Research Insights in Semiarid Ecosystems

Impacts of grazing and shrub management on hydrologic attributes in semi- arid rangelands

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Features of Semiarid Systems

- Plant – soil interactions serve as one of the most important positive feedback loops in rangeland systems
- Ecosystem disturbances, whether abiotic or biotic that cause induce vegetation stress can be viewed as positive or negative depending on interactions with other factors such as climate
- Grazing or tree (shrub) management

Impacts of Management on Semiarid Hydrology

- Vegetation distribution is inherently more heterogeneous in rangeland than in other ecosystems such as croplands

Vegetation Heterogeneity Increasing?

Impacts of Management on Semiarid Hydrology

- Vegetation distribution is inherently more heterogeneous in rangeland than in other ecosystems such as croplands
- **An important ecosystem function reduced by loss of soil resources was the capacity to capture and infiltrate rainfall**
- **Vegetation change triggers a reinforcing cycle increasing the degradative effects of rainfall on soil structure, increasing soil C and N loss and increasing water runoff and soil erosion**

Preliminary Results – Juniper Rangeland Management

- **Juniper woodland was fenced and maintained since 1947 (exclosure), 90 km SW of Flagstaff**
- **In 1965, trees were removed in the exclosure and revegetation studies initiated: compared with chained then grazed rangeland**
- **~35 yr later, the soil C & N and water infiltration were compared**
- Initial vegetation studies conducted by Tom Johnsen, Jr. (retired)

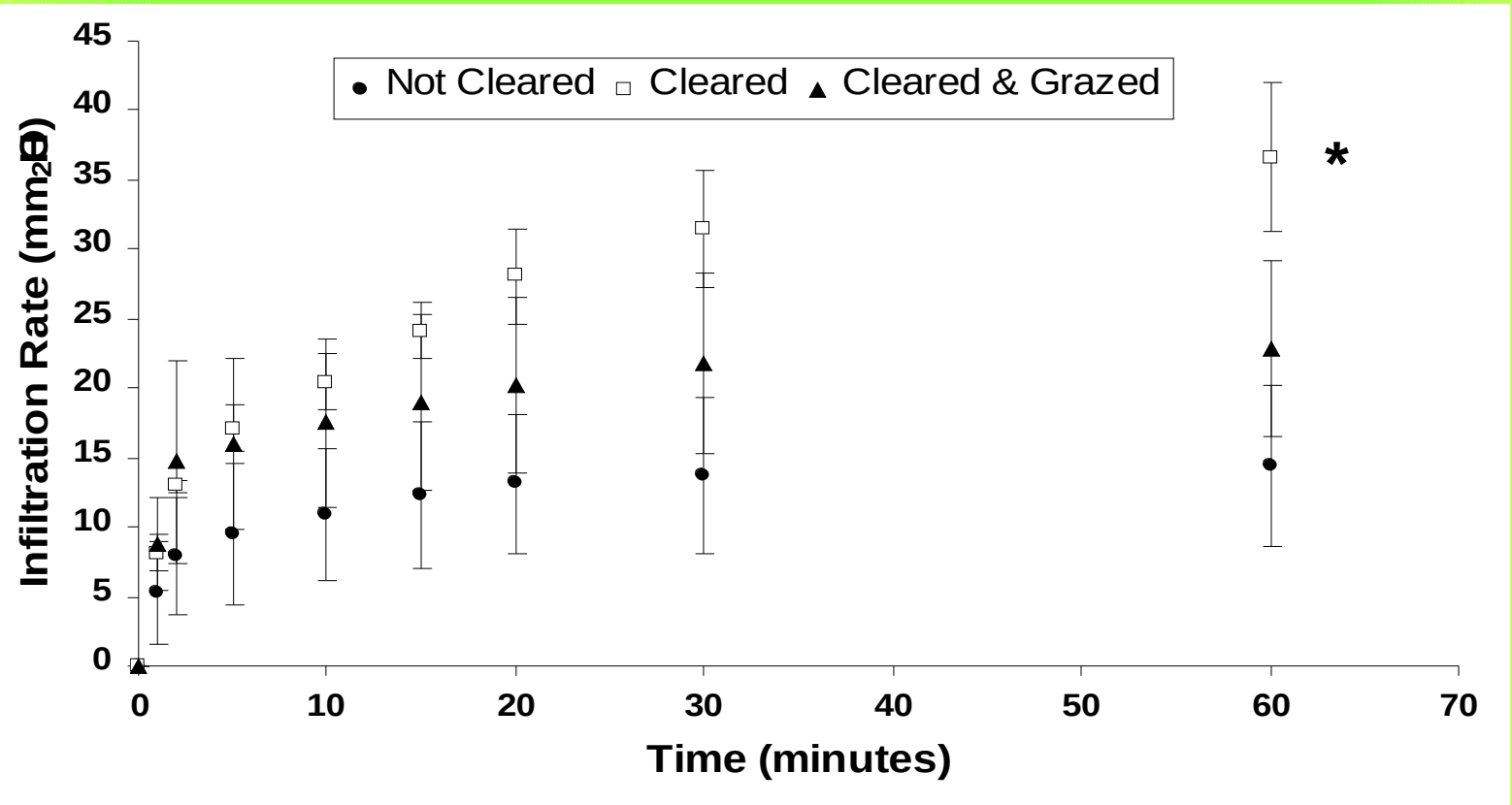
Drake Sites – May 2002

Exclosure Never cleared

Exclosure 1965 cleared

Cleared & Grazed

Juniper Removal with or without Grazing (36 yr) - Drake AZ



*Soil bulk density (- 0.96, ρ < 0.05), total N content (0.99, ρ < 0.001), organic C content (0.98, ρ < 0.01), total CH and AA concentrations (0.96, ρ < 0.05 and 0.998, ρ < 0.001, respectively)

Infiltration Relationships

- **Limited influence of biologic factors on the initial infiltration process (< 10 min) when infiltration was uniform in all directions**
- **A strong relationship between soil/ plant interactions and to the ability to transmit water for storms of longer duration – measurements including a grass plant had 40% greater infiltration**

Santa Rita Infiltrations – Rodent Station

August 2003

Good monsoon with limited grazing in 2003

August 2004

Limited monsoon with intensive grazing in 2004

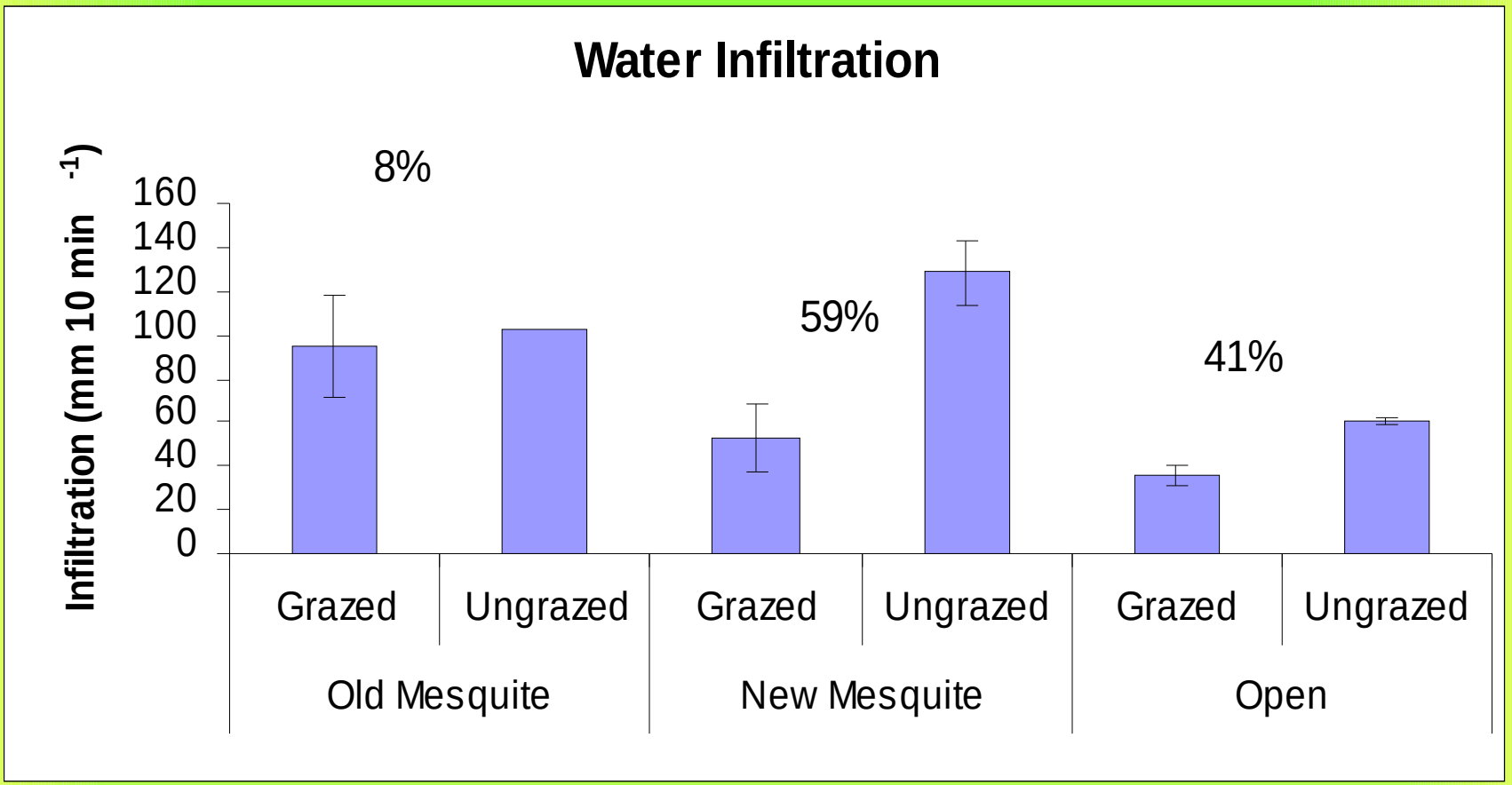
Santa Rita Mesquite - Grazed

Large mesquite

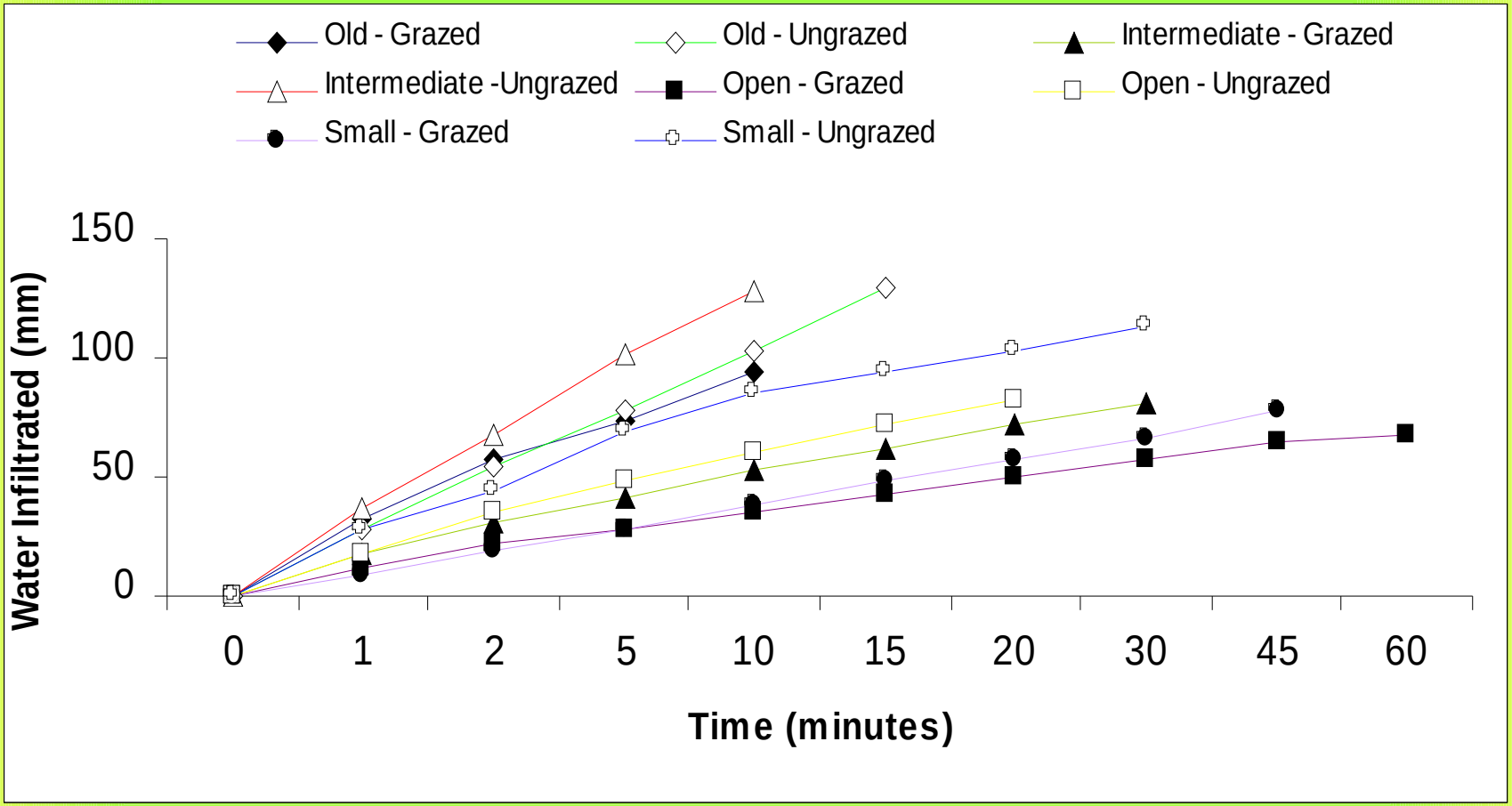
Small mesquite

Open

Santa Rita Grazed vs. Exclosure

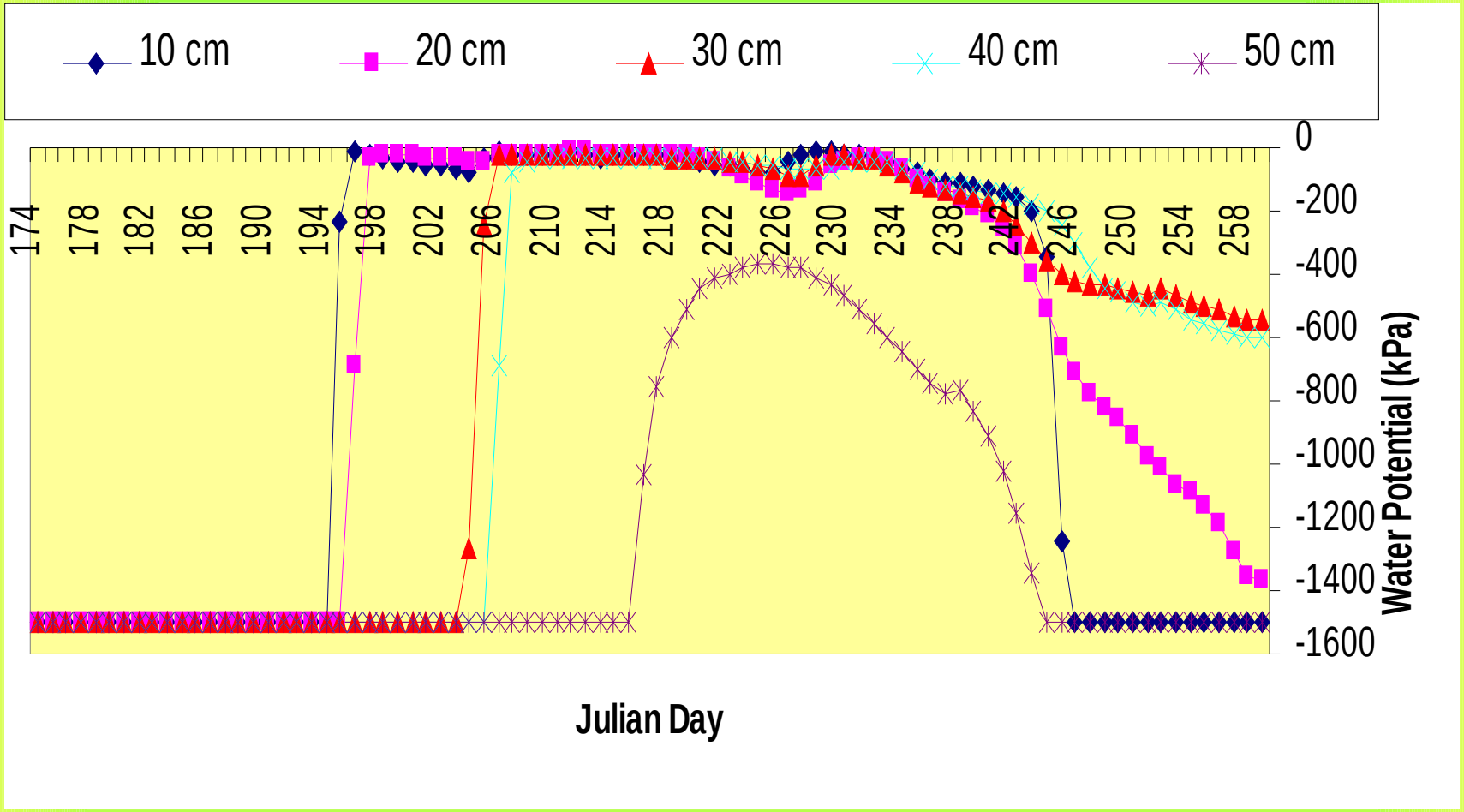


Cumulative Infiltration Rates



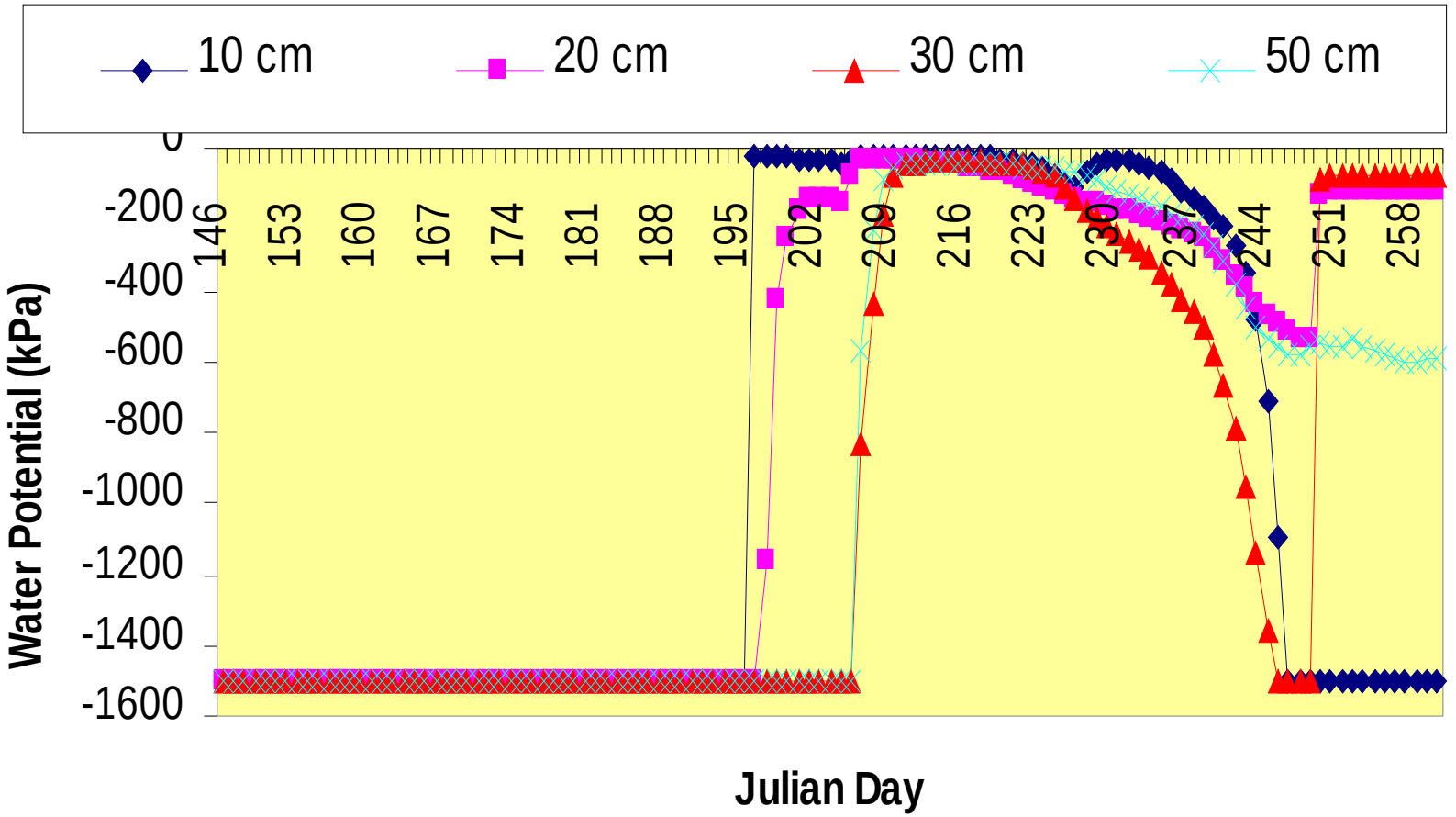
Large mesquite > intermediate > small > open for grazed sites

Soil Moisture - 2004



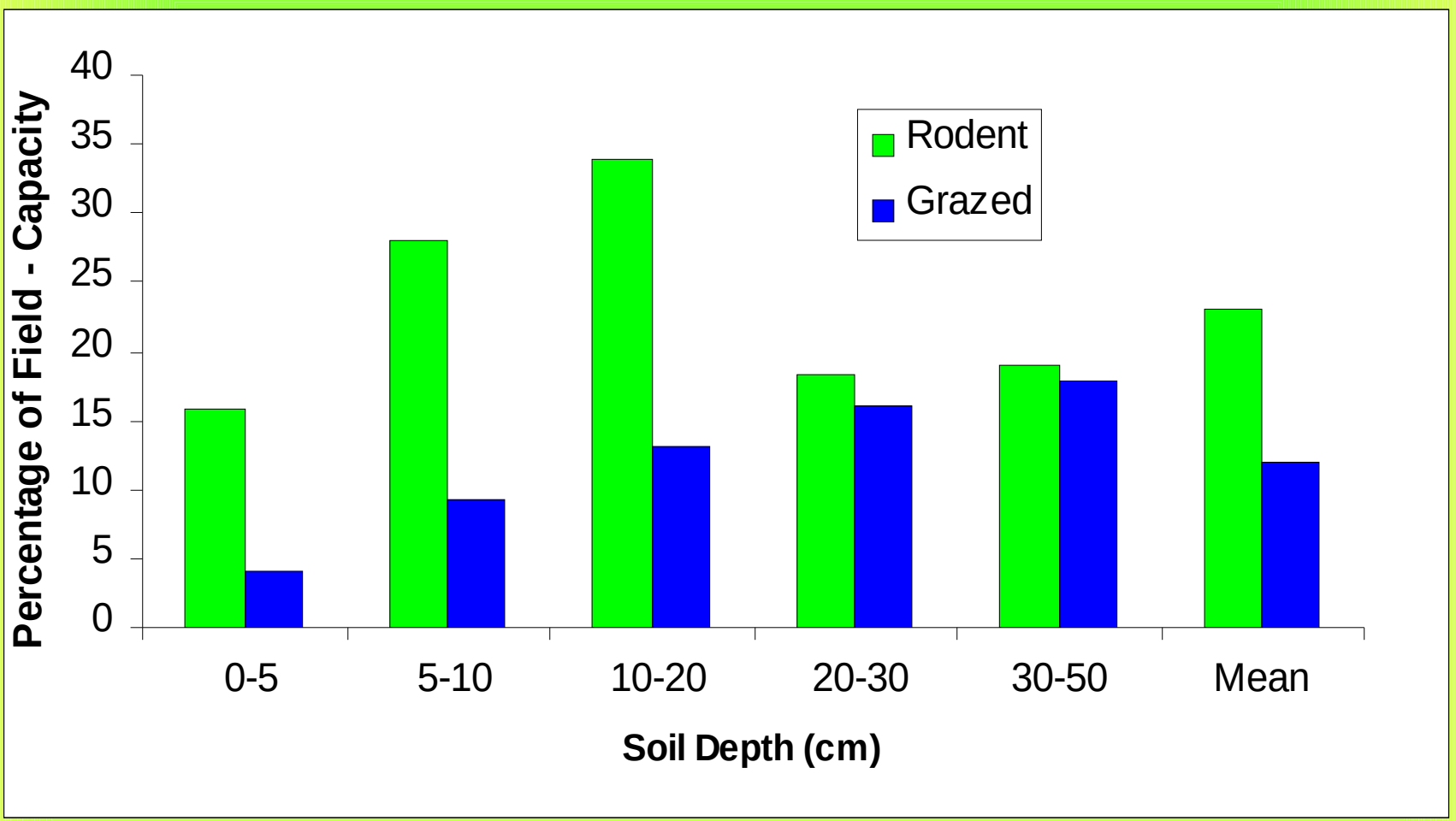
Open site - grazed

Soil Moisture – 2004



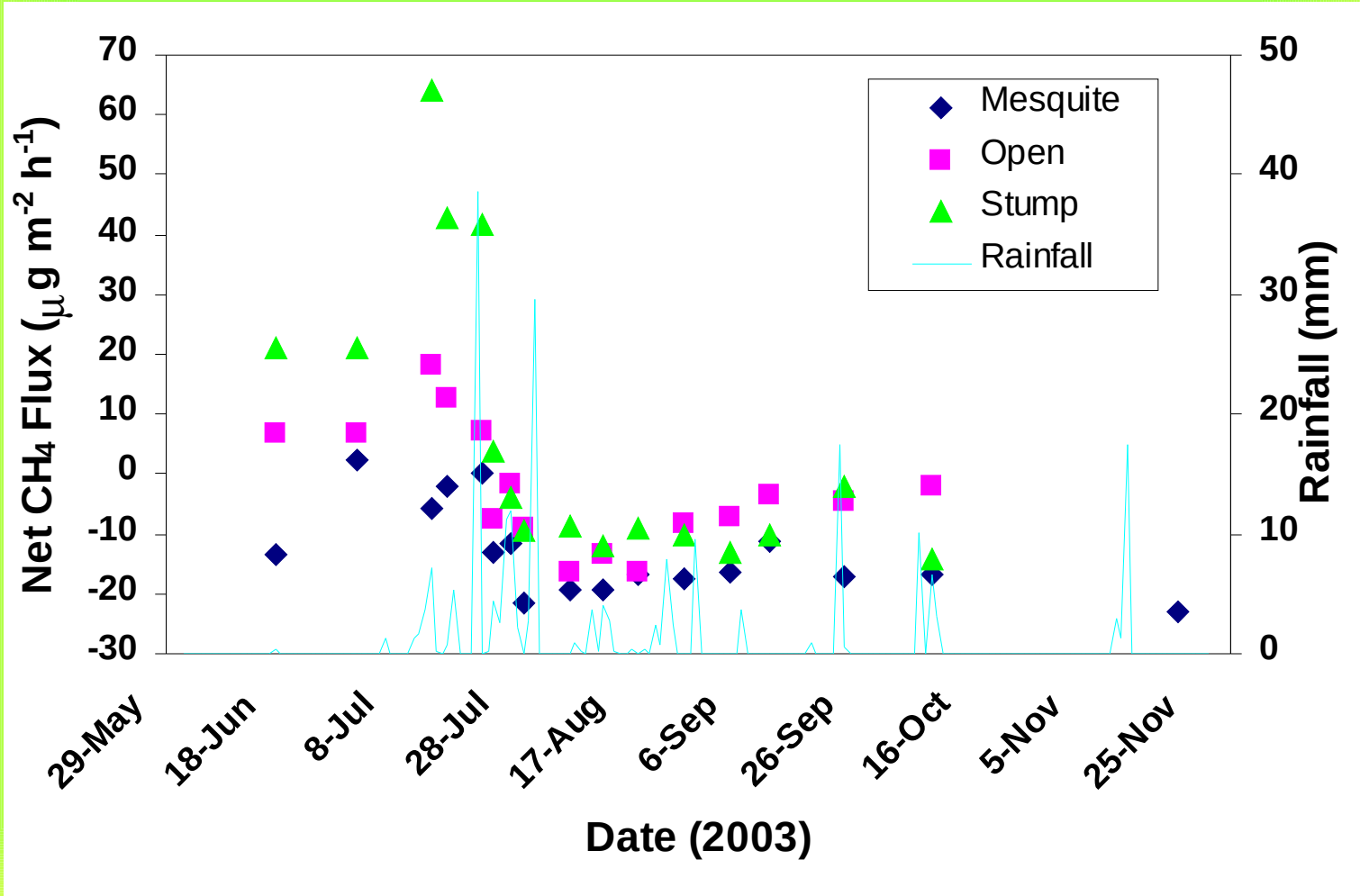
Ungrazed – Rodent Station

Soil Moisture – March 2004

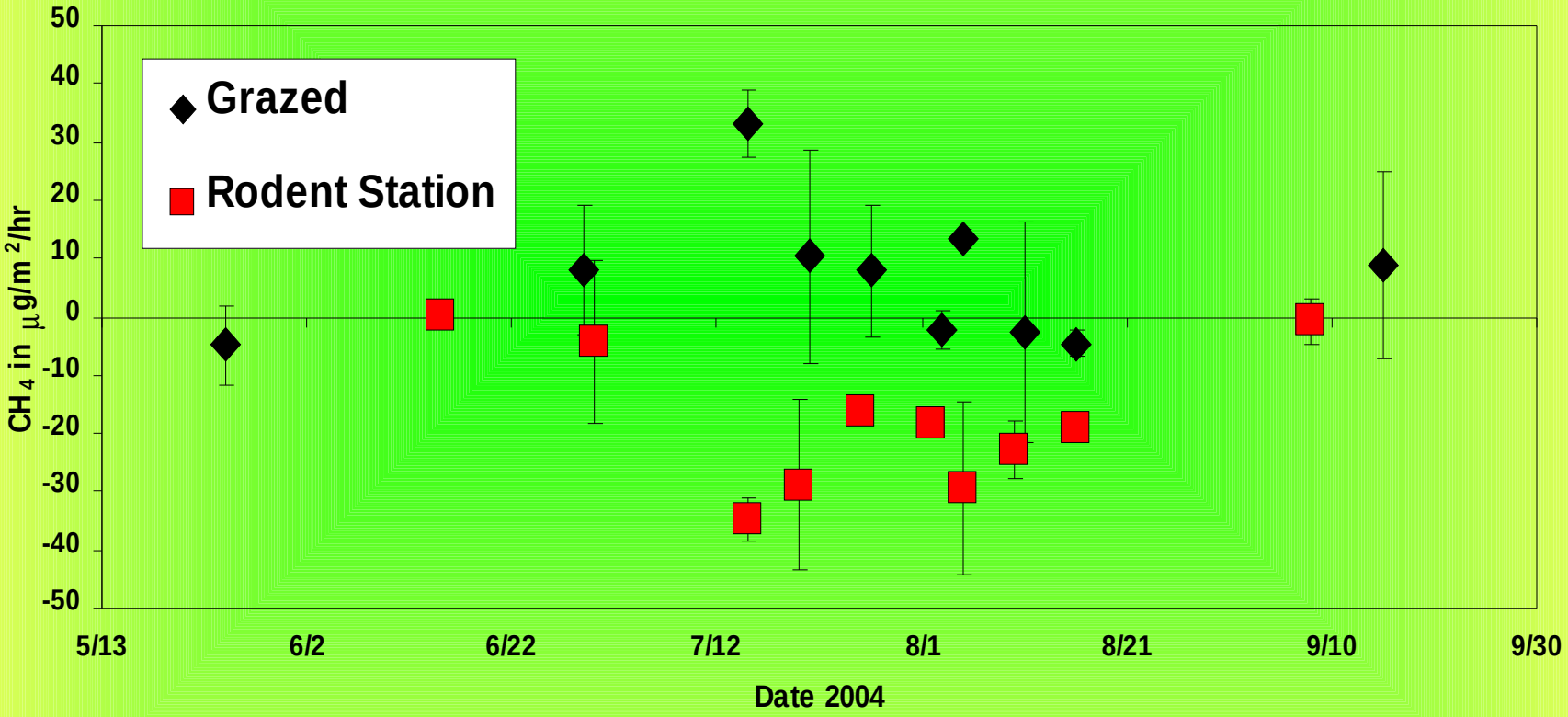


Mean of four measures each

Methane Fluxes - 2003



Methane Fluxes – 2004
Open sites



Ideas

- Water infiltration rates depend on our management
- Increased mesquite coverage has positive impact on water infiltration
- Removal of mesquite results in reversal of positive impacts – C and N content, water infiltration rates, etc.
- Grazing impacts soil water content even following more gentle cool season storms

Ideas

- Research has shown that grazing impacts on semiarid vegetation were limited or mitigated during period of normal or above- normal rainfall, but were magnified during years of below normal precipitation
- So is moderate grazing during a normal period of moisture the same as moderate grazing during an extended drought?

Climate Change?

SR 400 mm+

SR 300 mm +

SR 250 mm+

Optimism!

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Individuals and Groups

- USDA- ARS
- Southwest Watershed Research Center
- Arid Lands Institute
- Tom Johnsen, Jr. (retired)
- Mitch McClaran
- Tom Thompson