Rill Connectivity and Erosion Following Logging on Burned Hillslopes in Central California

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Project Background

Post-fire erosion is a threat to downstream aquatic resources[1]. Post-fire logging ("salvage logging") can increase erosion[2], and rilling (**Fig. 1**) is often the dominant erosion and sediment transport mechanism on burned hillslopes[1].

Rill networks can rapidly transport sediment downslope to aquatic systems. It is unclear what impacts salvage logging may have on the formation of rill networks.

Fig. 1: Rill erosion in a burned area one year post-fire (left), in a high traffic skid trail (center), and diverted by a waterbar in a skid trail (right).

Objectives

- Quantify effects of salvage logging on rill lengths relative to unlogged areas.
- Characterize rill initiation points.
- Relate mechanical disturbance to rill length, density, and sediment yields.

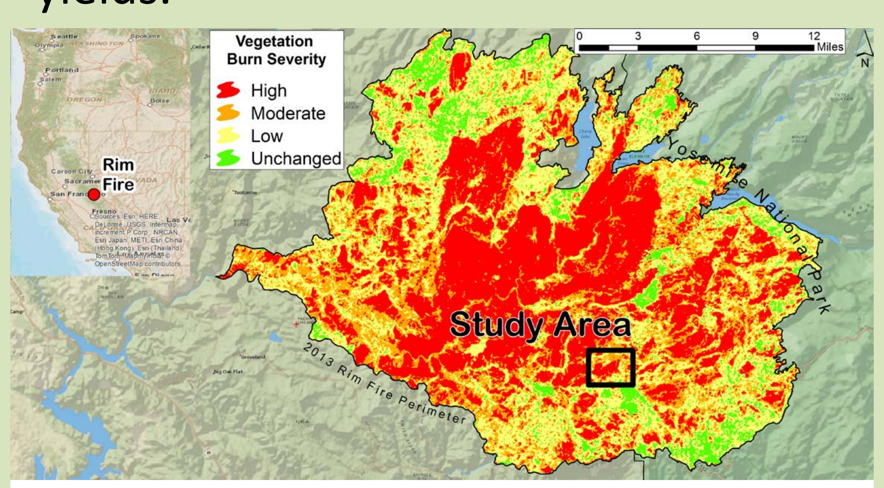

Fig. 2: Fire perimeter, burn severity.

Fig. 3: Silt fence at outlet.

Methods

- Seven catchments (0.1-0.4 ha) were identified in areas of high burn severity in the 2013 Rim Fire (**Fig. 2**).
- Five catchments were logged in December 2014, two were unlogged controls.
- Silt fences[3] were constructed at the outlet of each catchment after logging and before significant rainfall (**Fig. 3**).
- Logging disturbances were surveyed and categorized as high traffic skid trails, low traffic skid trails, and feller-buncher tracks.
- In May 2015, rills that reached the silt fence in each catchment were mapped and measured (**Fig. 4**).
- In May and August 2015 the following were quantified for each disturbance type present in each catchment:
  - Ground cover using 100 point grids
  - Soil bulk density at 0-5 cm and 5-10 cm
  - Field saturated hydraulic conductivity by dual head infiltrometer
  - Soil water repellency by water drop penetration time at 0 cm, 1 cm, and 3 cm

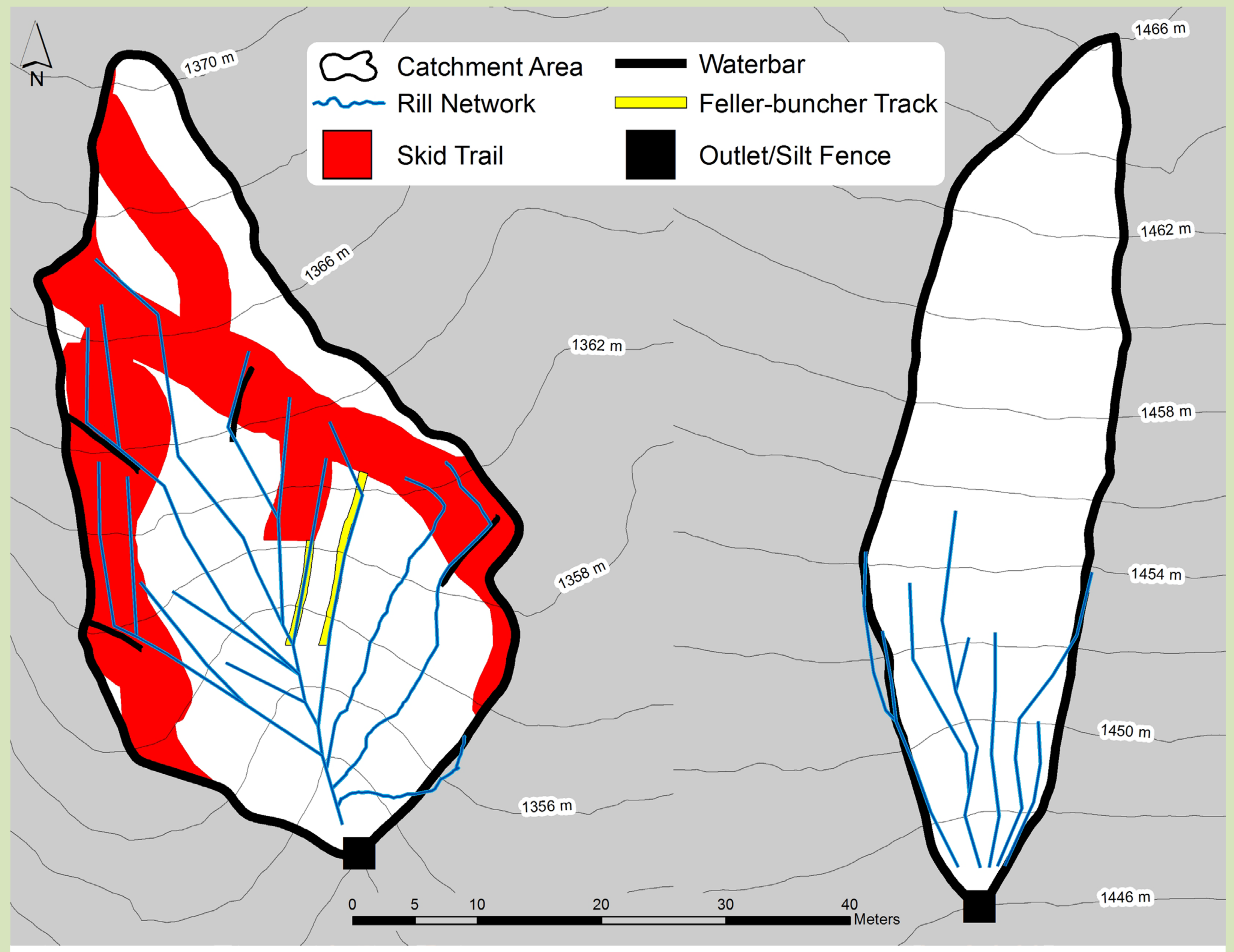

Fig. 4: Logged catchment and disturbance (left) and unlogged catchment (right), with rill networks for each catchment.

Results

- High traffic skid trails increased bare soil and bulk density, and reduced vegetation and infiltration relative to undisturbed soil (**Fig. 5.1, 5.2, 5.3, 5.4**).
- Increased water repellency was observed at 3cm depth across all the catchments in undisturbed soil but was not observed in skid trails (**Fig. 6**).
- Rills that originated in undisturbed soil had a median total length of only 9.9 m. Rills that originated in high traffic skid trails had a median total length of 24.4 m (**Fig. 7**).
- Maximum sediment yields from a single rain event were 0.2 – 5.8 Mg ha^{-1}. Sediment yield was positively correlated to rill density (sum of rill lengths divided by catchment area) (**Fig. 8**).

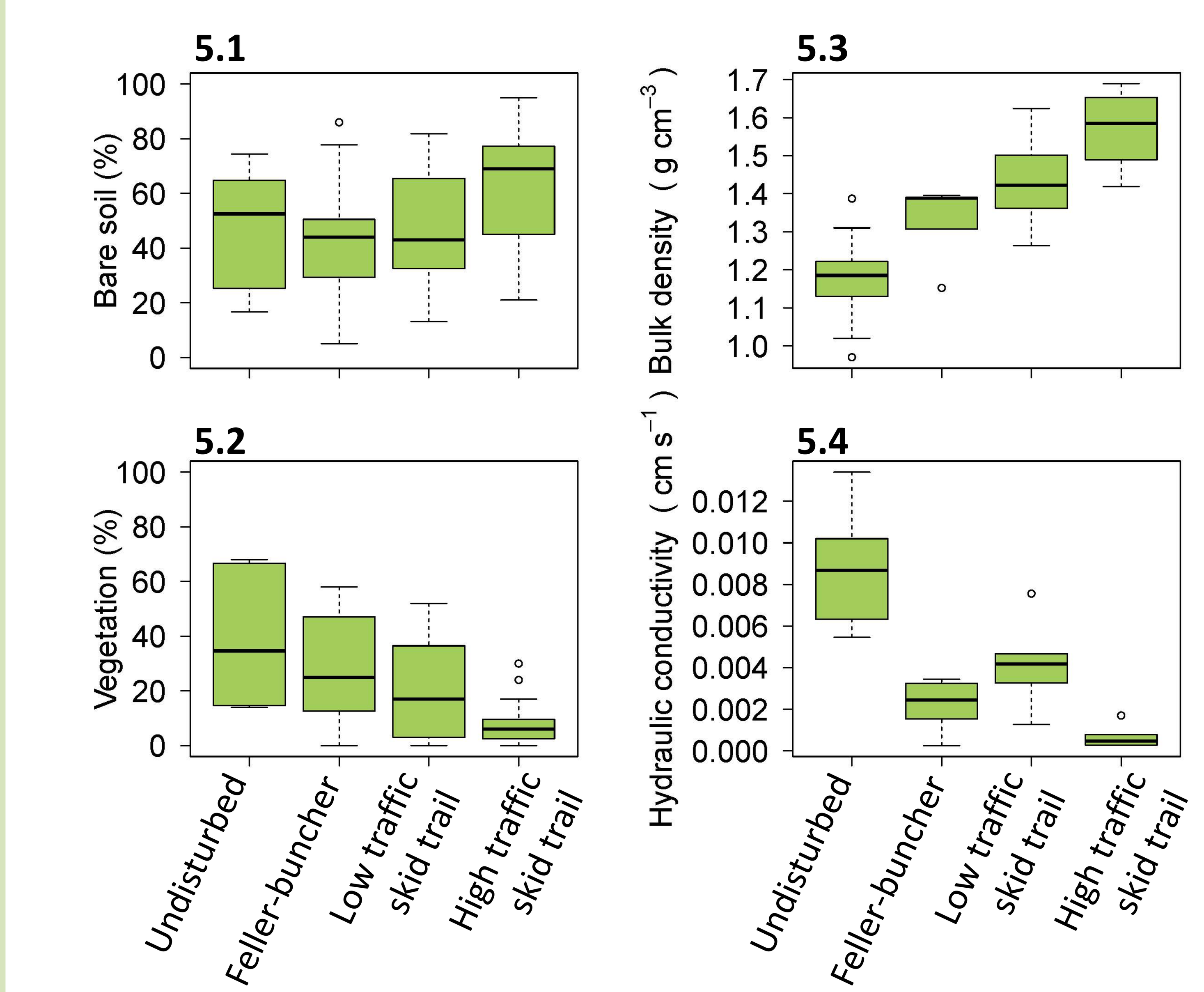

Fig. 5: **5.1**) Bare soil; **5.2**) Vegetation cover; **5.3**) Soil bulk density at 5-10 cm; **5.4**) Field saturated hydraulic conductivity

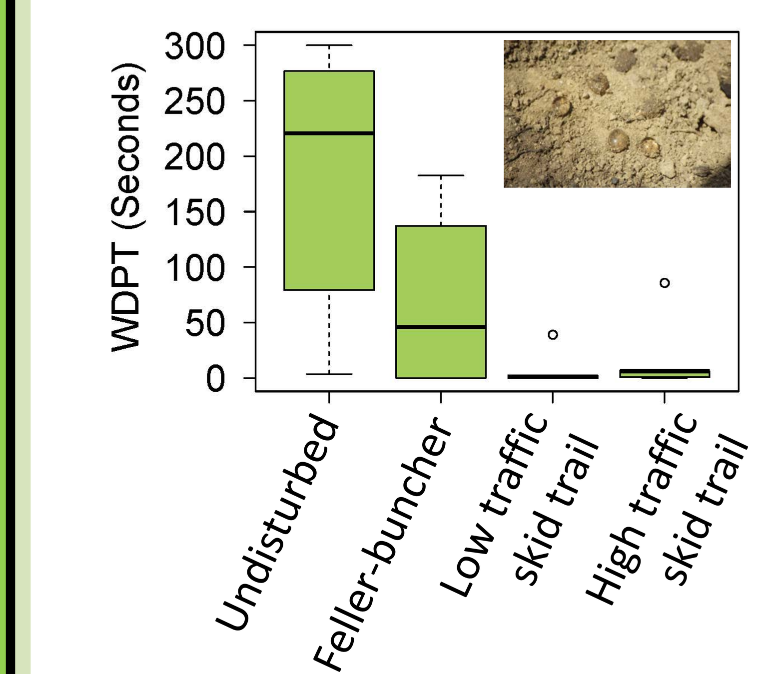

Fig. 6: Water drop penetration time at 3 cm depth.

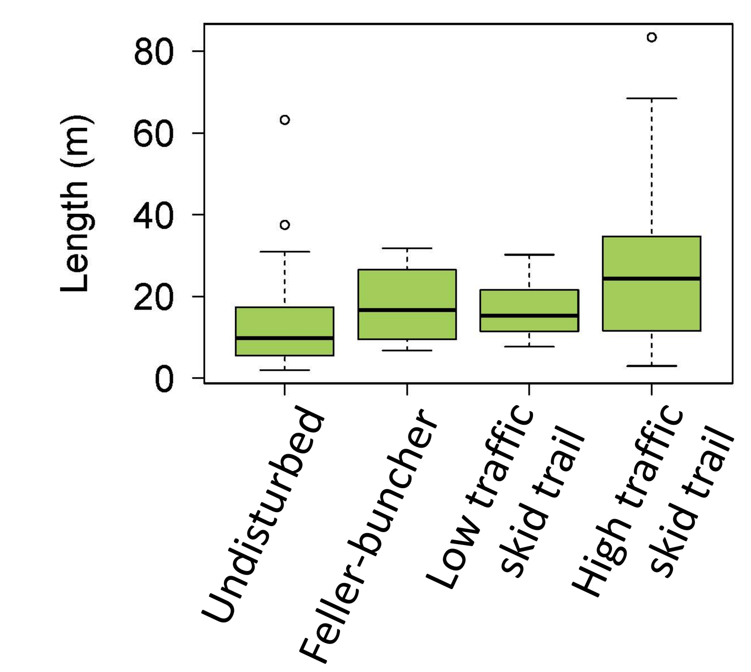

Fig. 7: Total length for individual rills by disturbance type at origin point.

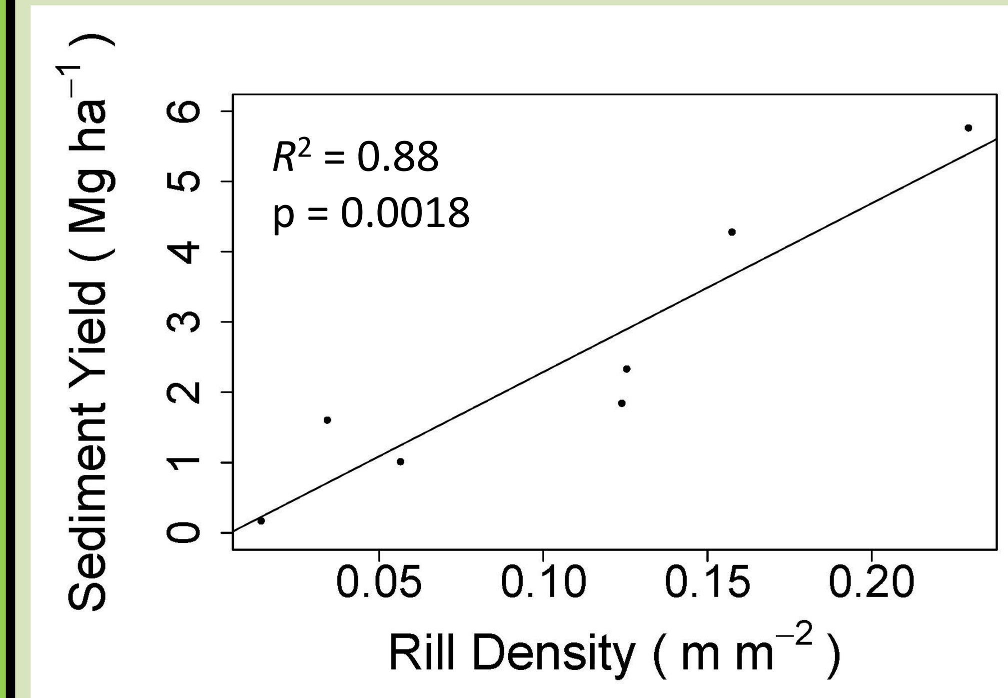

Fig. 8: Maximum sediment yield versus rill density for a single rain event.

Fig. 9: High traffic skid trail with rill erosion, five months post-salvage

Discussion

- High traffic skid trails reduced ground cover, increased soil bulk density, and reduced infiltration, causing rill erosion (**Fig. 9**). In skid trails, rill lengths increased when rills were diverted by waterbars, and continued downslope through undisturbed areas.
- Impacts of feller-bunchers and low-traffic skid trails fall between undisturbed soils and highly trafficked skid trails. These disturbances were typically spatially disconnected, and rills from tracks perpendicular to contours were connected to catchment outlets.
- In undisturbed soils, persistent water repellency, low levels of ground cover, and spatially connected patches of bare soil allowed rills that started in disturbed areas to continue downslope, thereby extending the drainage network.

Conclusion:

Salvage logging disturbance, in particular high traffic skid trails, increased rill lengths and rill connectivity. Sediment yields positively correlated to increased connectivity of rills, indicating the need to increase ground cover, particularly in areas of high traffic and downslope of disturbances.

Acknowledgements

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References

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