SageSTEP: Hydrology & Erosion

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What are the hydrologic impacts of woodland encroachment into sagebrush steppe & what effects do tree reduction treatments have on hydrologic response?
Research Objectives

Diagram showing the relationship between site susceptibility, rainfall intensity, concentrated flow, disturbed rangelands, run-off and erosion, overall flow velocity, rainsplash-sheetflow, undisturbed rangelands, bare ground, ground cover, surface roughness, soil water repellency, and hydrologic vulnerability.
Rainfall Simulation

Stand Pipe-Type Simulations, 13 – 32.5 m²

Oscillating Arm Simulations, 0.5 m²
Plot and Site Characterization
Experimental Design

Key components:
- Known rainfall rate
- Microsite response
- Process partitioning
- Frequent sampling
- Plot characterization
- Replication
- Annual controls
- Multi-year experiments
Replication Over Regional Scale

**Replication by Plant Community**
- Shrubland Sites: 6
- Woodland Sites: 4

**Soil Types:**
- loam, silt loam, sandy loam

**Replication by Experiment Type**
- Large Rainfall Plots: 324
- Small Rainfall Plots: 974
- Concentrated Flow Plots: 930
Small Plot Characteristics

**Interspace**
- Litter: <1 cm
- Stability: <10%

**Juniper**
- Litter: 5-7 cm
- Stability: 75%

**Shrub**
- Litter: <1 cm
- Stability: 15%

**Pinyon**
- Litter: 9 cm
- Stability: 75%

**Graph**
- Depth From Mineral Soil Surface (cm)
- WDPT (s)
Effects of Cover & Repellency

- Tree and shrub areas represent relatively stable locations.
- Impacts of encroachment depend on its influence on bare interspace and site specific erodibility.
- Soil water repellency has greater impact on runoff generation whereas litter cover has a greater influence on sediment yield.
Results: Large Plots

Treed areas relatively stable.

Shrub-interspaces less stable, with runoff and erosion increasing with increasing percent bare and rock cover.

Strongest correlations at the large plot scale support small plot assertions - hydrologic impacts of encroachment depend on its influence on bare interspace.
Scale and Stability

### Cumulative Runoff (mm)

- **MC Int**: 43 (Small Plot) 38 (Large Plot)
- **MC Tree**: 7 (Small Plot) 4 (Large Plot)
- **ON Int**: 39 (Small Plot) 39 (Large Plot)
- **ON Tree**: 23 (Small Plot) 9 (Large Plot)

### Cumulative Sed. (g m⁻²)

- **MC Int**: 52 (Small Plot) 222 (Large Plot)
- **MC Tree**: 3 (Small Plot) 24 (Large Plot)
- **ON Int**: 207 (Small Plot) 296 (Large Plot)
- **ON Tree**: 46 (Small Plot) 66 (Large Plot)
Effects of restorative treatments?

Juniper woodland

Recovered juniper woodland

Results 10 years following western juniper removal by cutting – Steens Mountains, Oregon.
Effects of Burning?

Large Plot Rainfall Simulation - 32.5 m² Scale

$Y = 0.023 \times \exp^{(0.051 \times X)}$

$r^2 = 0.77$  \hspace{0.5cm} n = 26
Conceptual Model

- Site Susceptibility

- Runoff and Erosion
  - Overall Flow Velocity

- Rainfall Intensity
  - High
  - Low

- Rainsplash-Sheetflow

- Undisturbed Rangelands

- Disturbed Rangelands

- Transition Zone

- Concentrated Flow

- Hydrologic Vulnerability

- Bare Ground
  - Ground Cover

- Surface Roughness

- Soil Water Repellency
Probabilistic Modeling

Erosion Risk Management Tool (ERMiT)

- WEPP Model driven
- Event based
- Probabilistic output
- Incorporates Variability
USDA - Rangeland Conservation Environmental Assessment Project (CEAP)

Assessing Environmental Benefits of Conservation Practices

- **Total Ground Cover %**: 60%
- **RETURN PERIOD GRAPHS**
  - P-Rain
  - Q-Runoff
  - Sediment Yield
  - Soil Loss

**2 YEAR RETURN PERIOD RESULTS**
- Rain (mm): 21.80
- Runoff (mm): 2.31
- Sediment Yield (ton/ha): 0.02
- Soil Loss (ton/ha): 0.02

**10 YEAR RETURN PERIOD RESULTS**
Summary

• Woodland encroachment at the study sites is influencing vegetation and ground cover in the shrub-interspace zone.

• Extensive bare ground (> 50%) in the shrub-interspace zone facilitates soil detachment and transport by raindrops, sheetflow, and concentrated flow.

• Significant soil loss is occurring on these landscapes at least over 30-50 m² scales.

• Overall hydrologic impact of woodland encroachment depends on the potential influence of tree dominance on the expanse and connectivity of bare interspace and site specific erodibility.

• Effects of tree removal treatments? Forthcoming.

• Results from this research provide a dataset from which rangeland management prediction tools can be developed.
Upcoming Publications
