USPPRP Monitoring:
Results from 2003 and Plans for 2004

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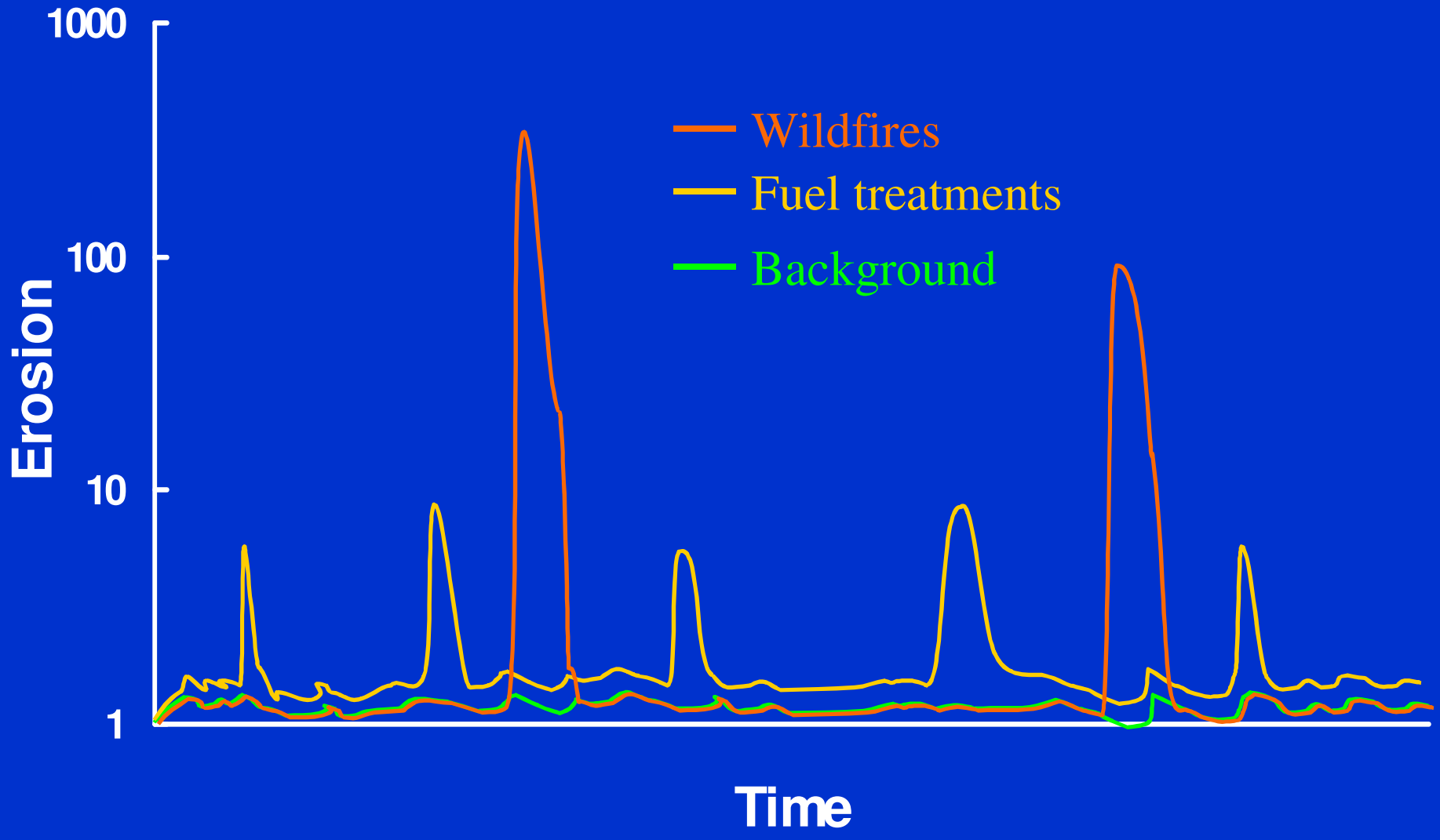
Overall Goal

Determine whether thinning causes changes in runoff, erosion rates, water quality, or channel morphology.

Wildfires vs. fuel treatments vs. background



Objectives: Hillslope Scale

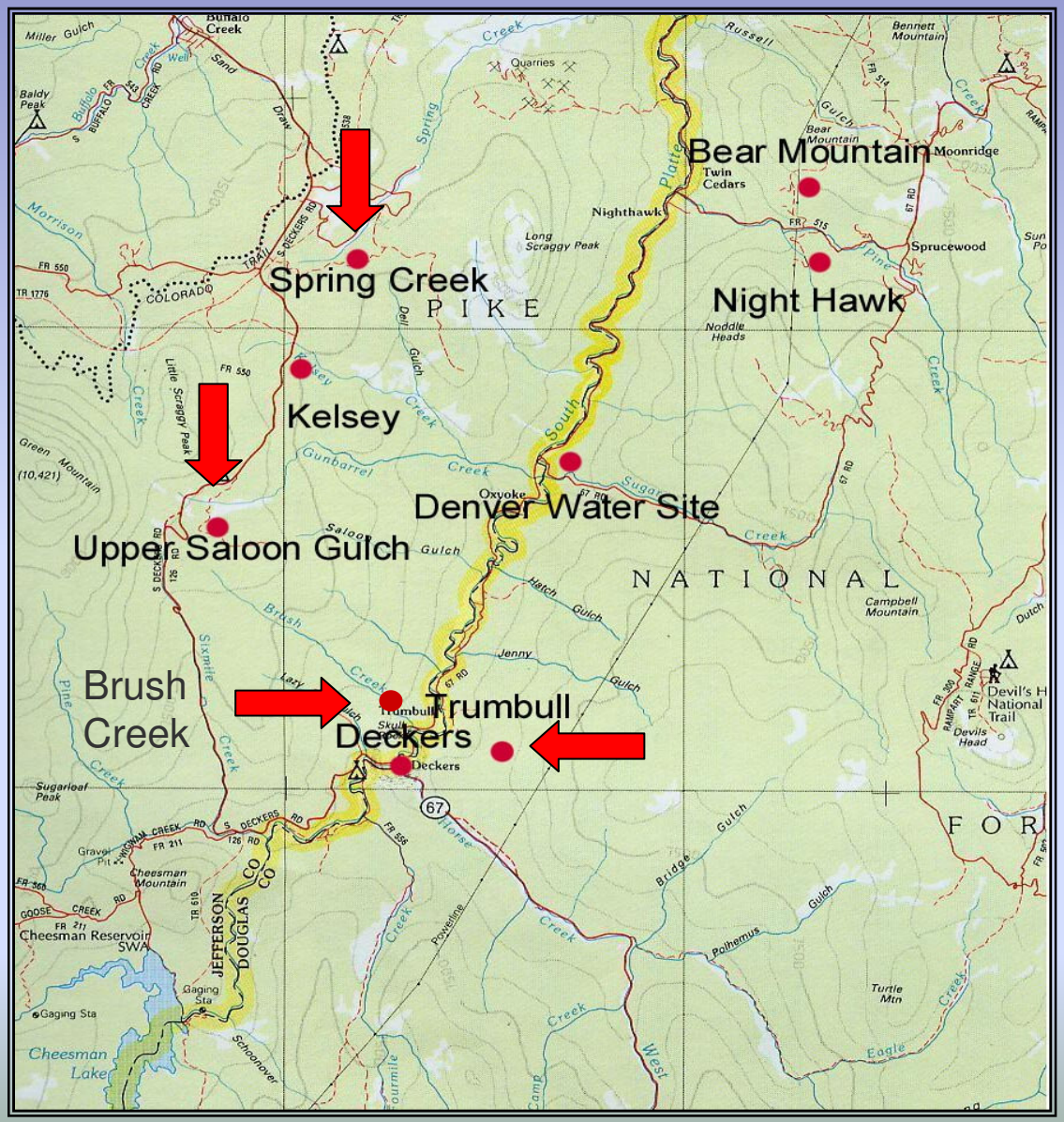
1. Monitor sediment production rates from thinned ("treated") and control swales;
2. Monitor sediment production rates from roads and assess the connectivity of roads to t he stream network;
3. Relate sediment production rates to precipitation and site characteristics.

Objectives: Watershed Scale

1. Monitor the effects of thinning on runoff in two small watersheds;

2. Monitor the effects of thinning on water quality and channel morphology in four small watersheds.

Initial Study Sites



Methods: Hillslope scale

- Monitor sediment production from paired swales;
  - 11 pairs in Upper Saloon Gulch;
  - 8 pairs in Trumbull.
- Monitor sediment production from road segments;
  - 5 segments in Upper Saloon Gulch;
  - 8 segments in Spring Creek;
  - 3 segments in Trumbull.
- Measure key site characteristics (e.g., contributing area, slope, and percent cover);
- Six recording rain gauges.


Sediment Fence in Swale: Upper Saloon Gulch

Sediment fence for a road segment: Spring Creek

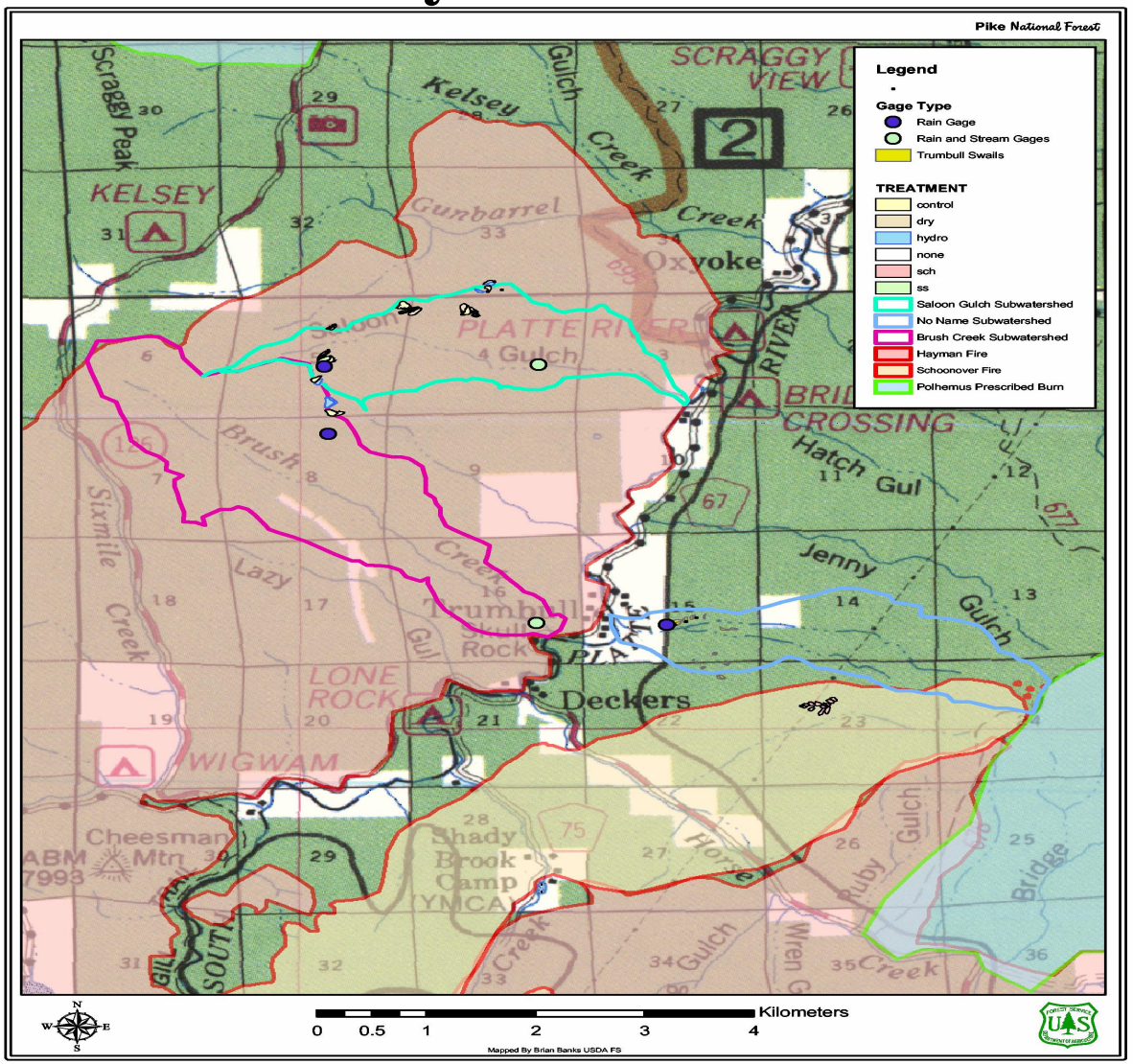
Methods: Watershed Scale

- Continuous monitoring of runoff by installing H-flumes on Saloon Gulch ("treated") and Brush Creek ("control");
- Annual monitoring of channel characteristics on streams draining Trumbull, Saloon Gulch, and Spring Creek;
- Periodic monitoring of discharge and water quality on Trumbull, Saloon Gulch, Spring Creek, and Brush Creek;

Initial Results: Hillslope Scale

- Paired swales: 2001
  - No sediment was produced from any of the 22 swales in Upper Saloon Gulch;
  - Only 3 of 20 swales in Trumbull area produced sediment.
- Roads: 2001-2002
  - 16 of 20 road segments produced sediment in 2001; mean erosion rate was 1.5 kg m^{-2};
  - 13 of 20 road segments produced sediment in 2002; mean erosion rate was 0.8 kg m^{-2}.

Areas burned by the Schoonover and Hayman fires, May-June 2002

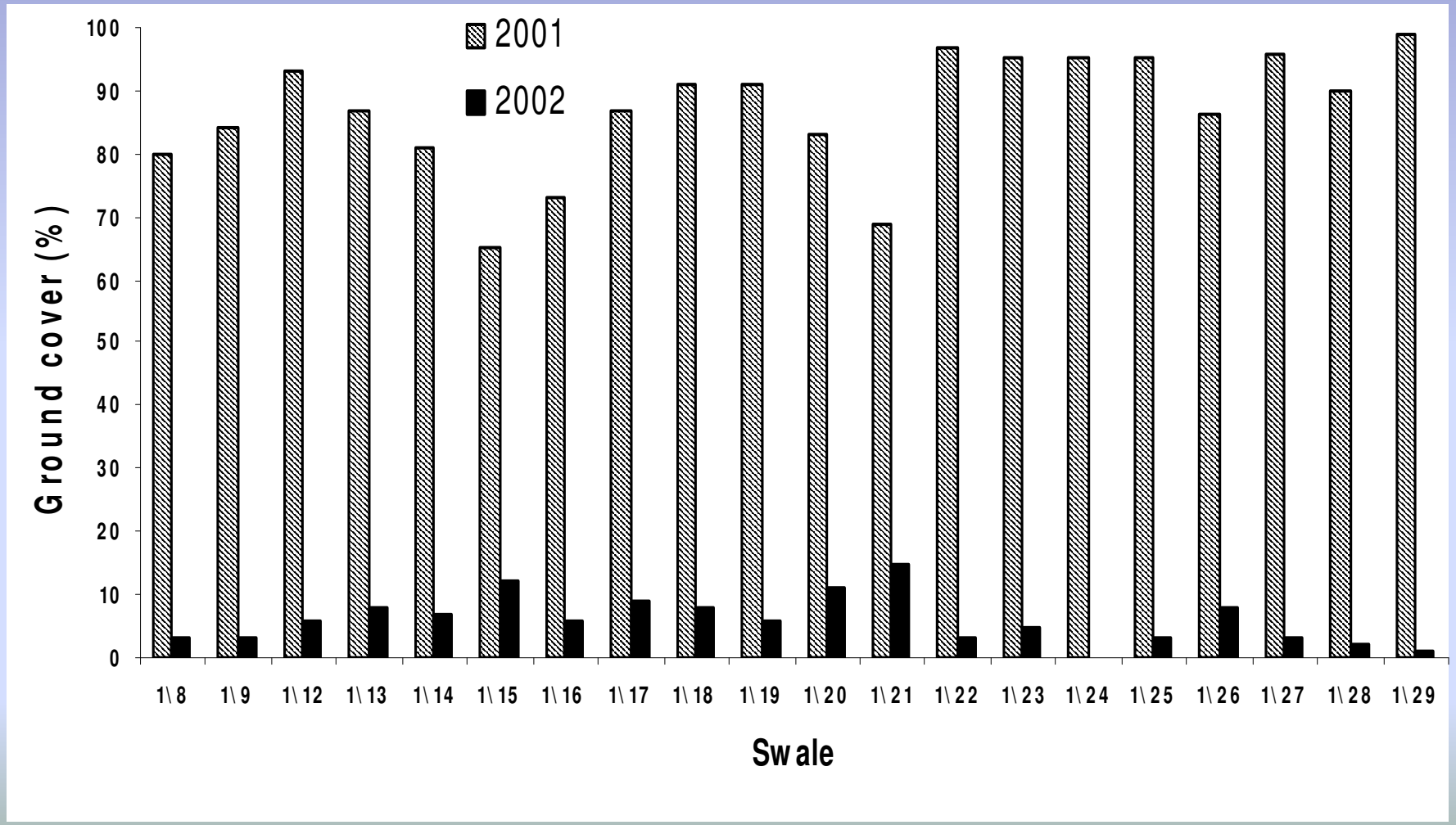


Effects of Hayman Fire on Study Sites

- Majority of Saloon Gulch and Brush Creek catchments were burned;
- Trumbull and Spring Creek areas were not burned;
- Efforts temporary focused on measuring sediment production from the burned sites, and effectiveness of the rehabilitation techniques;
- Unique opportunity to compare pre- and post-fire conditions.

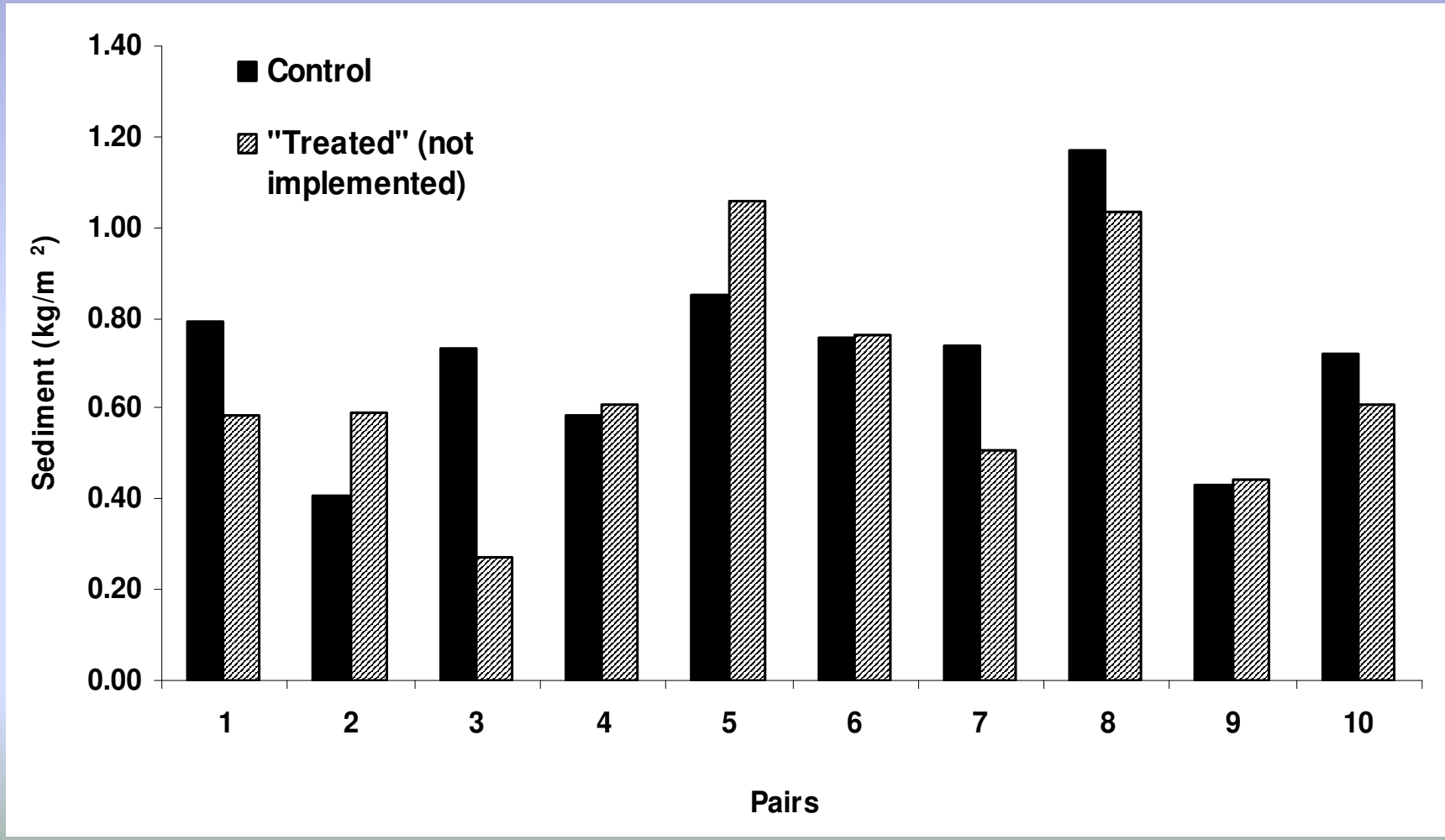

Formerly unchannelled swale: Upper Saloon Gulch

Mean percent ground cover in Upper Saloon Gulch in 2001 (prior to burning) and 2002 (after the Hayman fire)

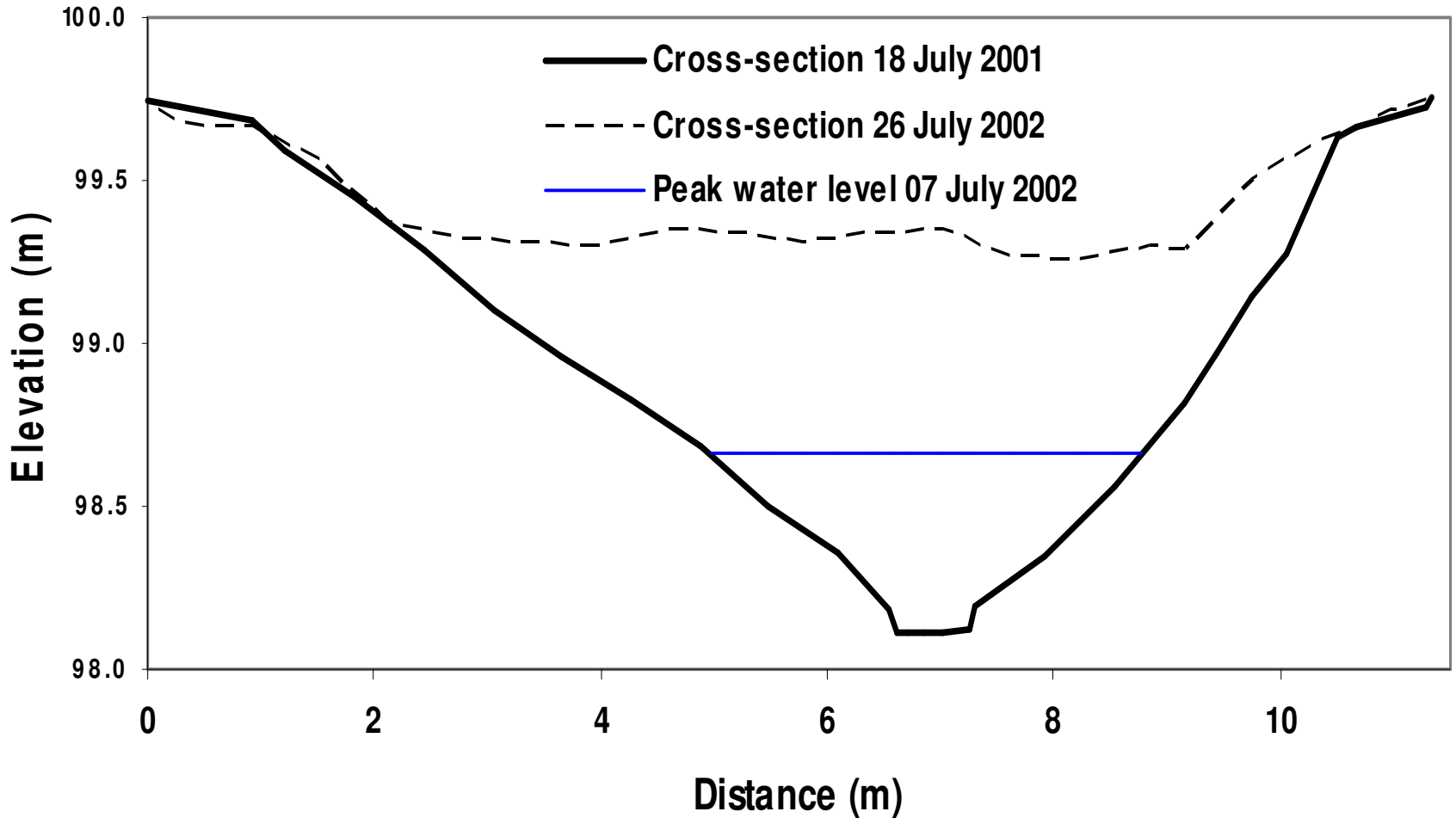



Sediment collected from an 11-mm Storm

Sediment production from paired swales in Upper Saloon Gulch: 21 July 2002 storm (11 mm in 45 minutes)



Channel cross-section in Saloon Gulch in 2001 and 2002 after the Hayman fire



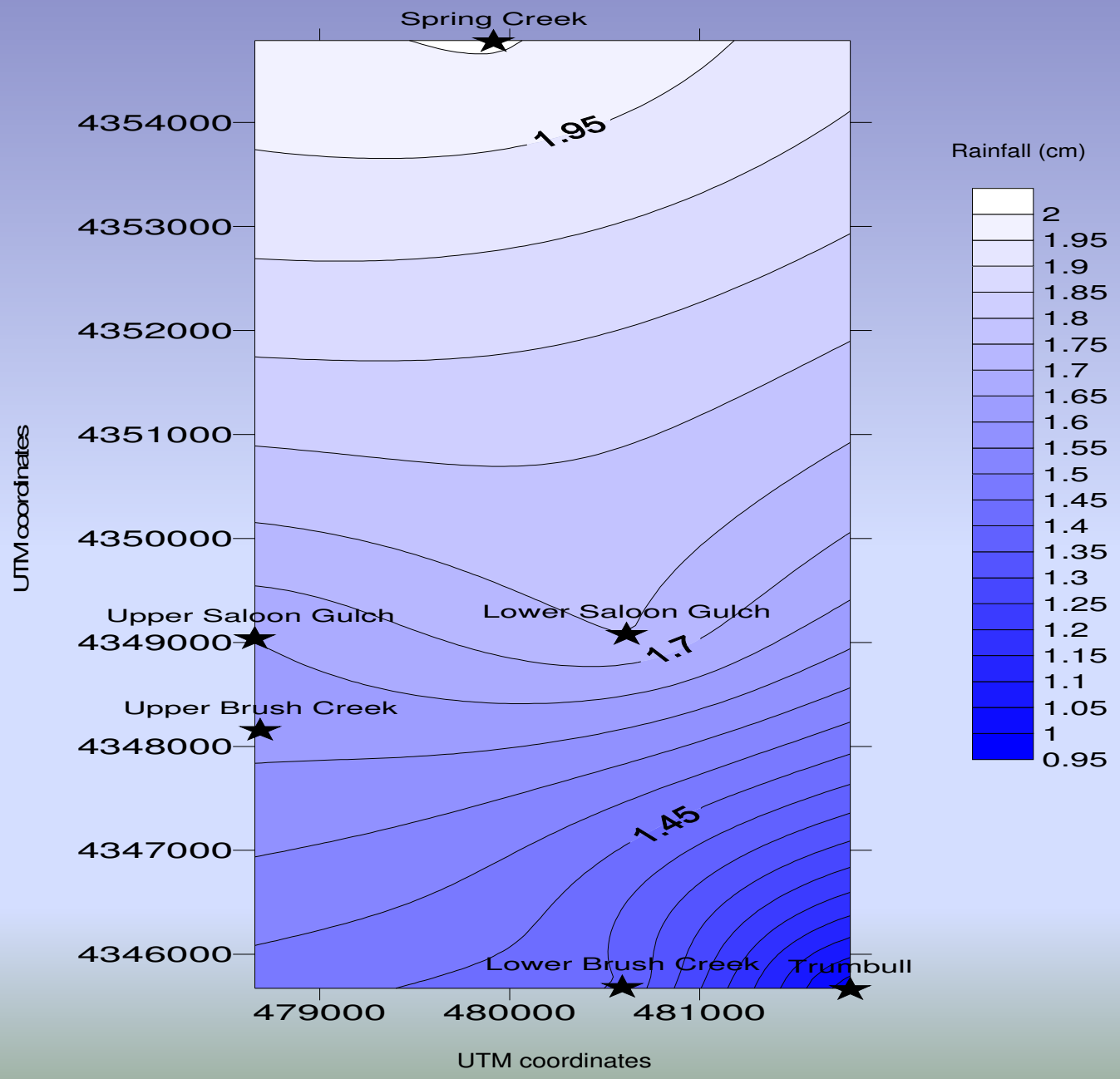
Objectives: 2003

- Hillslope Scale:
  - Continue monitoring sediment production from thinned (“treated”) and control swales in Trumbull;
  - Continue monitoring sediment production from roads;
  - Establish new sites to monitor the effects of forest thinning on sediment production rates;
  - Establish new sites to monitor sediment production rates from the roads in areas to be thinned.

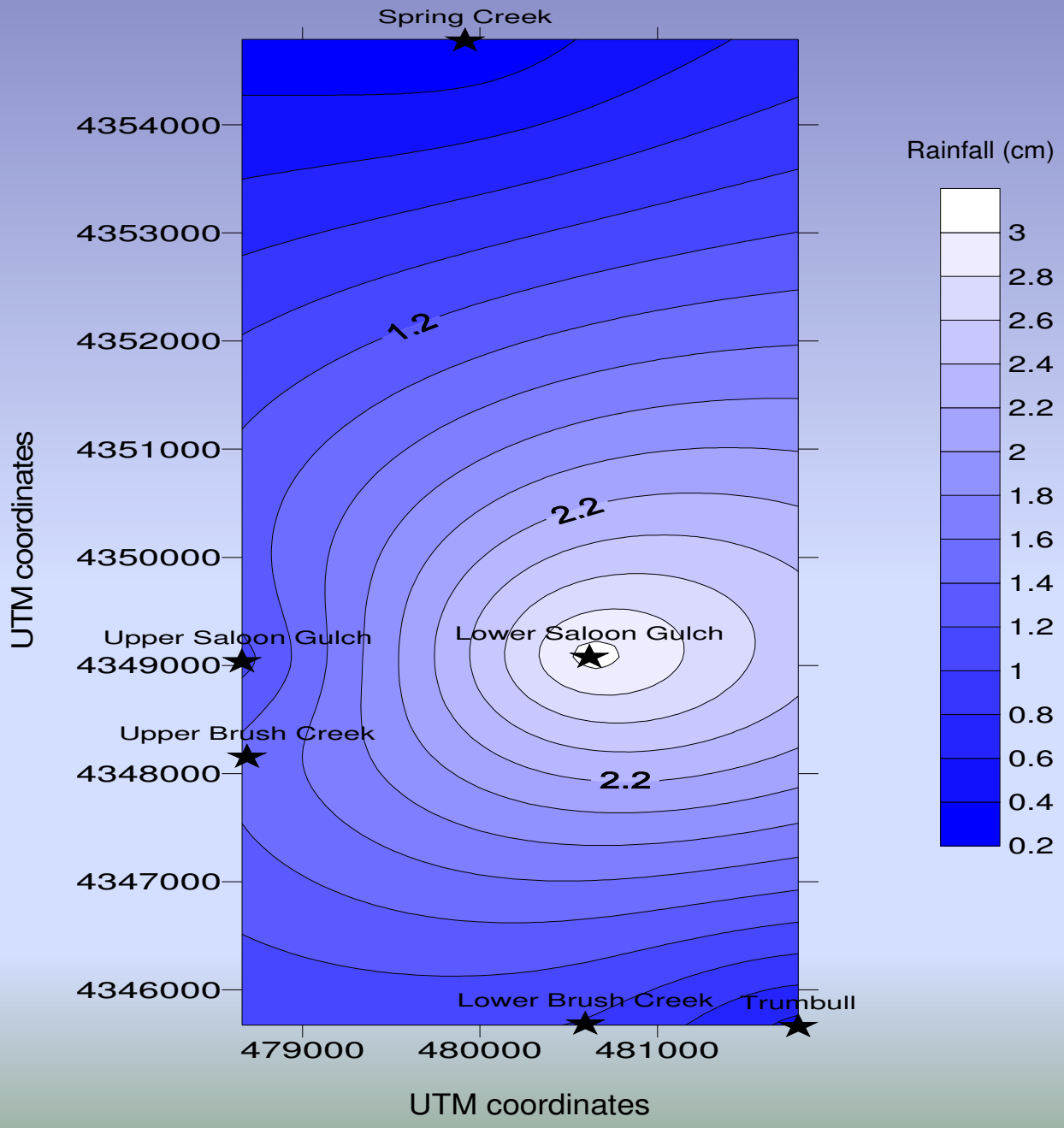
Precipitation

- Variable over the study area;
- Amount of erosion depends on the intensity and magnitude of the precipitation events;
- Mean monthly rainfall in 2002 and 2003 was below the long-term mean for the area;

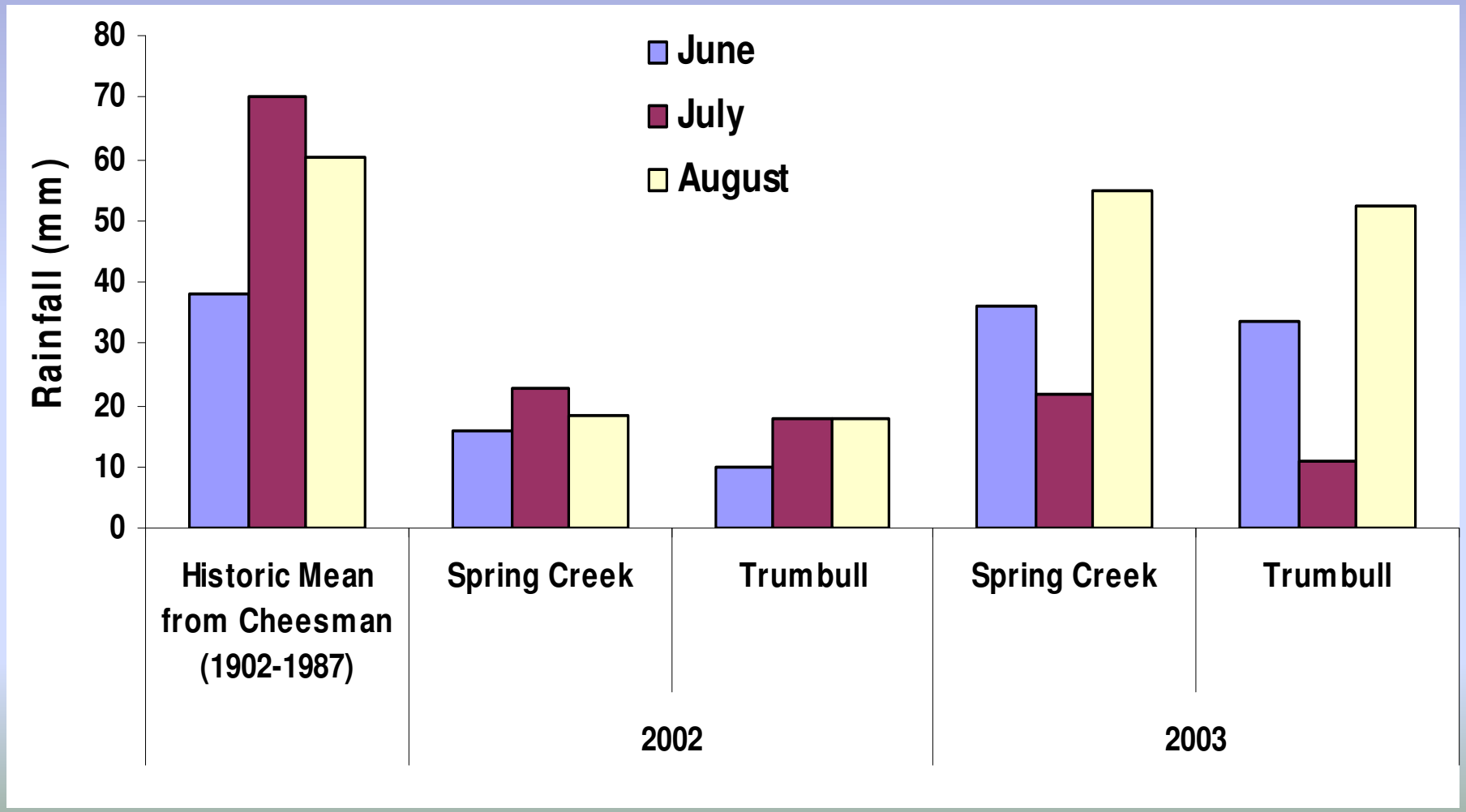
Rainfall for storm on 06 July 2002

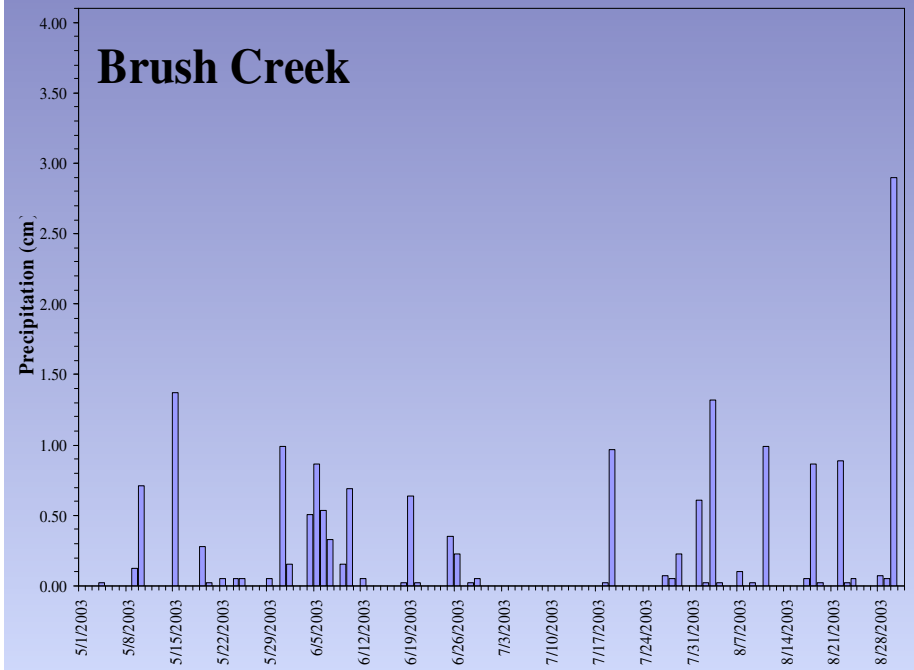


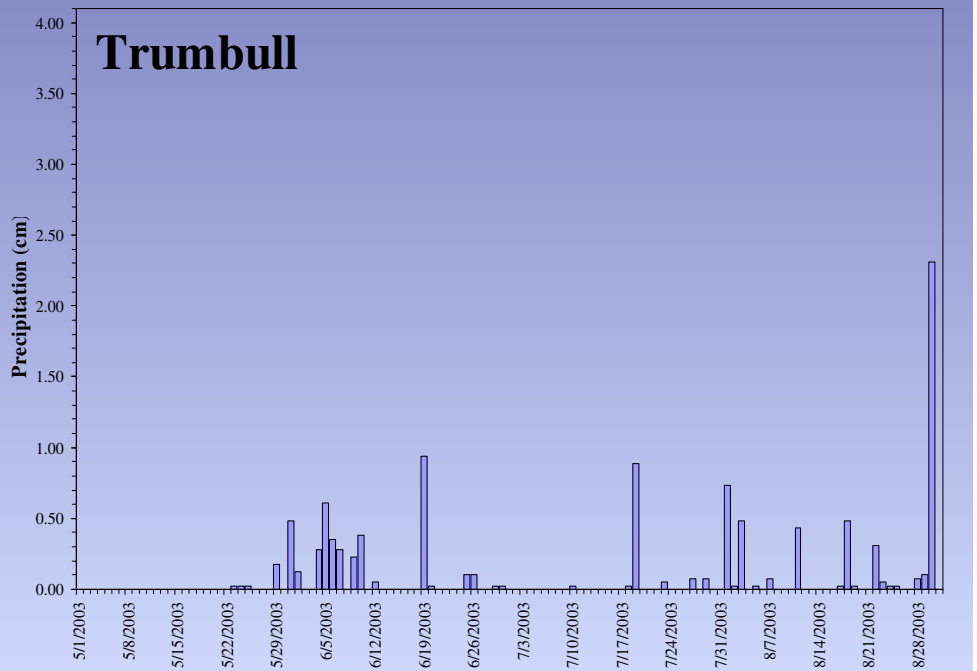
Rainfall for storm on 21 July 2002



Monthly rainfall in summer 2002 and 2003 vs. long-term mean at Cheeseman Reservoir




Brush Creek
Precipitation (cm)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
5/1/2003
5/8/2003
5/15/2003
5/22/2003
5/29/2003
6/5/2003
6/12/2003
6/19/2003
6/26/2003
7/3/2003
7/10/2003
7/17/2003
7/24/2003
7/31/2003
8/7/2003
8/14/2003
8/21/2003
8/28/2003


Trumbull
Precipitation (cm)
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5/22/2003
5/29/2003
6/5/2003
6/12/2003
6/19/2003
6/26/2003
7/3/2003
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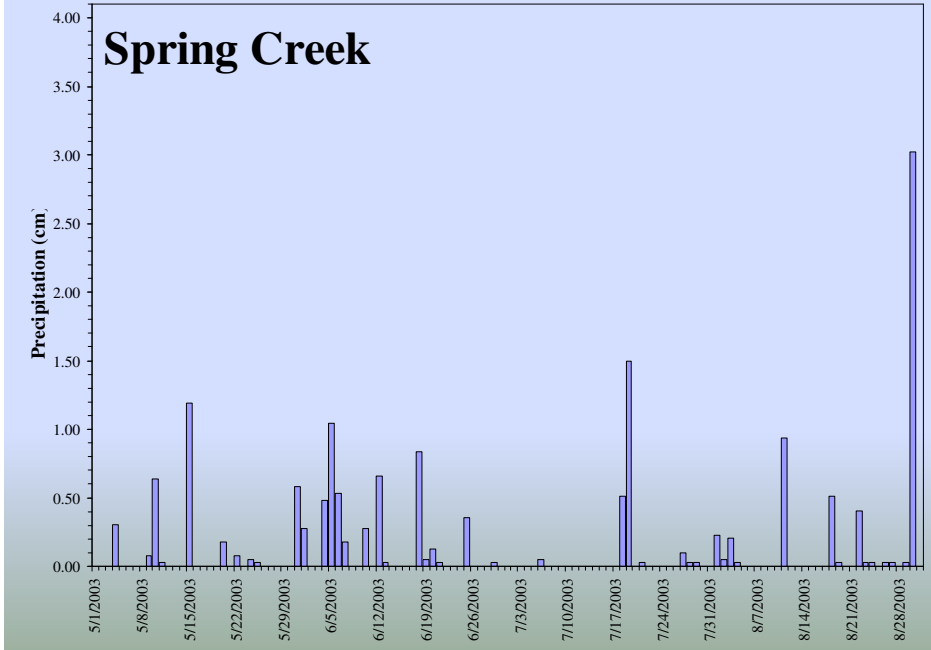
8/21/2003
8/28/2003


Spring Creek
Precipitation (cm)
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3.00
2.50
2.00
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6/5/2003
6/12/2003
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6/26/2003
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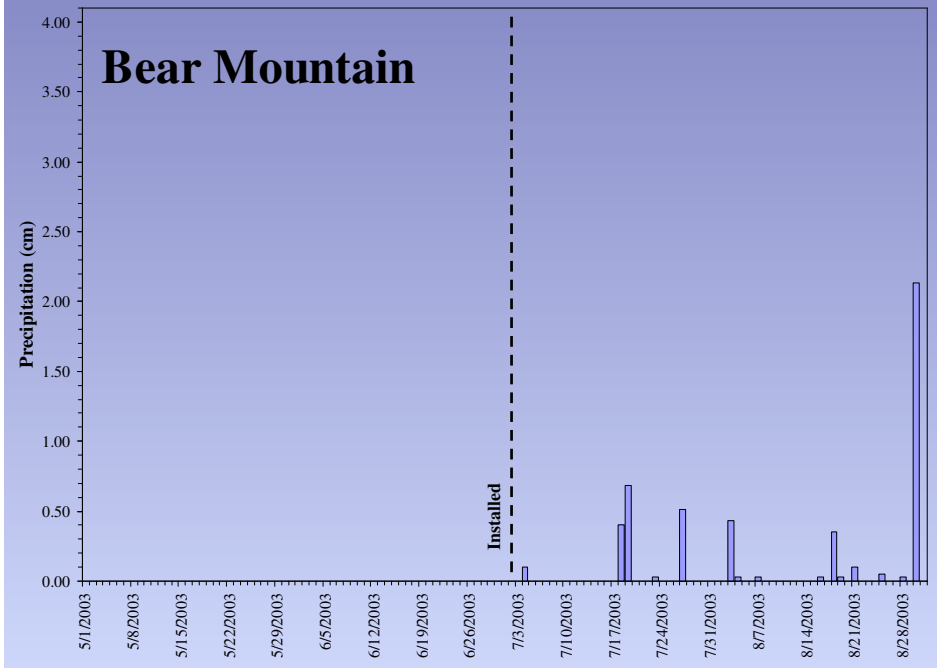
8/21/2003
8/28/2003


Bear Mountain
Precipitation (cm)
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3.00
2.50
2.00
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Installed
5/1/2003
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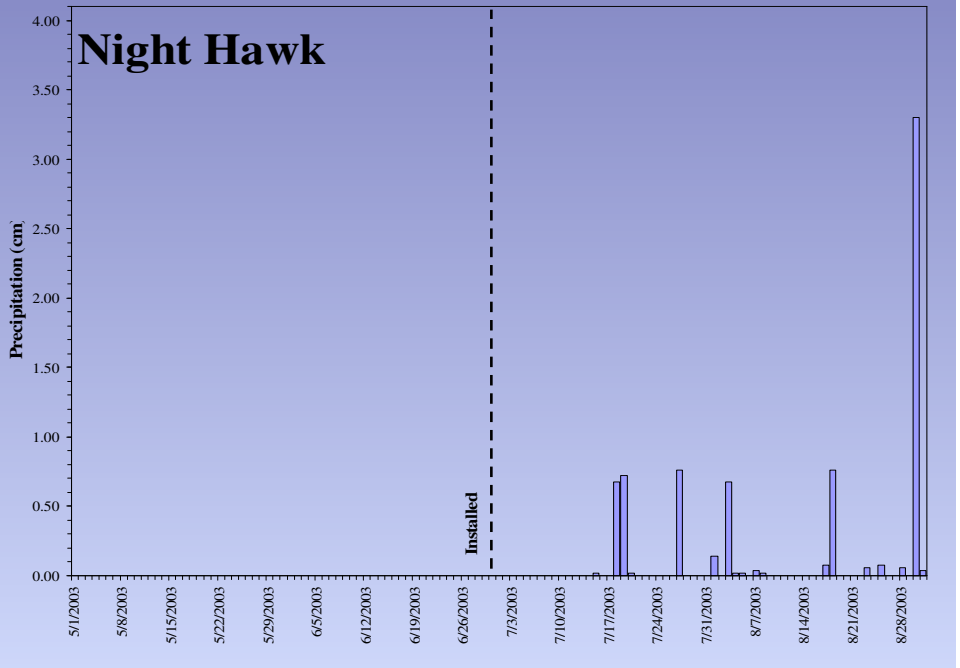
Night Hawk
Precipitation (cm)
4.00
3.50
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Installed
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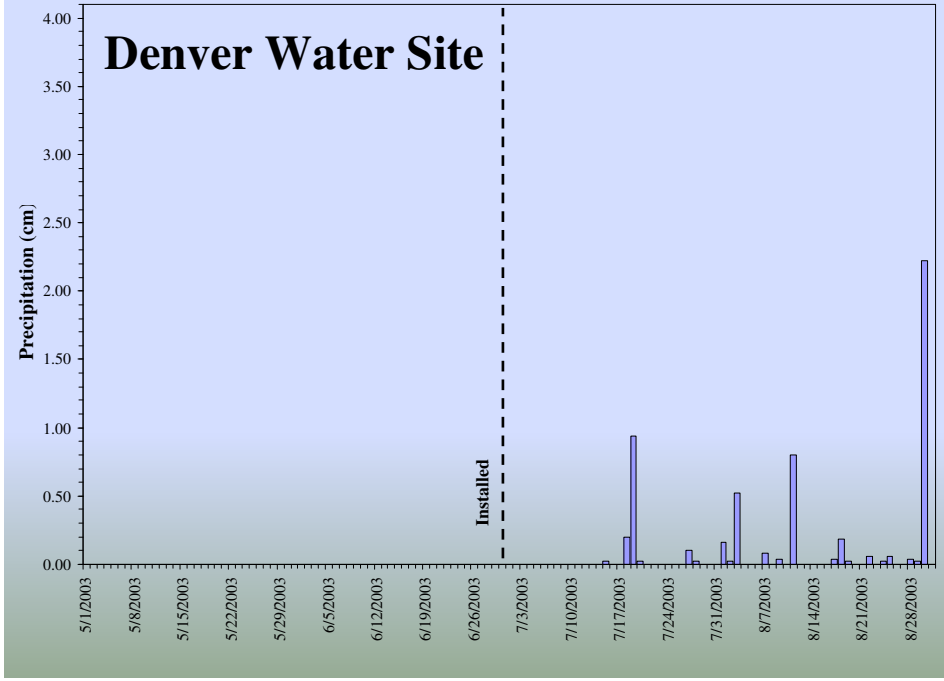
Denver Water Site
Precipitation (cm)
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3.00
2.50
2.00
1.50
1.00
0.50
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Installed
5/1/2003
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5/22/2003
5/29/2003
6/5/2003
6/12/2003
6/19/2003
6/26/2003
7/3/2003
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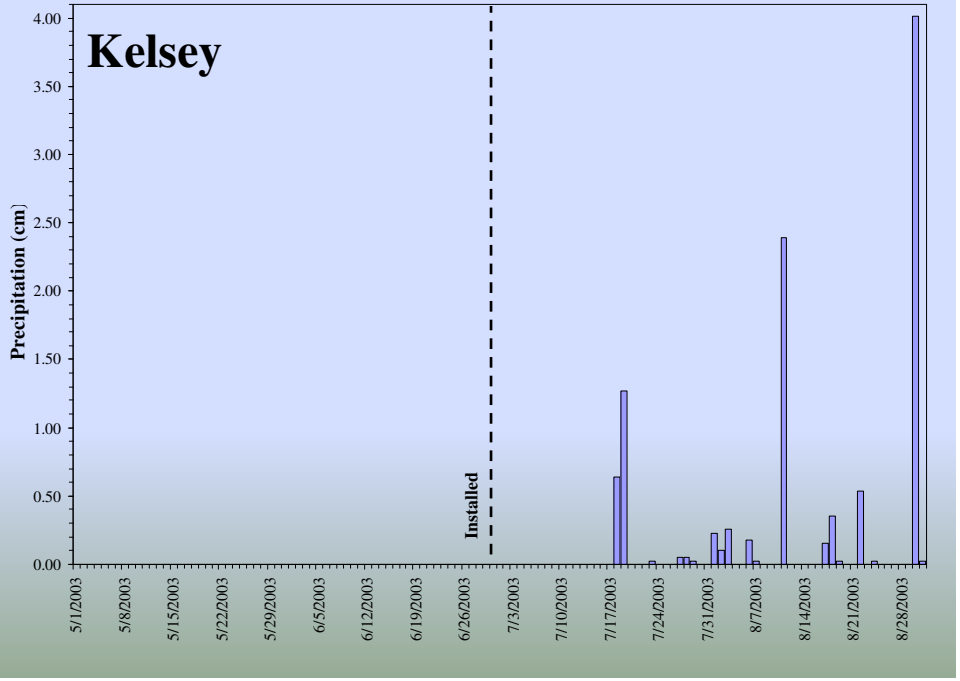
8/21/2003
8/28/2003


Kelsey
Precipitation (cm)
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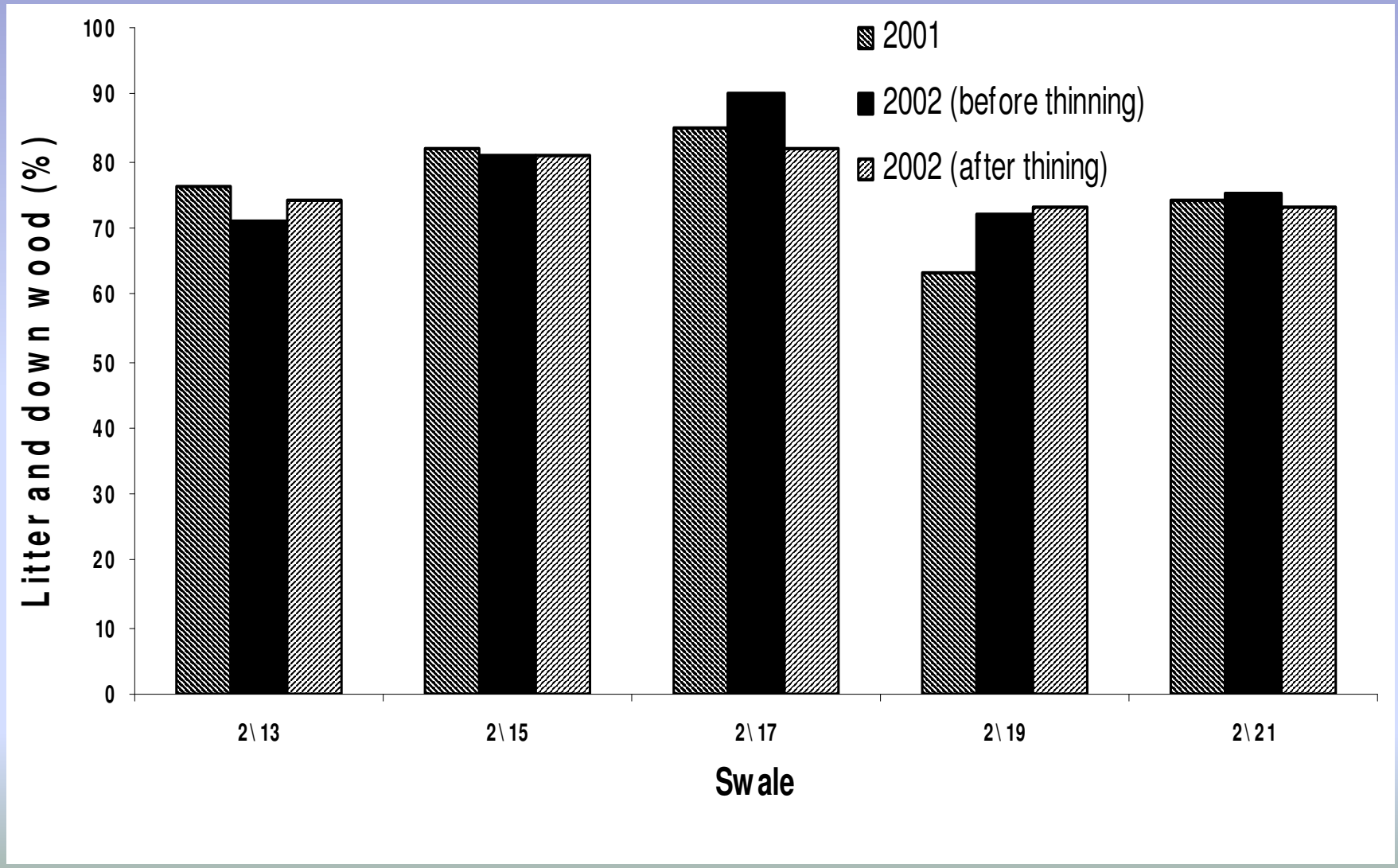
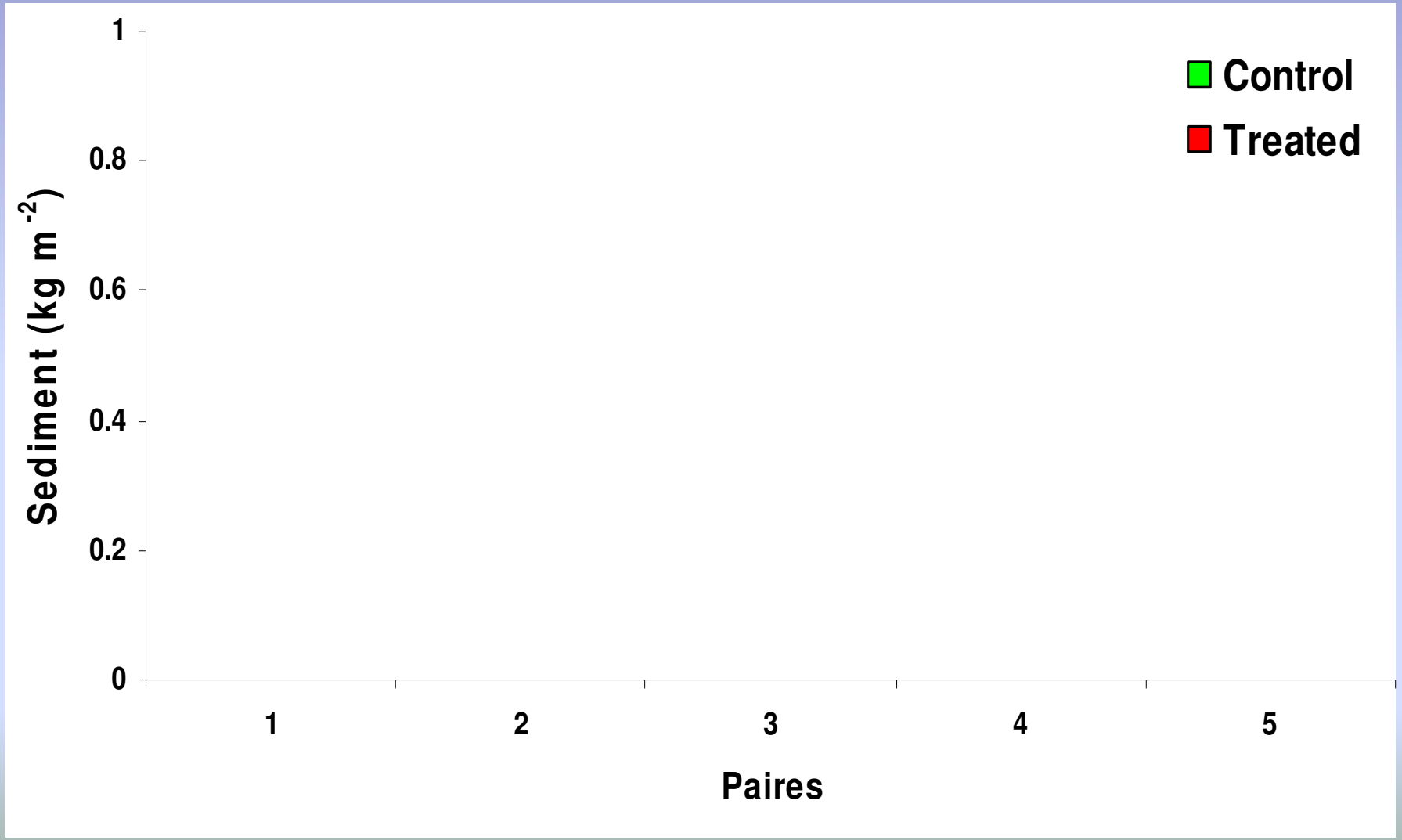
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Installed
5/1/2003
5/8/2003
5/15/2003
5/22/2003
5/29/2003
6/5/2003
6/12/2003
6/19/2003
6/26/2003
7/3/2003
7/10/2003
7/17/2003
7/24/2003
7/31/2003
8/7/2003
8/14/2003
8/21/2003
8/28/2003

Swale in Trumbull after Thinning

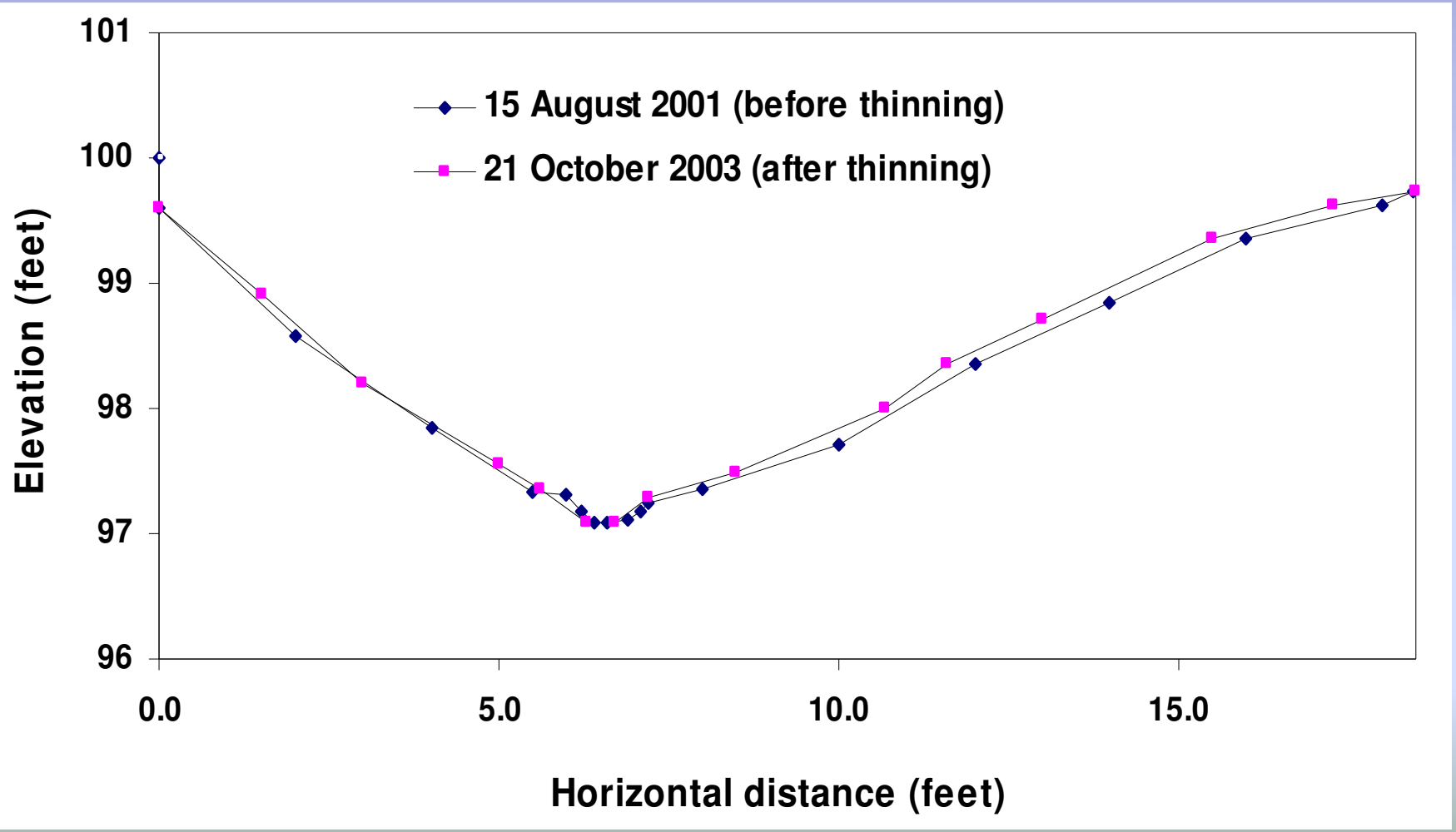
Percent litter and downed wood before and after thinning



Sediment production from paired swales in Trumbull: 2003



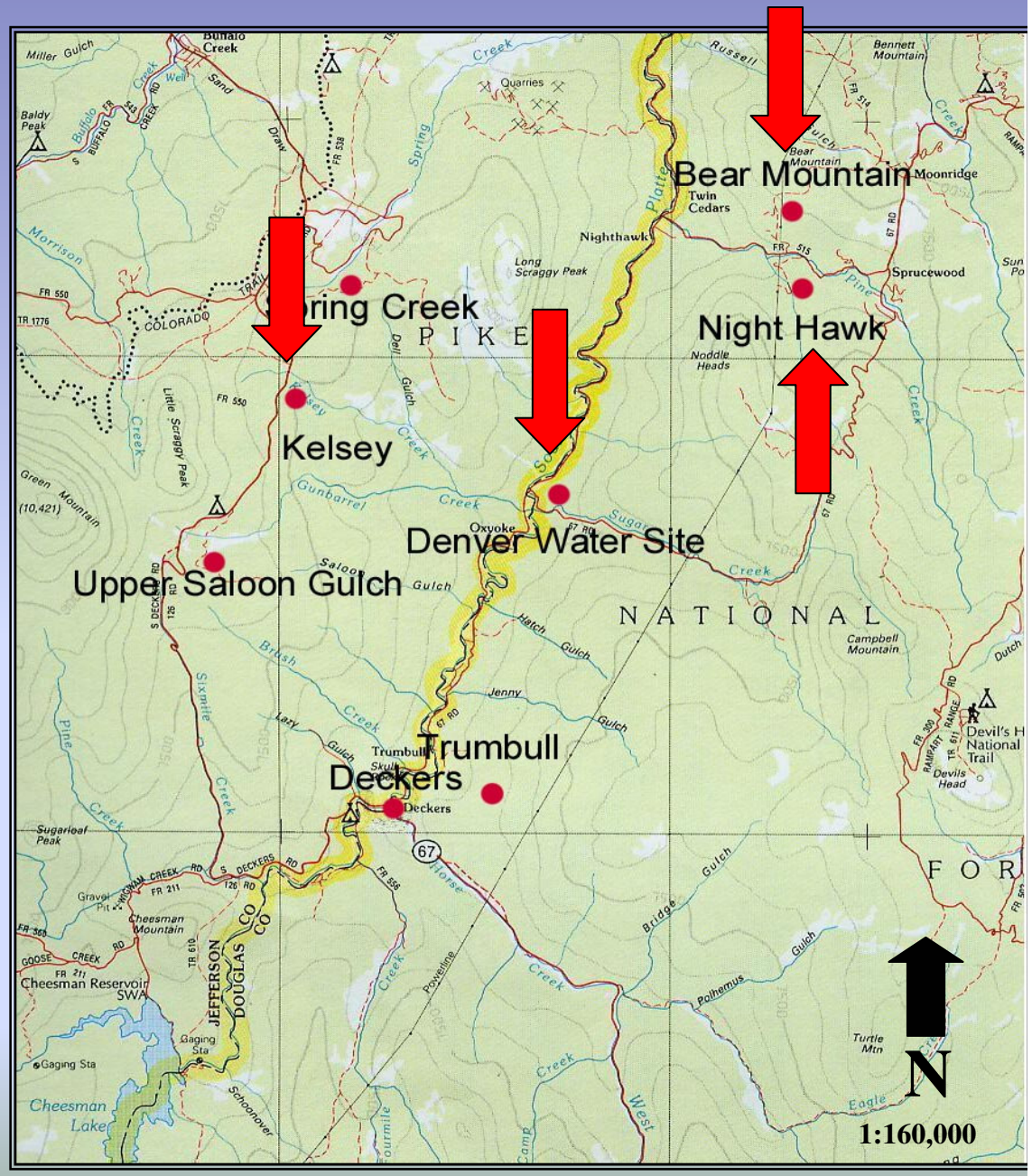
Channel cross-section in Trumbull in 2001 (before thinning) and 2003 (after thinning)



New Sites: 2003

- Denver Water;
- Bear Mountain;
- Kelsey;
- Night Hawk.

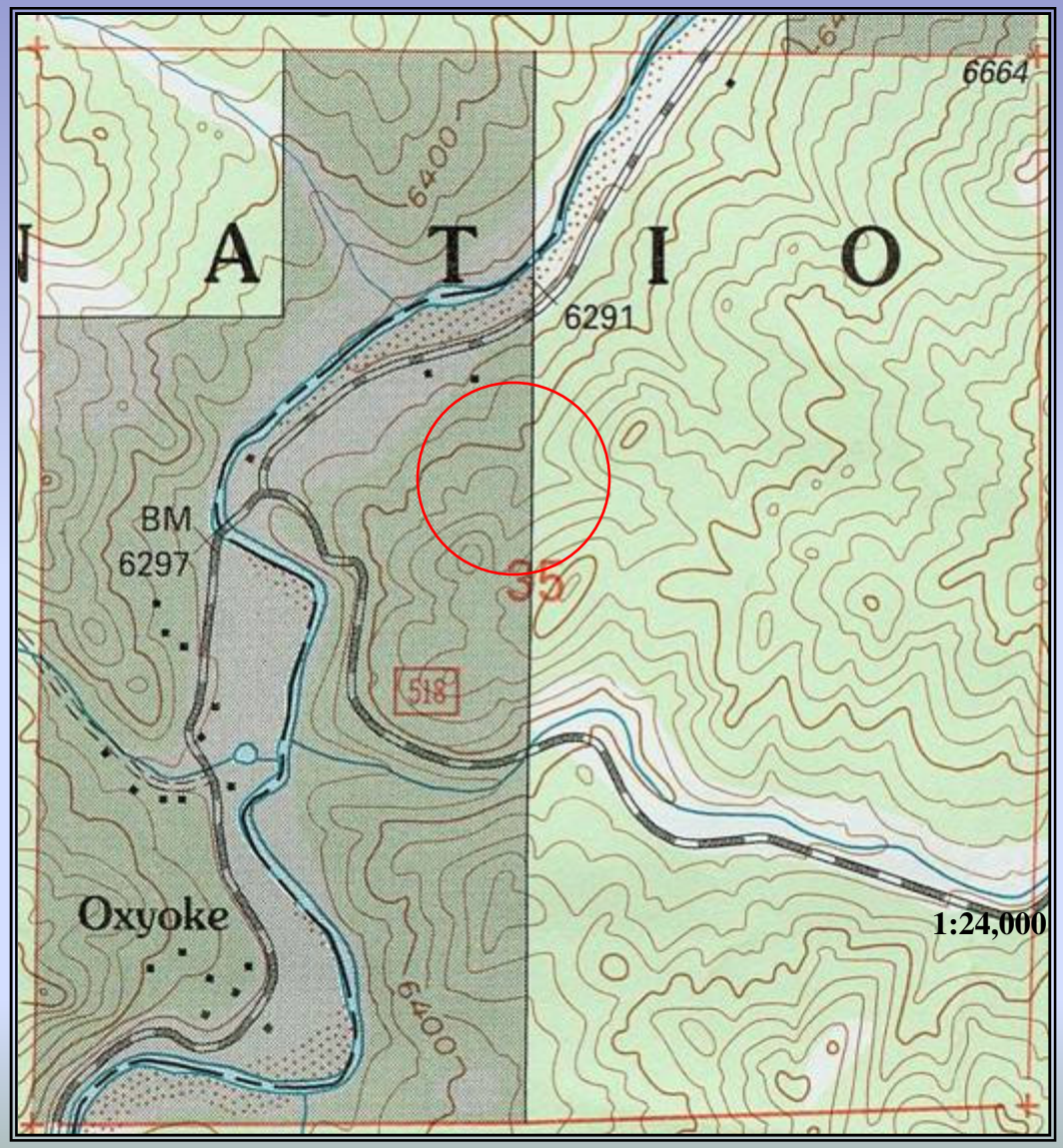
Site	Pairs of Swales	Road Segments
Denver Water	3	1
Bear Mountain	5	0
Kelsey	4	2
Night Hawk	0	3



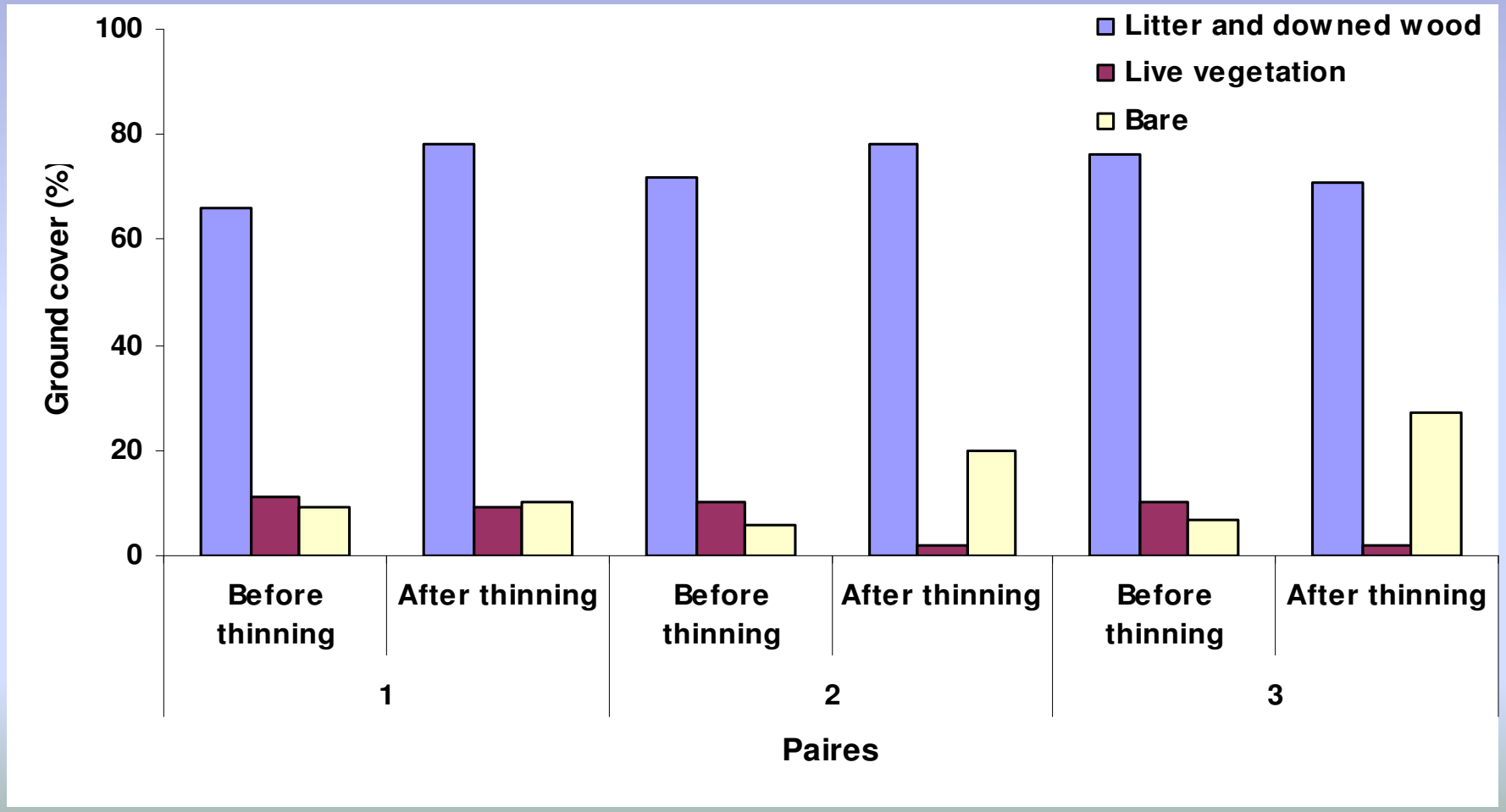
Denver Water Site

- 50-60% slopes;
- Three paired swales established in April 2003;
- Three treated swales thinned by Hydro-Axe in late April 2003.

Swale	Area (m^2)	% Disturbed
#2	2035	51
#4	888	41
#5	1149	38



Percent Cover Before and After Thinning: Paired Swales, Denver Water Site

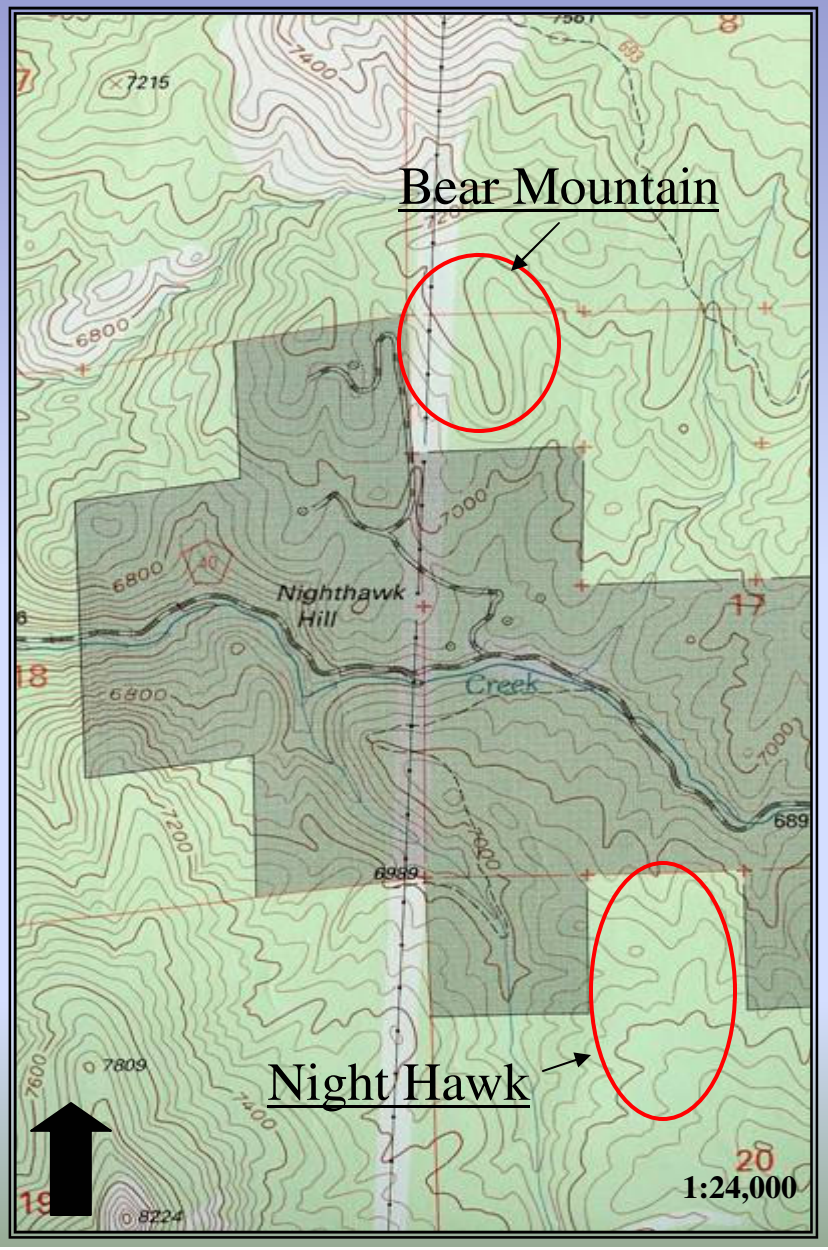


Results from Denver Water Site: 2003

- None of the paired swales produced any sediment;
- Fence installed at confluence of four treated swales also captured no sediment;
- Fence on steep, highly-disturbed track produced 0.01 kg m^{-2} and 0.07 kg m^{-2} from 5.2 mm and 15.2 mm rainstorms, respectively.

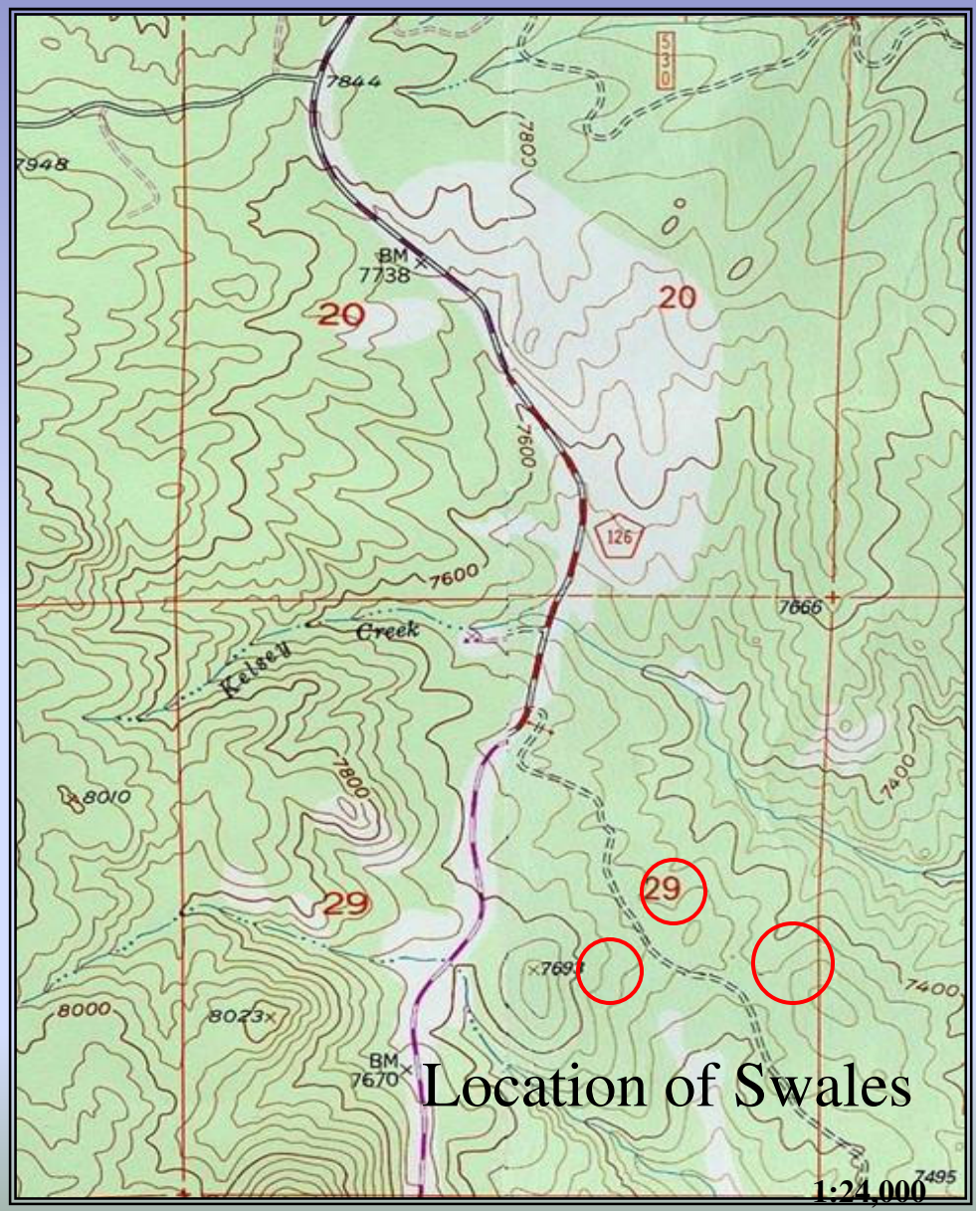
Bear Mountain and Night Hawk Sites

- Bear Mountain:
  - 5 paired swales established in June 2003;
  - 5 swales thinned in December 2003 by Hydro-Axe;
- Night Hawk site:
  - 3 road fences installed in summer 2003;
  - Has not been thinned;
- Rain gauges installed at both sites in summer 2003.



Kelsey Site

- 4 paired swales established in June 2003;
- Scheduled for thinning early in 2004;
- 2 road fences installed in June 2003;
- One rain gauge installed in early summer 2003.

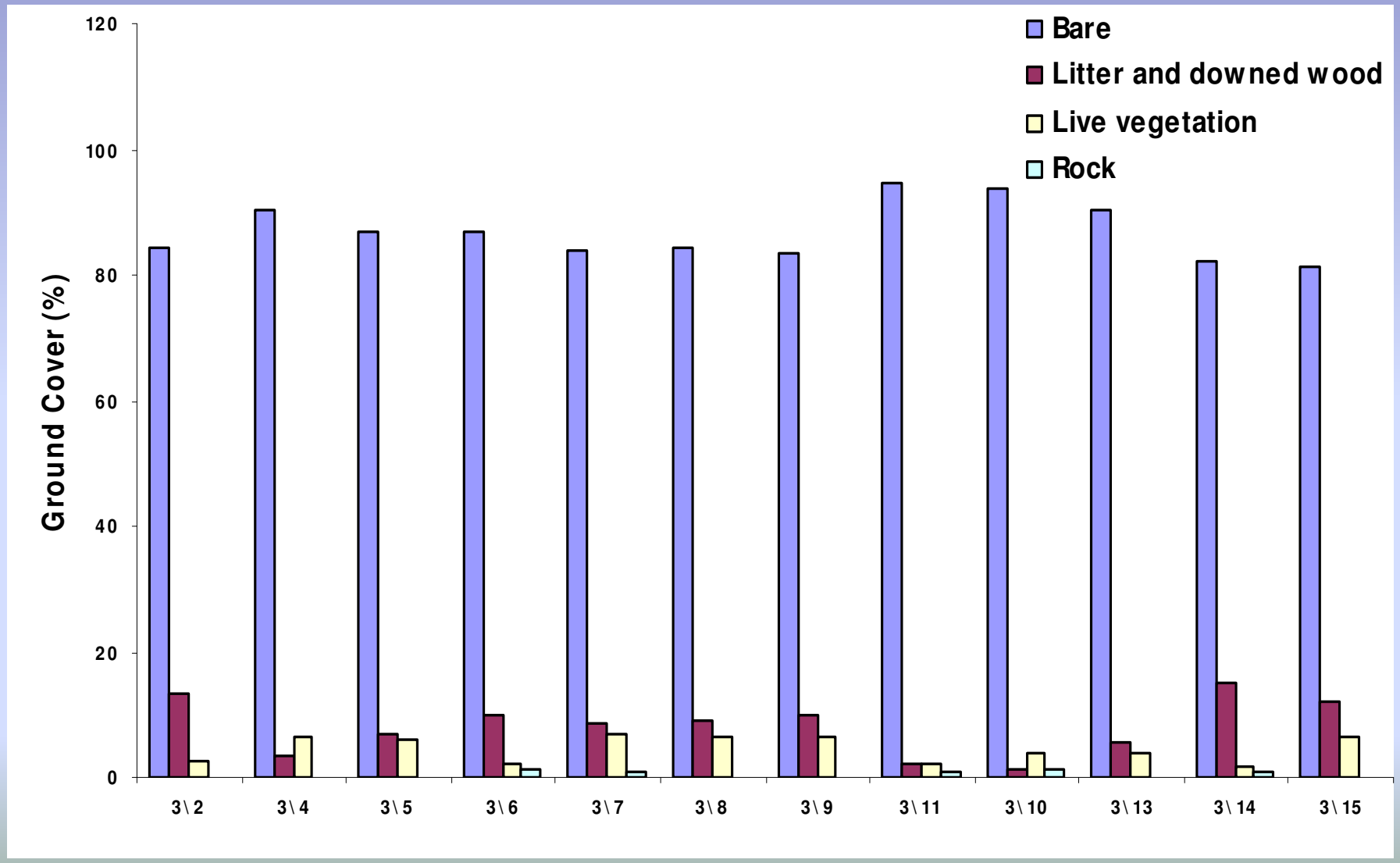


Location of Swales

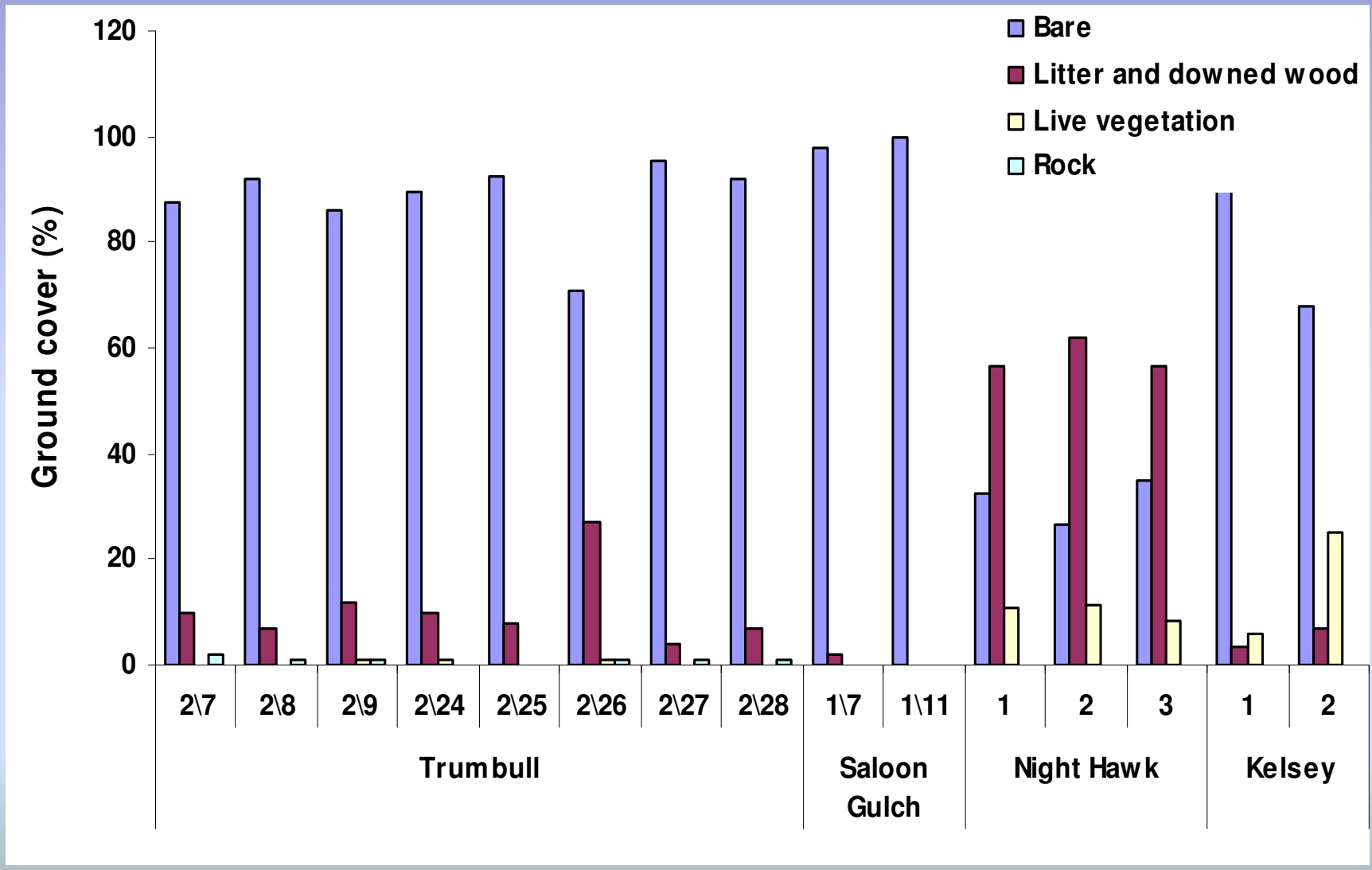
Summary of sediment production from paired swales: 2003

Site	Number of paired swales	Number of fences that produced sediment	Mean erosion rate (kg m^{-2})
Bear Mountain	5	0	0
Denver Water	3	0	0
Kelsey	4	0	0
Night Hawk	0	0	0
Spring Creek	1	0	0
Trumbull	8	0	0
Upper Saloon	0	0	0

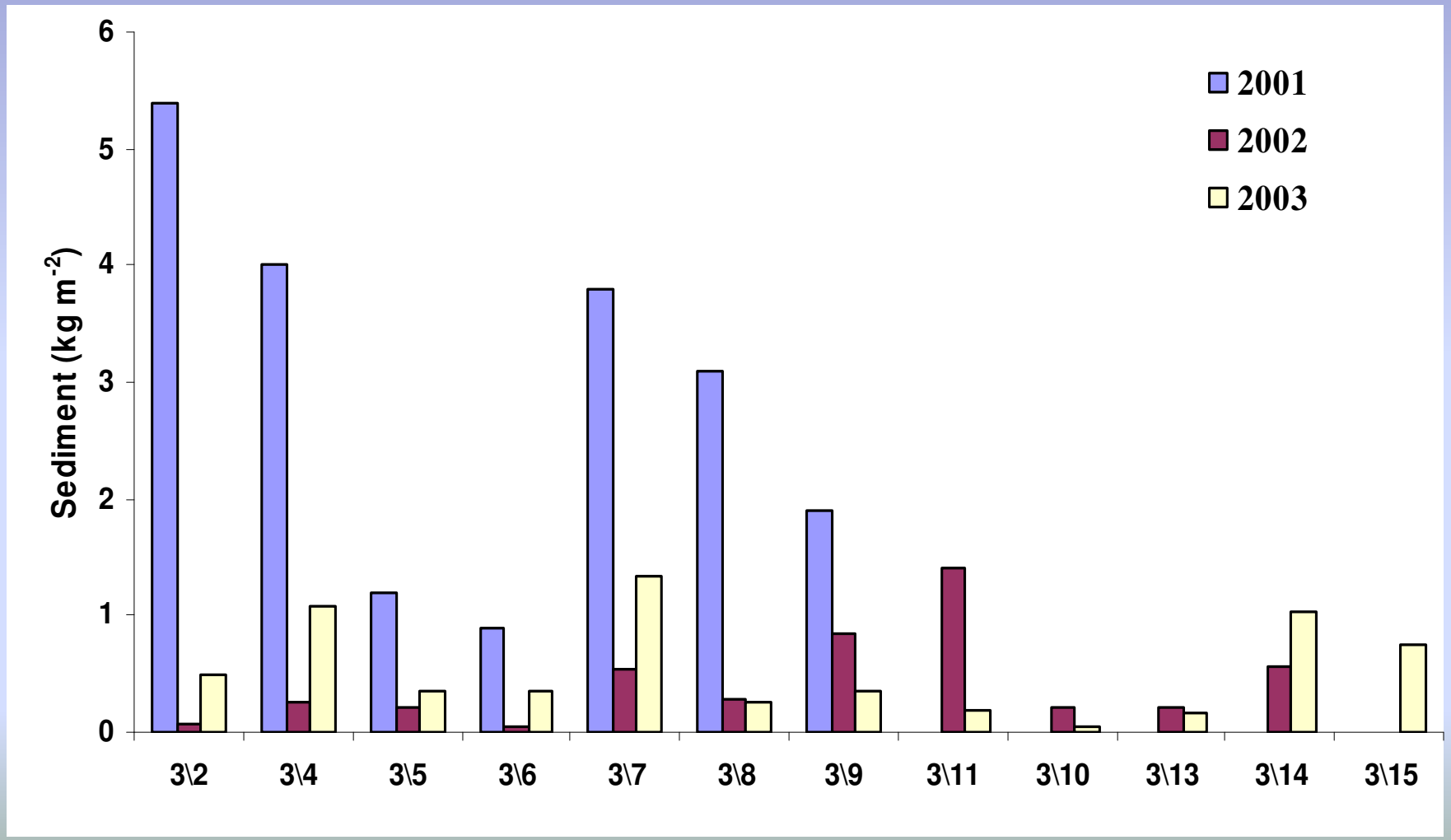
Percent cover on road segments: Spring Creek 2003



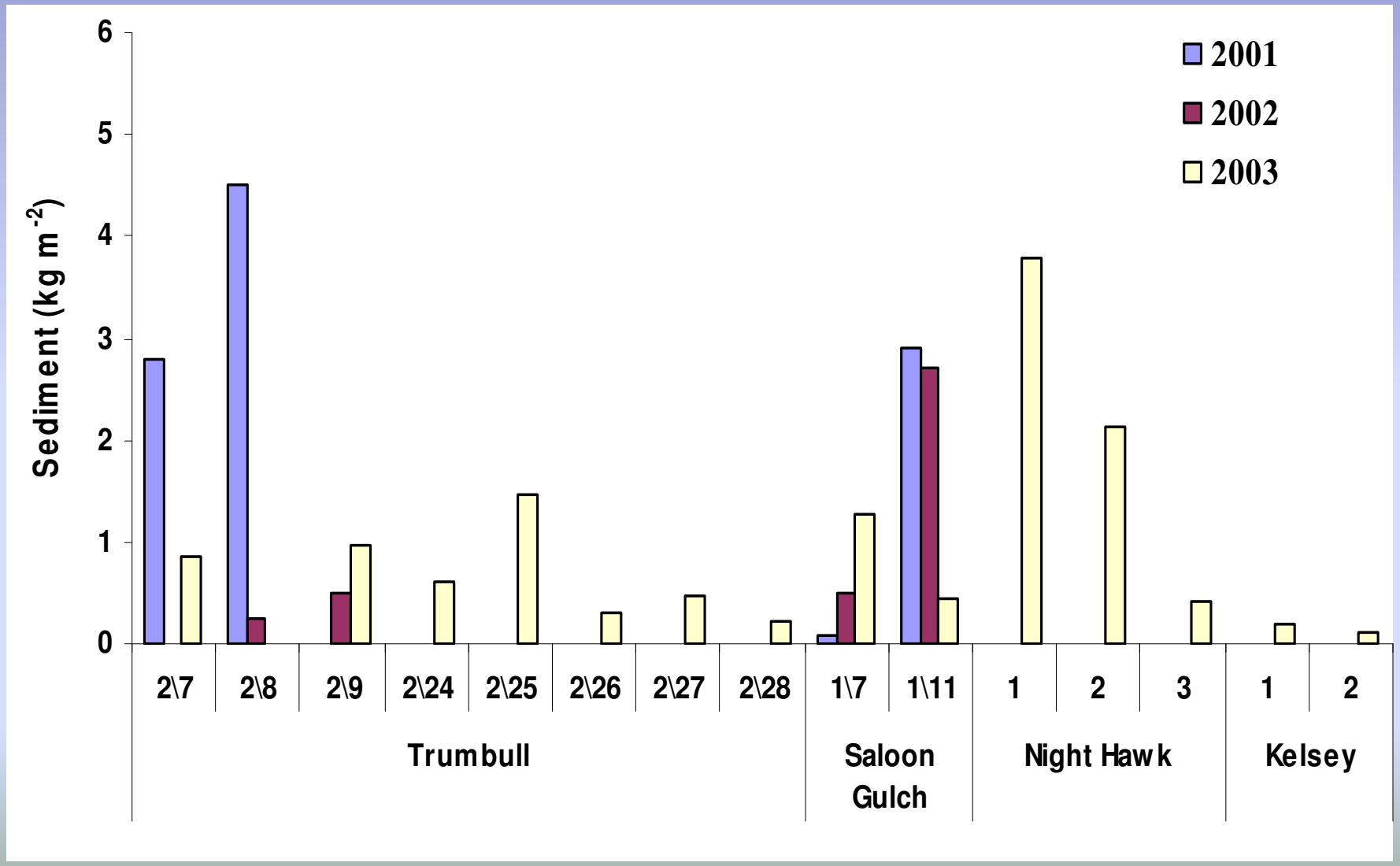
Percent cover on road segments: Summer 2003



Sediment production rates from road segments in Spring Creek, 2001-2003



Sediment production rates from road segments in other sites, 2001-2003



Summary of sediment production from road segments: 2003

Site	Number of road fences	Number of fences that produced sediment	Mean erosion rate (kg m^{-2})
Spring Creek	13	13	0.54
Trumbull	4	4	0.58
Upper Saloon	2	2	0.86
Denver Water	1	1	0.08
Kelsey	2	2	0.16
Night Hawk	3	3	2.11

Road Connectivity Classes

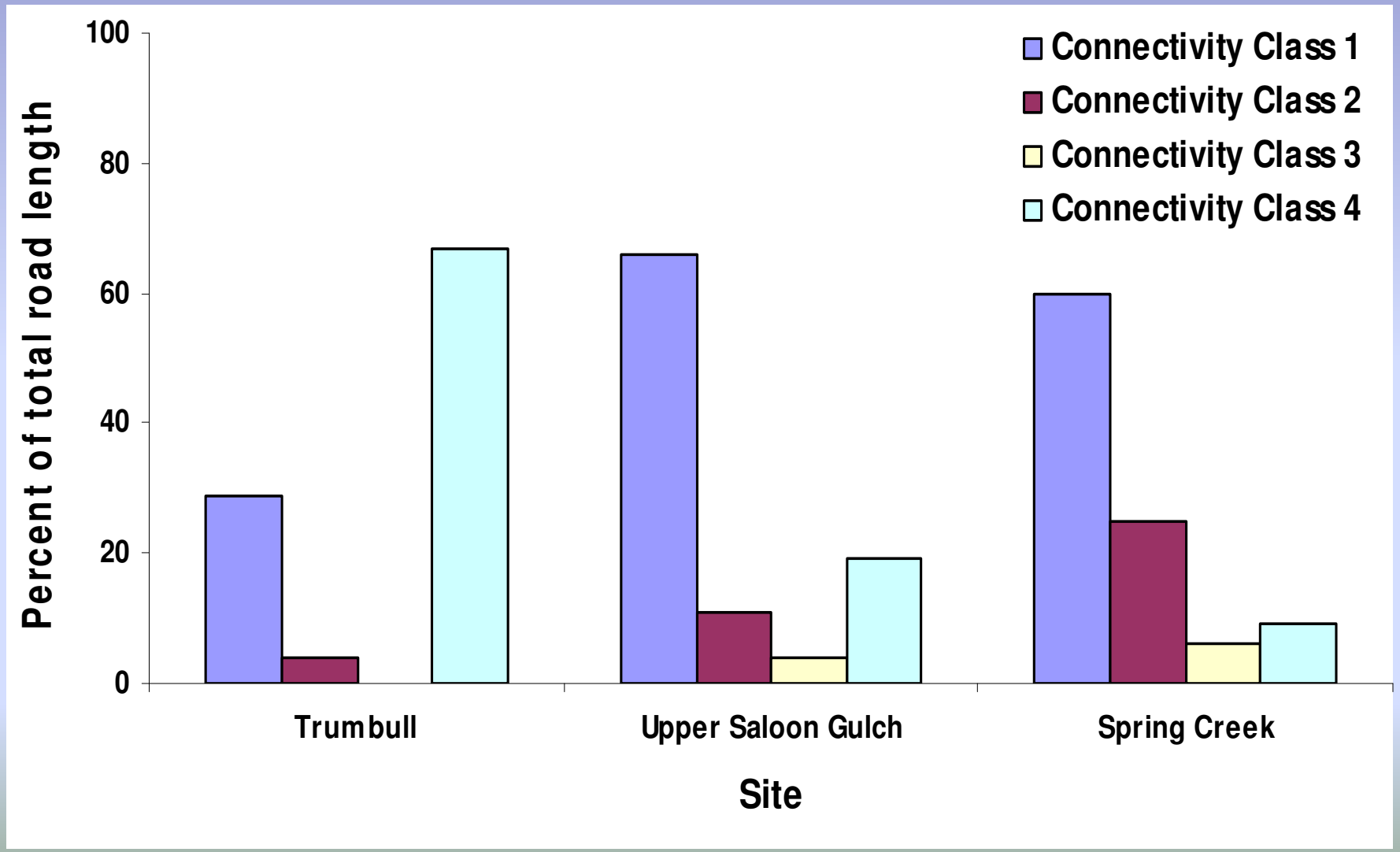
(1) No sign of concentrated flow below the drainage outlet;

(2) Concentrated flow present but extends for less than 20 m;

(3) Concentrated flow extends for more than 20 m but stops more than 10 m from the edge of a stream;

(4) A continuous rill or sediment plume to a stream channel.

Road connectivity in three study sites



Tasks for 2004: Continue Existing Sites

- Continue monitoring sediment production and percent cover for 30 paired swales and 3 single fences;
- Continuing monitoring sediment production, percent cover, and drainage characteristics for 29 road segments;
- Assess road connectivity in new sites;
- Continue monitoring channel characteristics in burned and unburned catchments;
- Pray for large storm events.

Tasks for 2004: Possible New Work

Consider evaluating the effects of forest thinning on:

(1) Soil moisture;

(2) Soil nitrogen.

Effects of Thinning on Soil Moisture

- Soil moisture affected by reduced interception, change in root water uptake, change in radiation, and change in soil evaporation due to effects of mulch;
- Literature suggests thinning increases soil moisture, but this may not be true in drier areas;
- Relatively easy to monitor, but capital cost ~$7000 for time-domain reflectometry.

Effects of Thinning on Soil Nitrogen

- Addition of mulch may reduce soil nitrogen levels and affect both tree growth and vegetative recovery;
- Monitor soil N using resin bags, measure tree ring growth, and surface vegetation;
- Compare sites with mulch and with mulch removed.

Conclusions (1)

- Thinning reduces live vegetation cover and increases percent bare soil;
- No detectable erosion, at least from smaller storms, even on steep slopes;
- Effect of thinning on erosion rates in from larger storms still unknown;
- Absence of runoff and erosion at the hillslope scale implies no change at the watershed scale;

Conclusions (2)

- Primary sediment source is unpaved roads, but in many cases the sediment will not reach the stream channel network;
- Wildfires increase runoff and erosion rates by several orders of magnitude;
- Effects of thinning on soil moisture and soil nitrogen have important implications for vegetative recovery and ecosystem functioning;
- Monitoring soil moisture has high capital costs while monitoring soil nitrogen less expensive.

Questions?