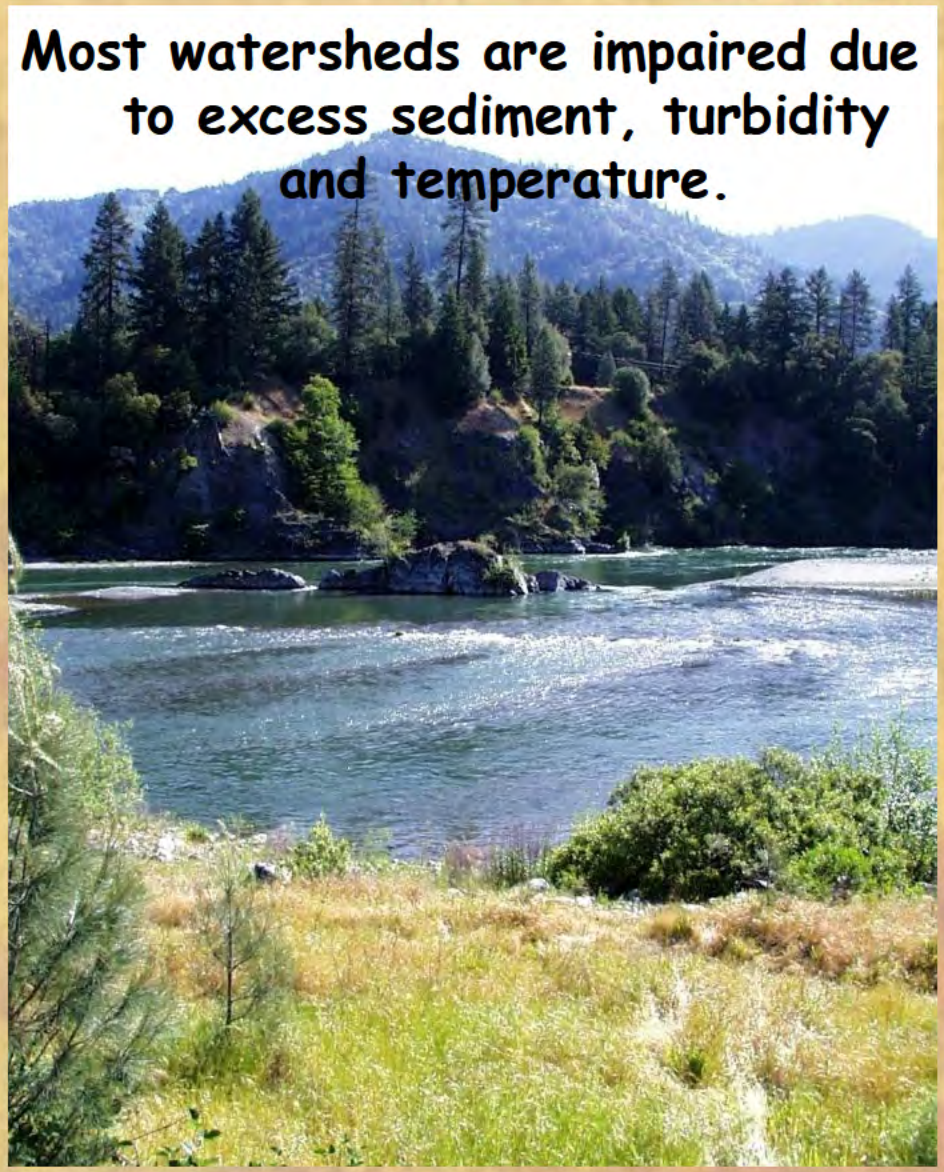
- Climate – Mediterranean - wet winters and dry summers (little to no rain 5+ mo)
- Precipitation – winter 1500 to 1800 mm; summer 5 to 20 mm
- Natural disturbance regime wildfires and floods – exposed soils very dry, fire-prone, hot soils

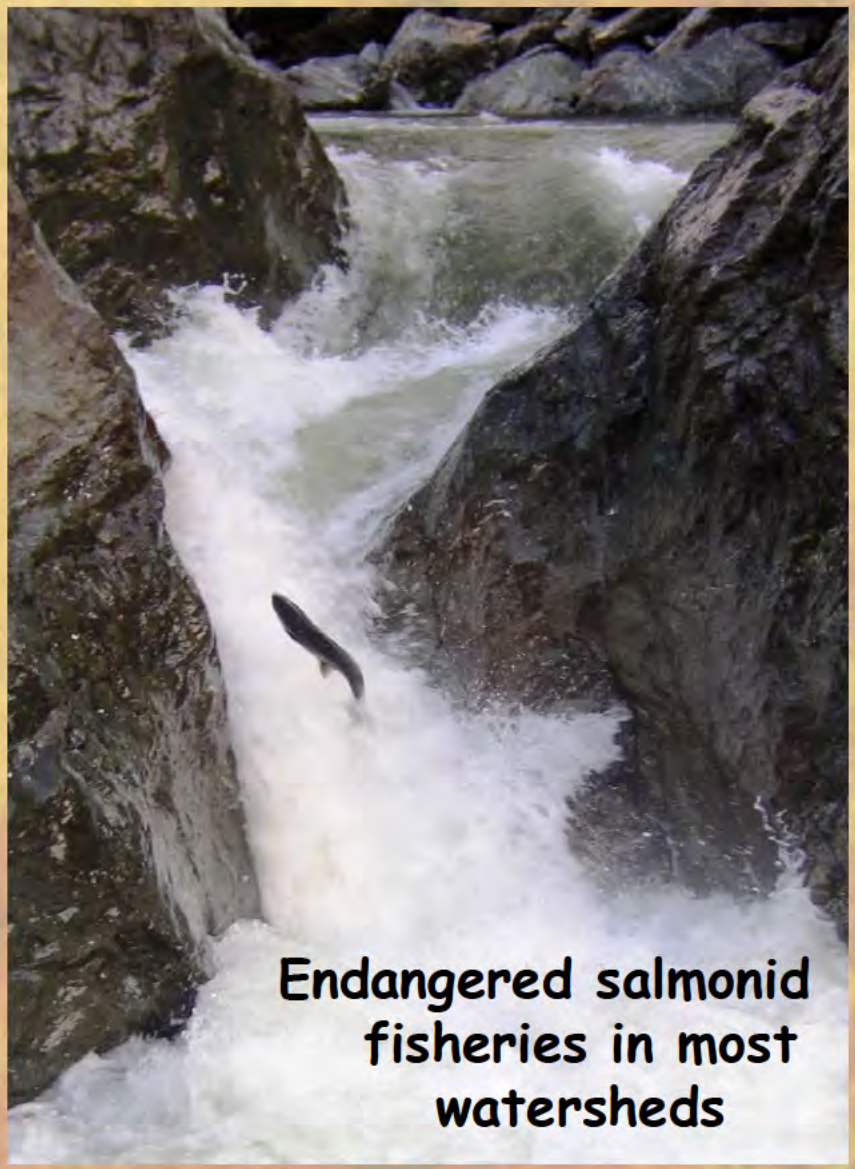
Arid sites in Northern California?

Geology: rapid tectonic uplift, highly faulted and fractured; lots of landslides

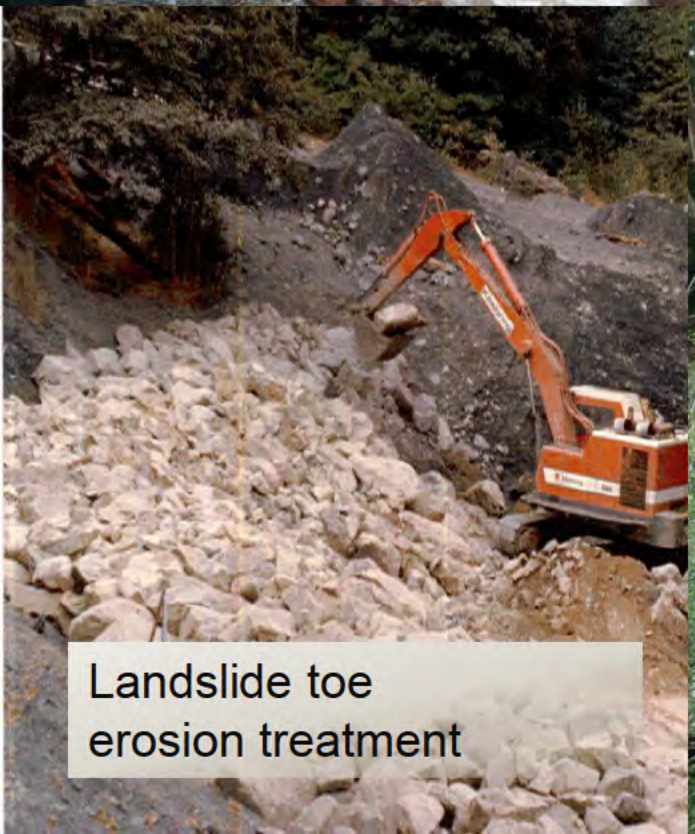
Soils: extremely droughty soils, high rock content, little to no OM very low N and fertility limitations (High Mg, Low Ca, heavy metals Cr, Ni, Pb)

Watershed Conditions in Northern California



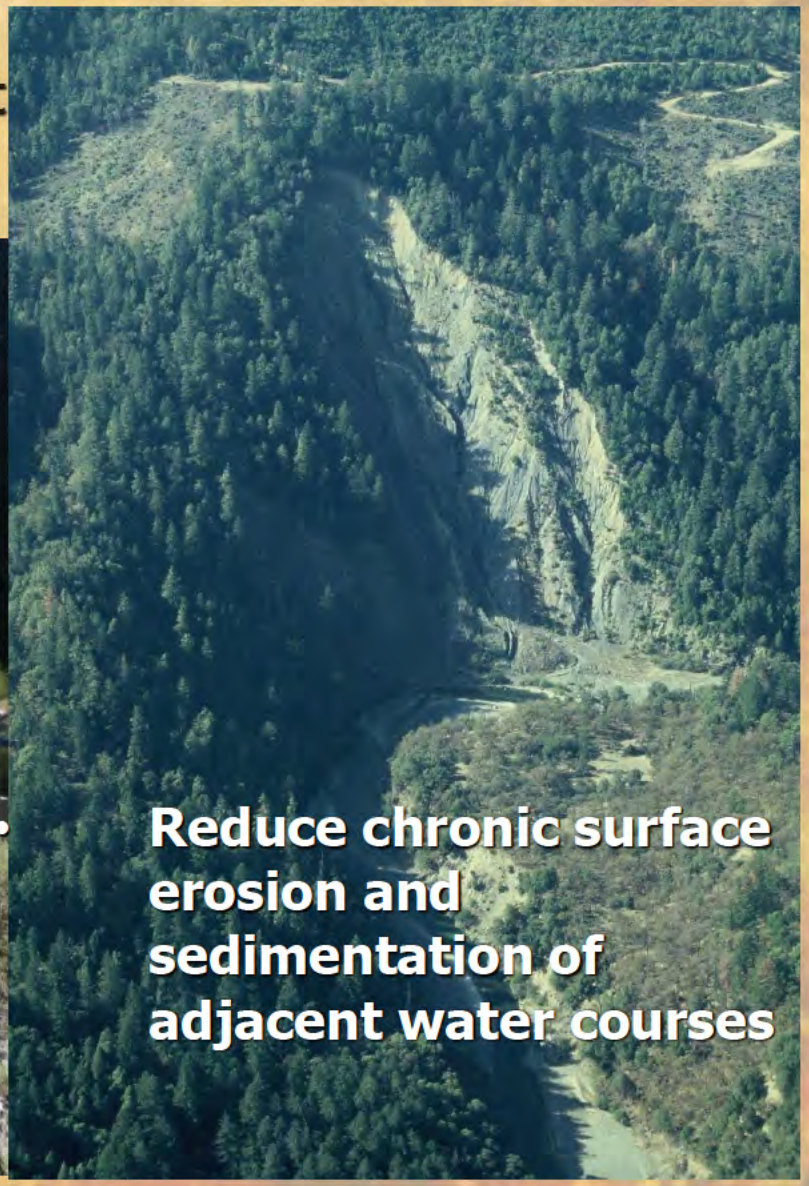


Treatments to address water quality

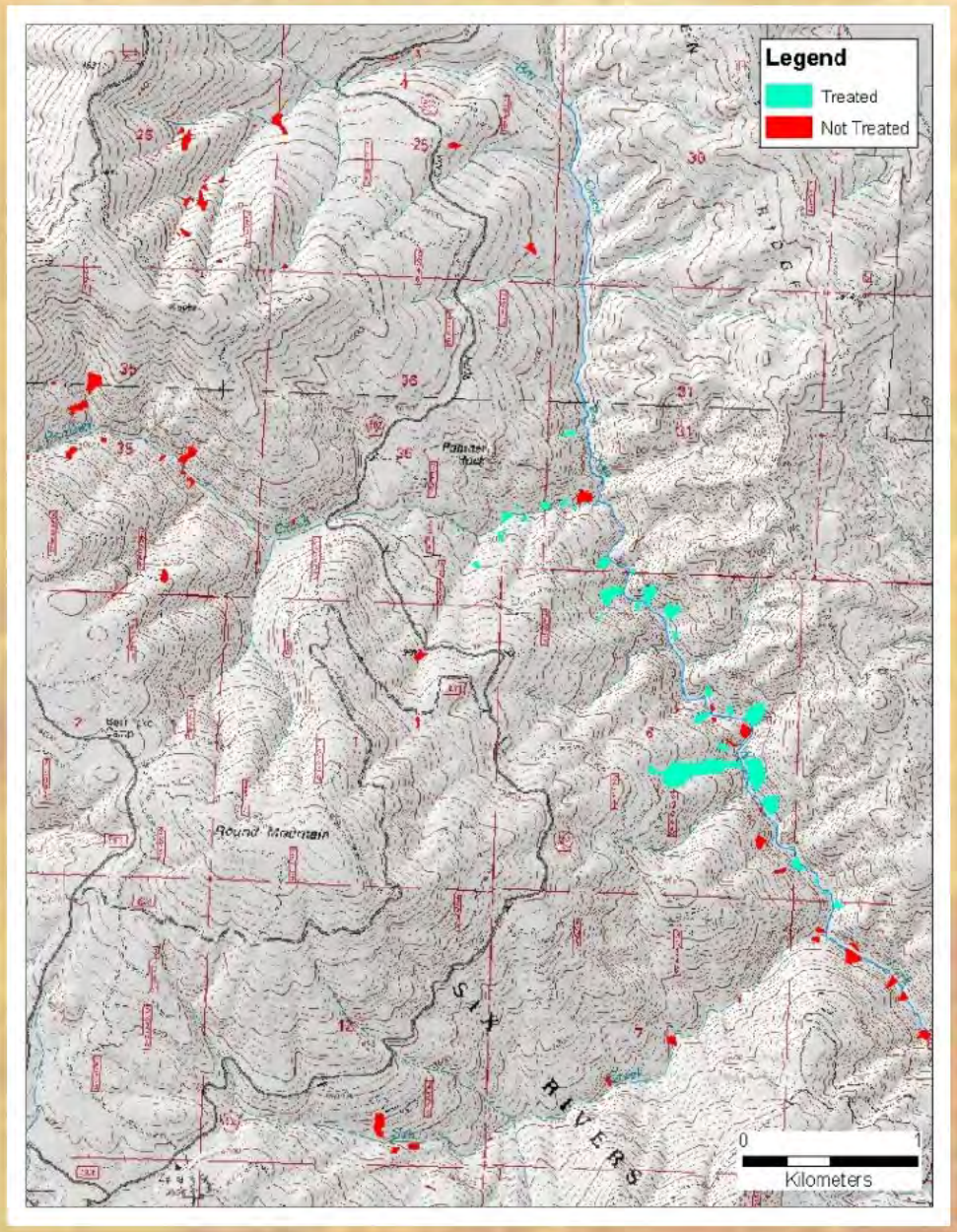


Afforestation of arid sites
Part I – purpose, goals and case studies

Improve water quality - legal requirement under Clean Water Act



Inventory and Assess areas suitable for afforestation



- Air photo inventory of all landslide features
- 10,000 landslides identified
- 210 landslides determined to be suitable and treated
- 11 High bar sites identified and treated

….most of afforestation work on landslides – small area but huge effort

Identifying Suitable reforestation sites

Site visits to determine suitability for planting

Sites must be:

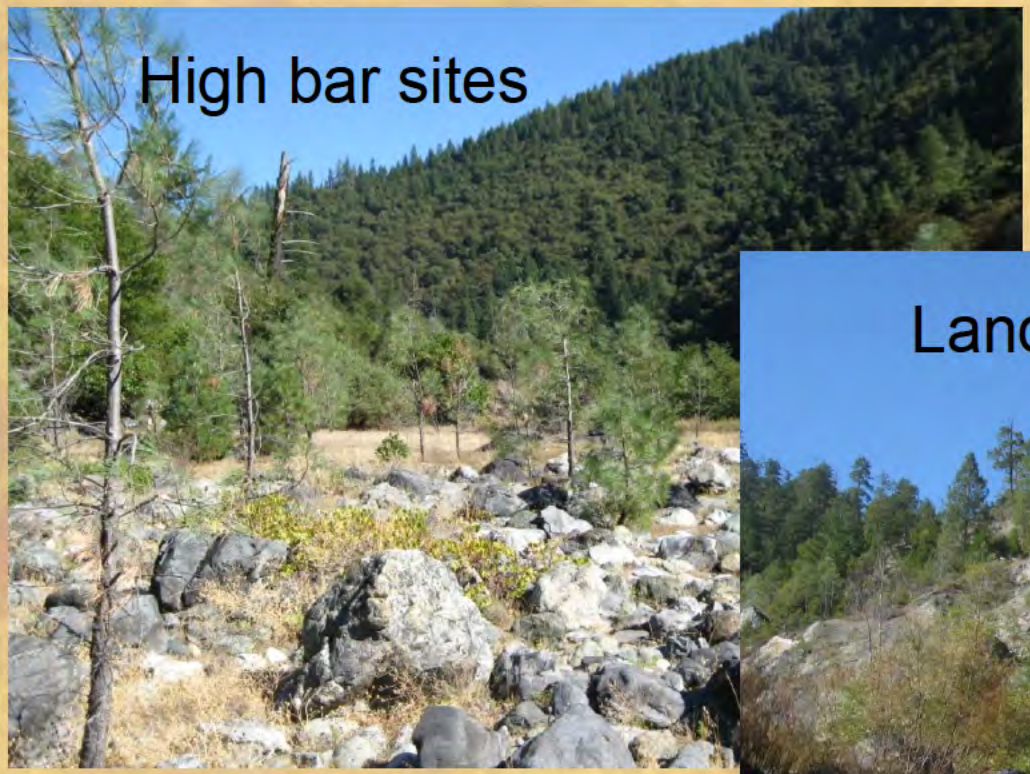
- reasonably stable, no earthflows
- Forest Service managed lands
- Readily accessible
- Not too steep

Helicopter aforestation efforts

- Helicopter Seeding in inaccessible areas determined to be cost prohibitive and difficult to monitor due to limited access

Afforestation efforts

Aforestation of arid sites – what worked?



South Fork Trinity River High bars

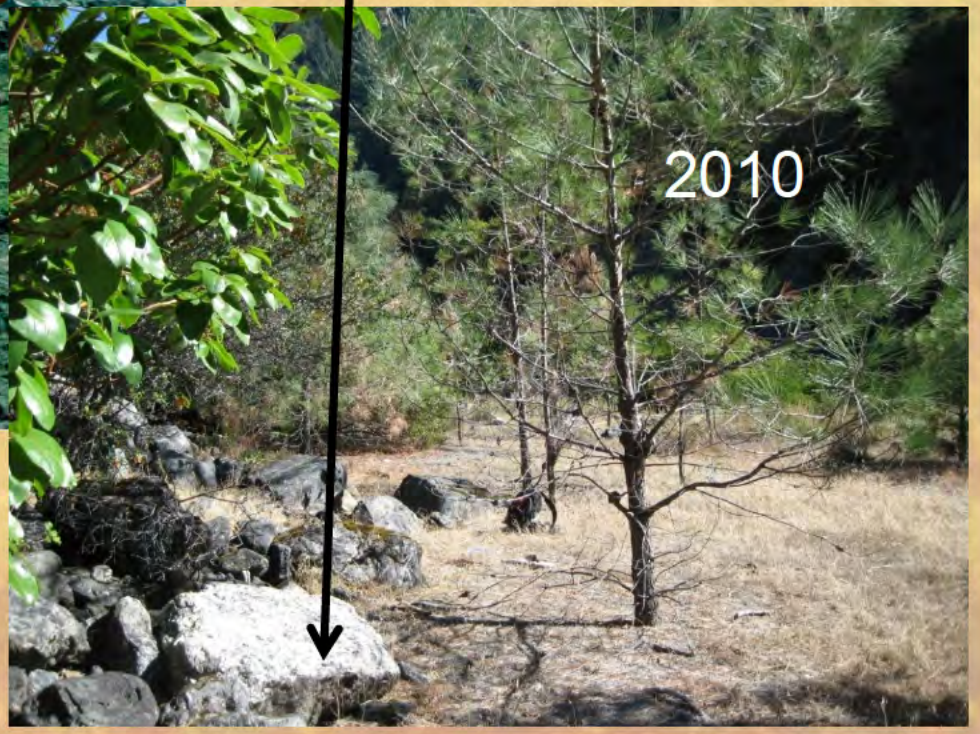
- South Fork Trinity River - impaired due to excess sediment and elevated stream temperatures

- Purpose: evaluate opportunities for confer planting in order to increase long-term stream shade along flood terraces

- Soils extremely gravely, loamy sands, excessively drained, little water holding capacity; low organic content

South Fork High bar planting

same rock



Treatments

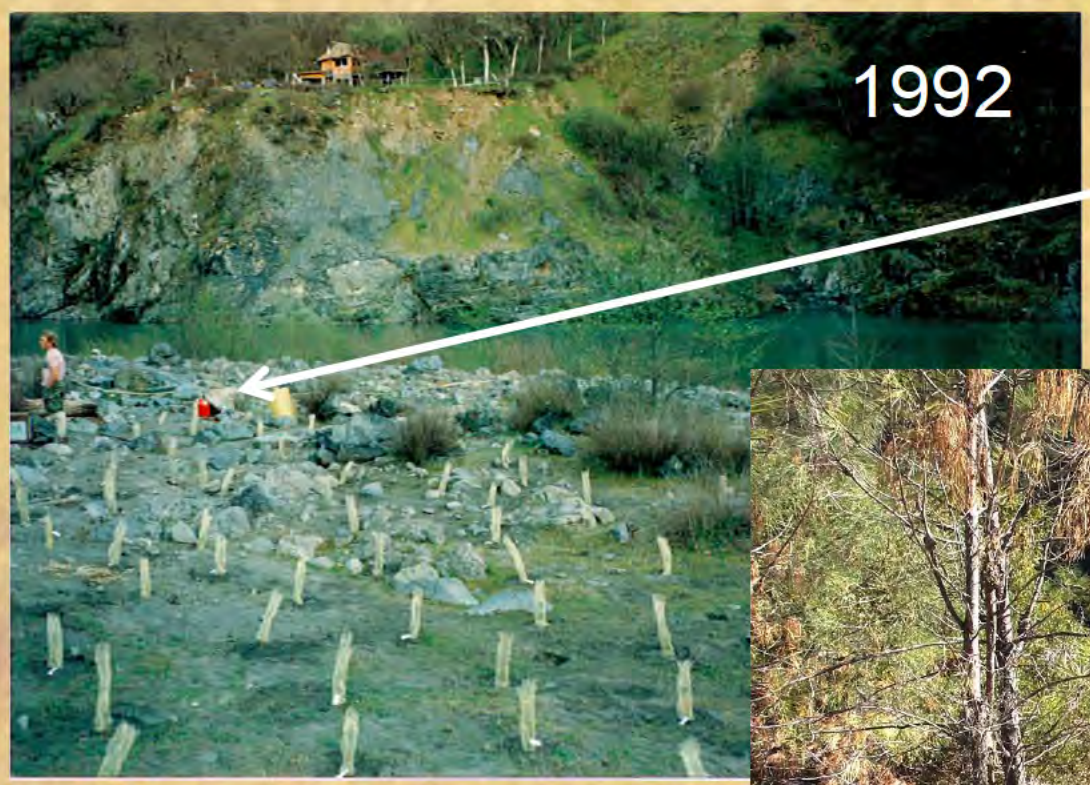
- **510 trees planted - Gray Pine**
  Jeffery Pine
- **1/3 no treatment**
- **1/3 bi-weekly watering 5 months**
- **1/3 soil amendment (Terra Sorb) and same bi-weekly watering**

South Fork High bar planting

1992

Same rock

South Fork High bar planting



Same rock

South Fork High bar planting

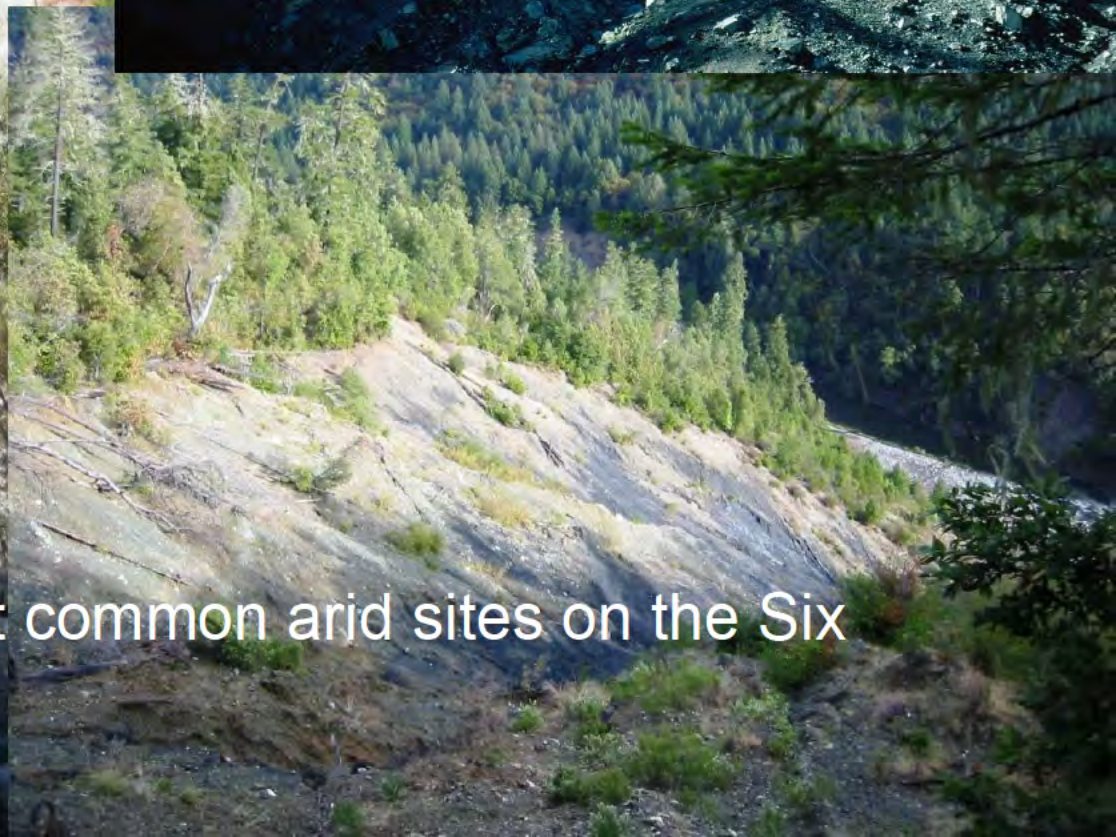
Same house

High bar survival rates

Results

- 10% survival, mostly Gray Pine
- Terra Sorb significantly increased first year survival
- Trees treated with Terra Sorb didn't have significantly higher 1st year survival compared with irrigated trees

Landslides



Landslides are the most common arid sites on the Six Rivers Forest

Badlands Landslide

1970

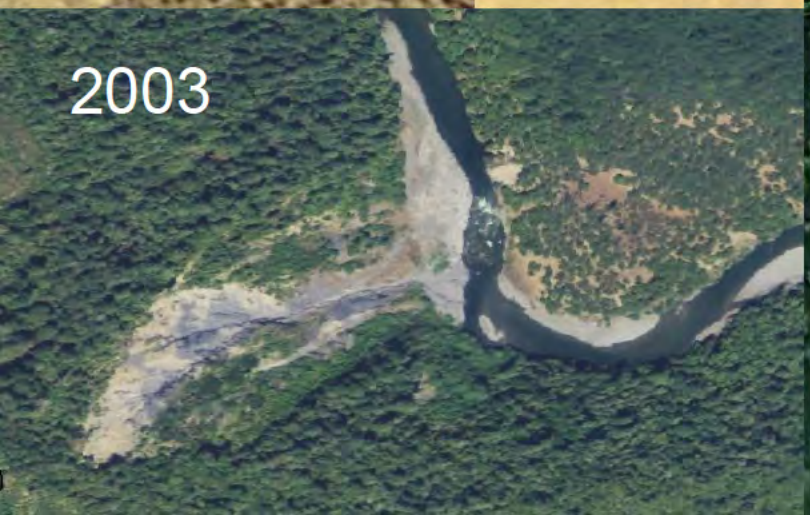
1980

1993

Seeded and planted
1992-1997

2003

2006



Badlands Landslide

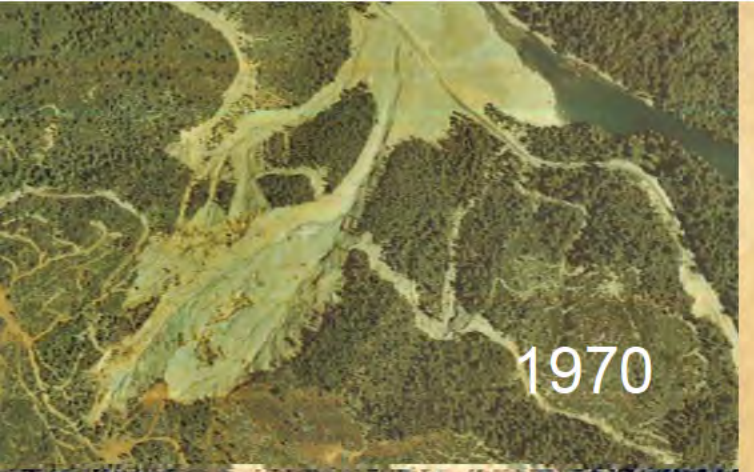
2010

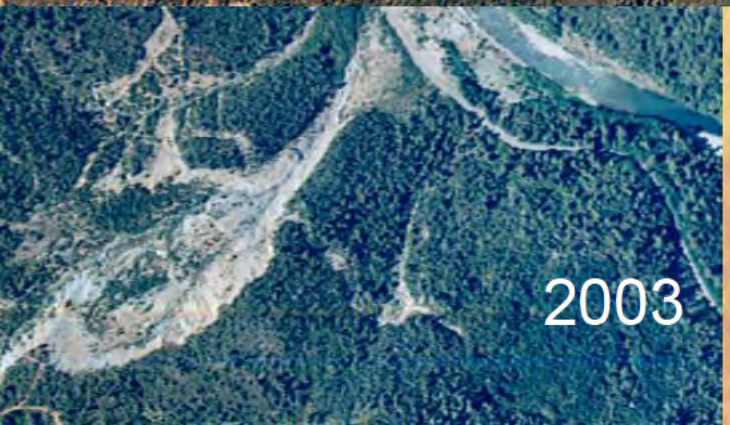
16,000 plants over a 5 year period

Establish forest floor and surface cover

Planting success only on northern aspect

Rattlesnake Landslide





Site challenges:

- Serpentine soils (high mineral content Mg vs Ca)
- Very rocky
- Excessively drained
- Low organic matter

Rattlesnake Landslide

Species Planted

- serpentine and drought tolerant
  - Jeffery Pine, Incense Cedar,
  - Black Locust,

Afforestation of arid sites
Part II – Lessons Learned

- Collecting seed, growing of seed stock at local nurseries
- Native vs non-native (black locust as a nursery species)
- Range of species collected, what worked and what didn't
- Use of fertilizer
- Timing of planting
  - Challenge of access (snow vs dry hot weather)
  - Weather can change from 5 to 30 degrees Celsius in a few weeks making success of planting challenging.

Tree species

- List varieties and why selected
- Big list here
- PIJE
- PISA
- CEIN

Planting techniques

- Location, location, location!

Aspect counts – north vs south facing

Native vs Non-Native
Black locust

Black locust nursery forest

Provision of suited stock

Timing problem

Species selction

- wrote a book

Considerations

- climate
- soil type
- site type
- cultural (seed avail, culture)

Challenges

- Access
- Safety
- Plantability
- Snow vs. drying period – narrow window
  - Hot soil surface
- Low elevations soil is too cold
  - 43 degrees

Planting quality

- Careful training and QA
- Site selection
- When it doubt, plant it, with love and hope, sometimes fertilizer

Challenges

- Soil fertility
- Drought
- Animals
- Erosion and Instability

Overall results

- ~10% survival average
- Riparian shade plantings worked acceptably (unexpected)
- Good increments of erosion control and site enhancement
- Very small carbon fixation increments
- Hard questions about native vs. non-native stock