



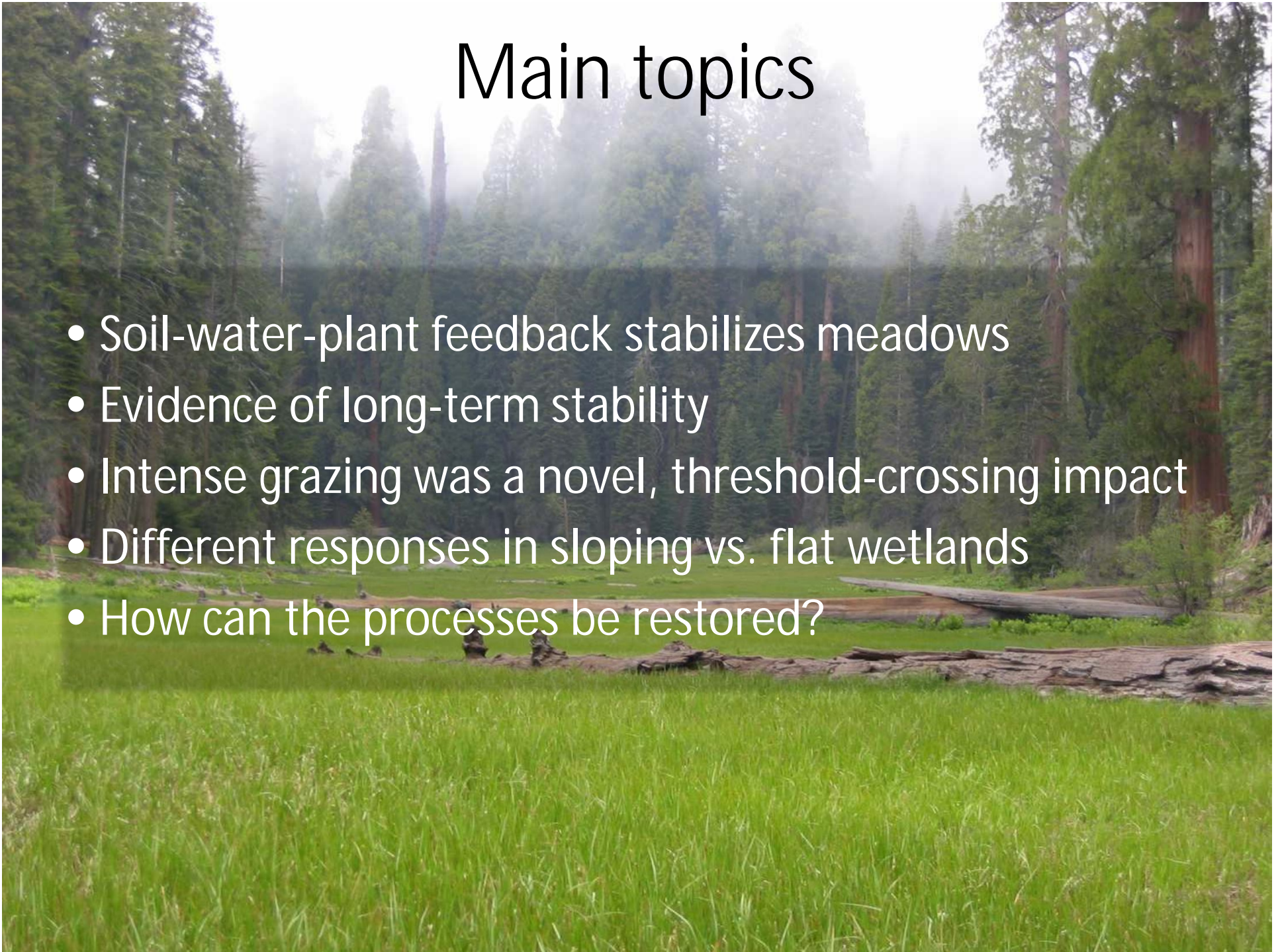
# Researching and repairing legacy grazing impacts in Sierra Nevada wetlands

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Sequoia NP 1948

# Main topics

- Soil-water-plant feedback stabilizes meadows
- Evidence of long-term stability
- Intense grazing was a novel, threshold-crossing impact
- Different responses in sloping vs. flat wetlands
- How can the processes be restored?

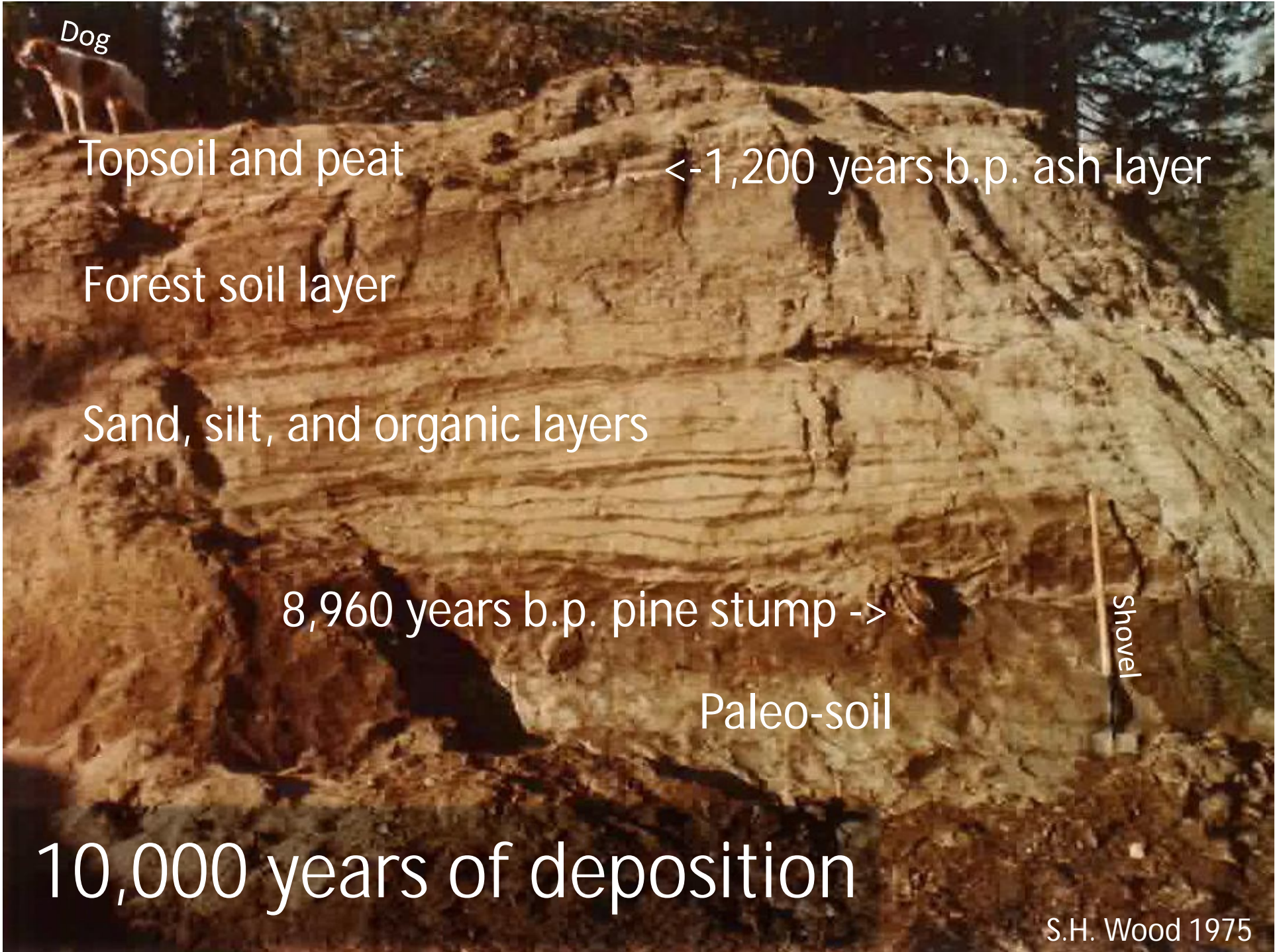


# Halstead Meadow, Sequoia NP



2005

5-10% slope



Dog

Topsoil and peat

<-1,200 years b.p. ash layer

Forest soil layer

Sand, silt, and organic layers

8,960 years b.p. pine stump ->

Paleo-soil

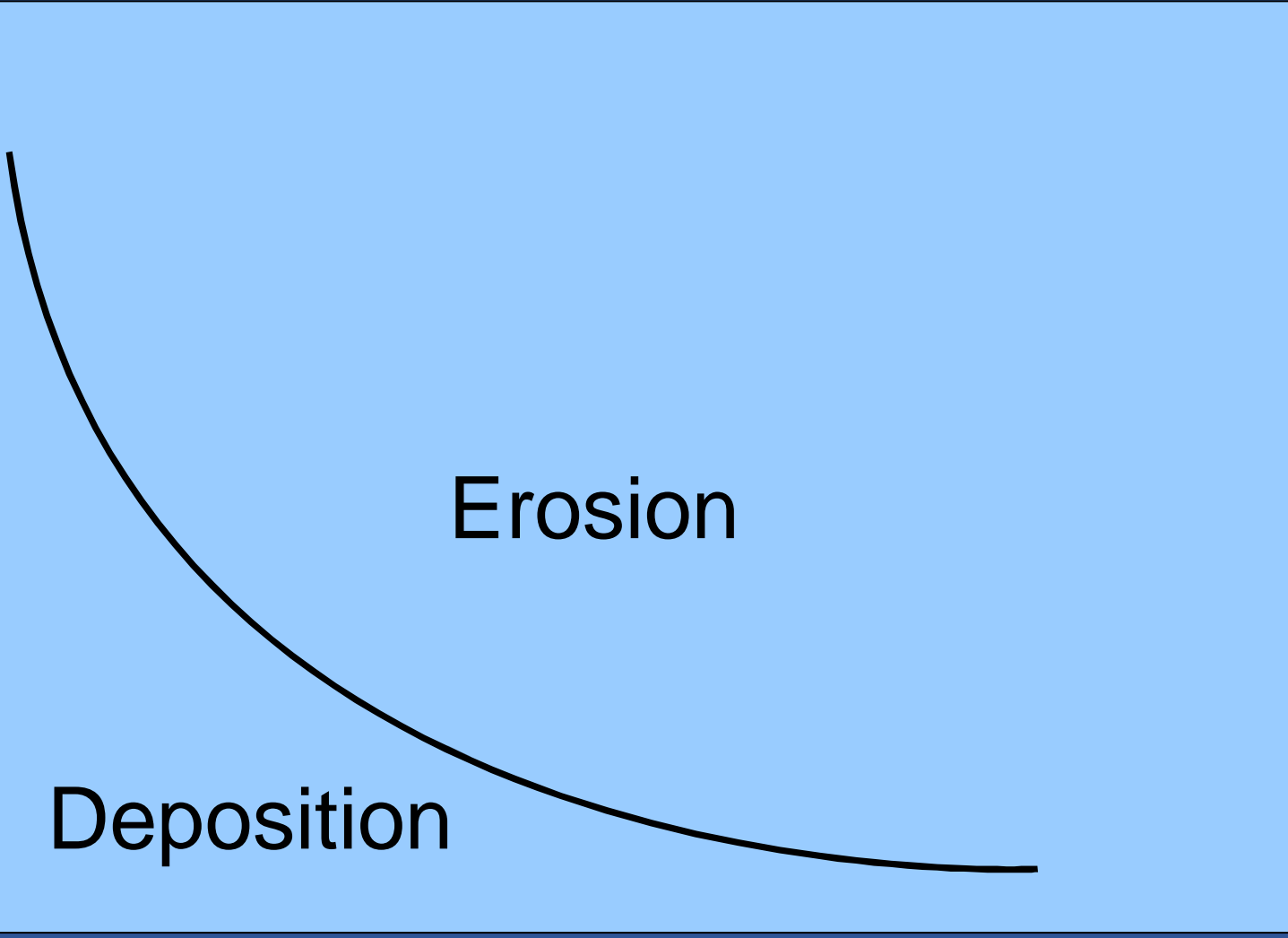
shovel

10,000 years of deposition

S.H. Wood 1975

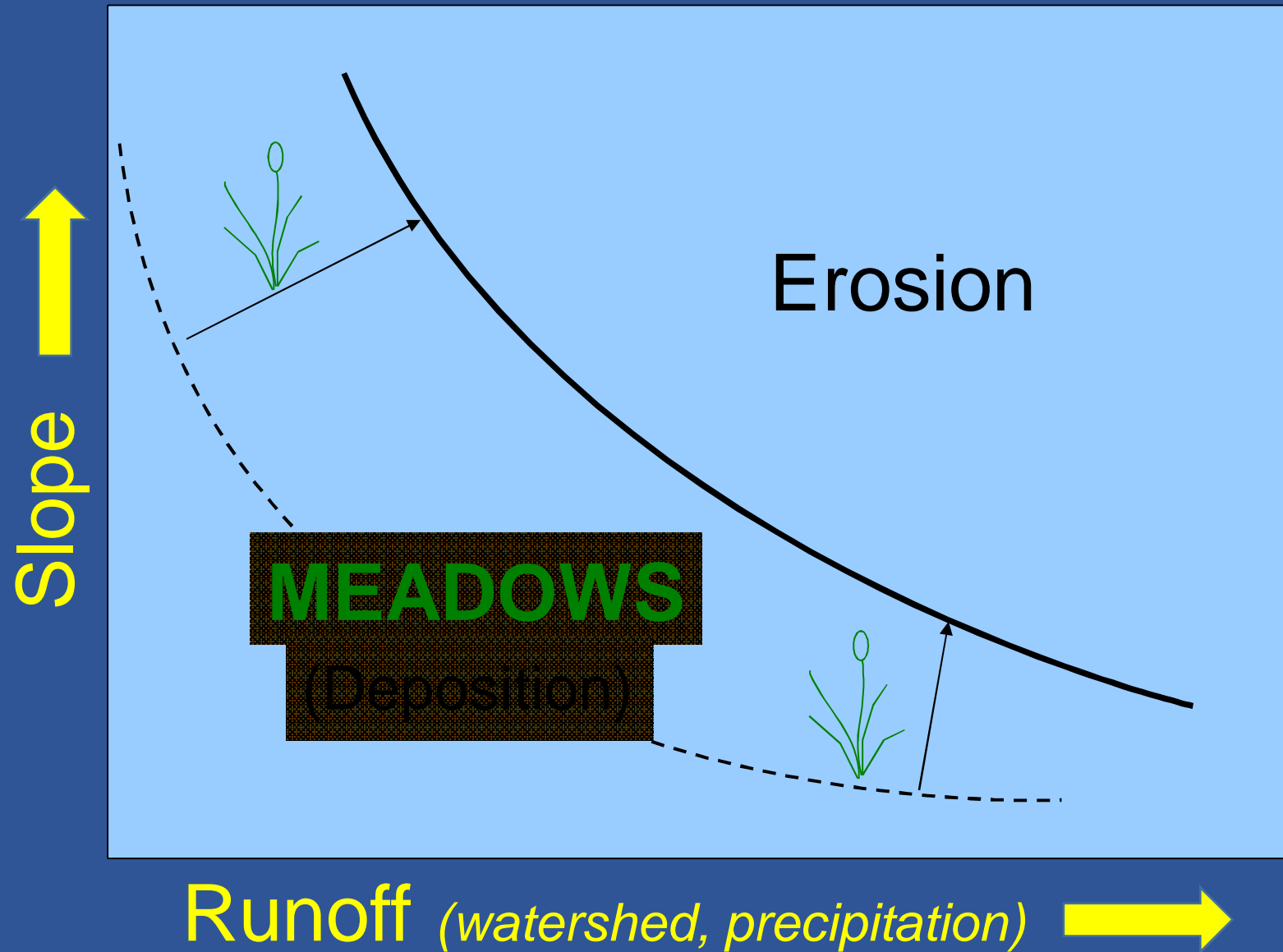
# Soil + water

Slope 

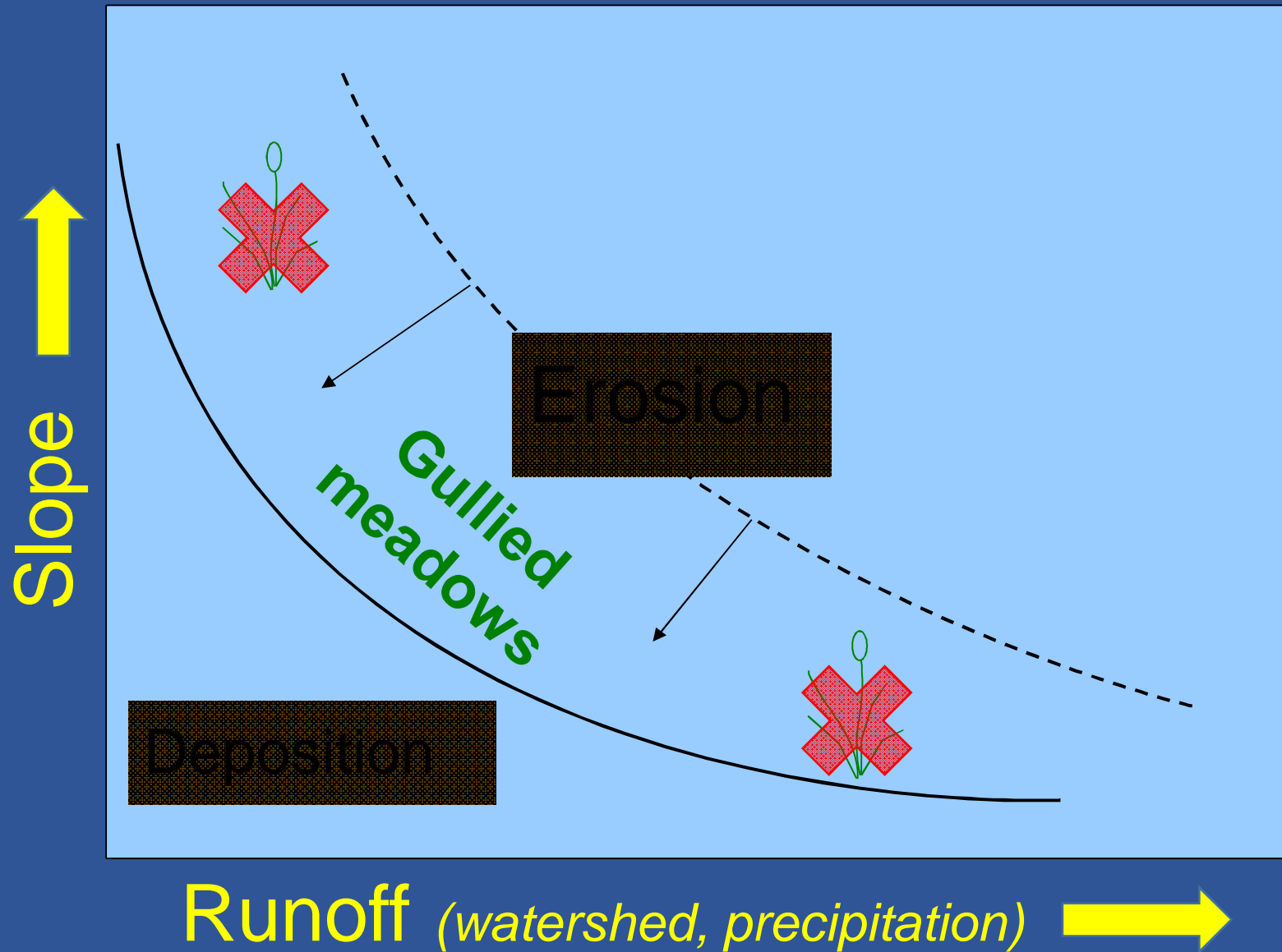


Runoff (*watershed, precipitation*) 

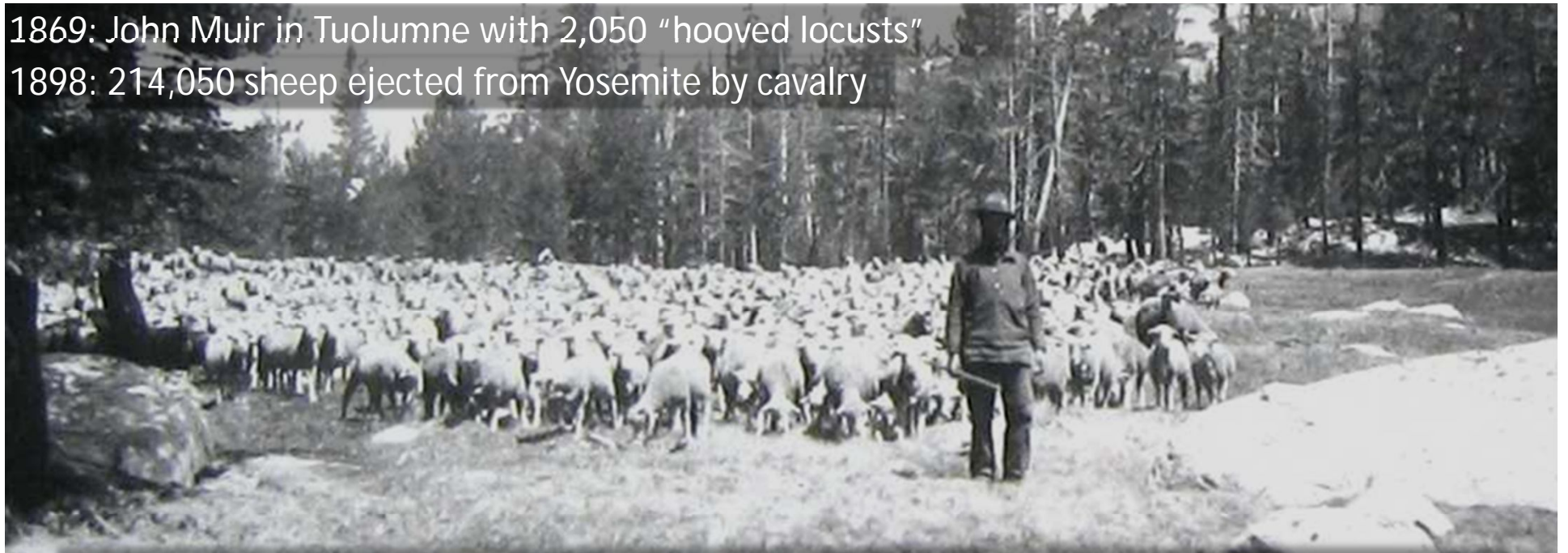
# Soil + water + plants



# Soil + water + ~~plants~~



1869: John Muir in Tuolumne with 2,050 "hooved locusts"  
1898: 214,050 sheep ejected from Yosemite by cavalry



Gold Rush, ~1850-1900. Era of unregulated grazing







Cattle grazing in Sequoia-Kings Canyon National Park, 1941

# Halstead Meadow, Sequoia NP



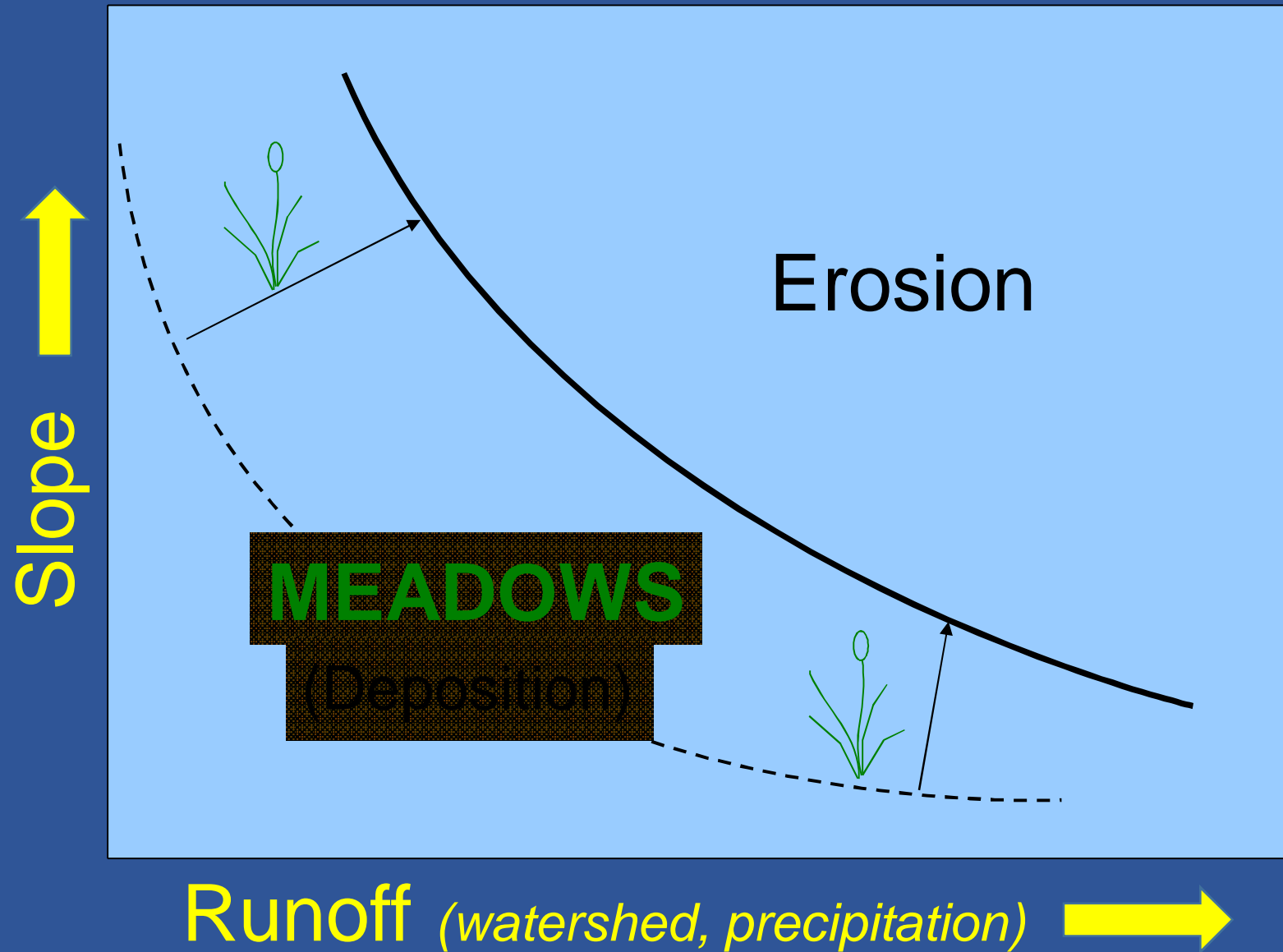
2006



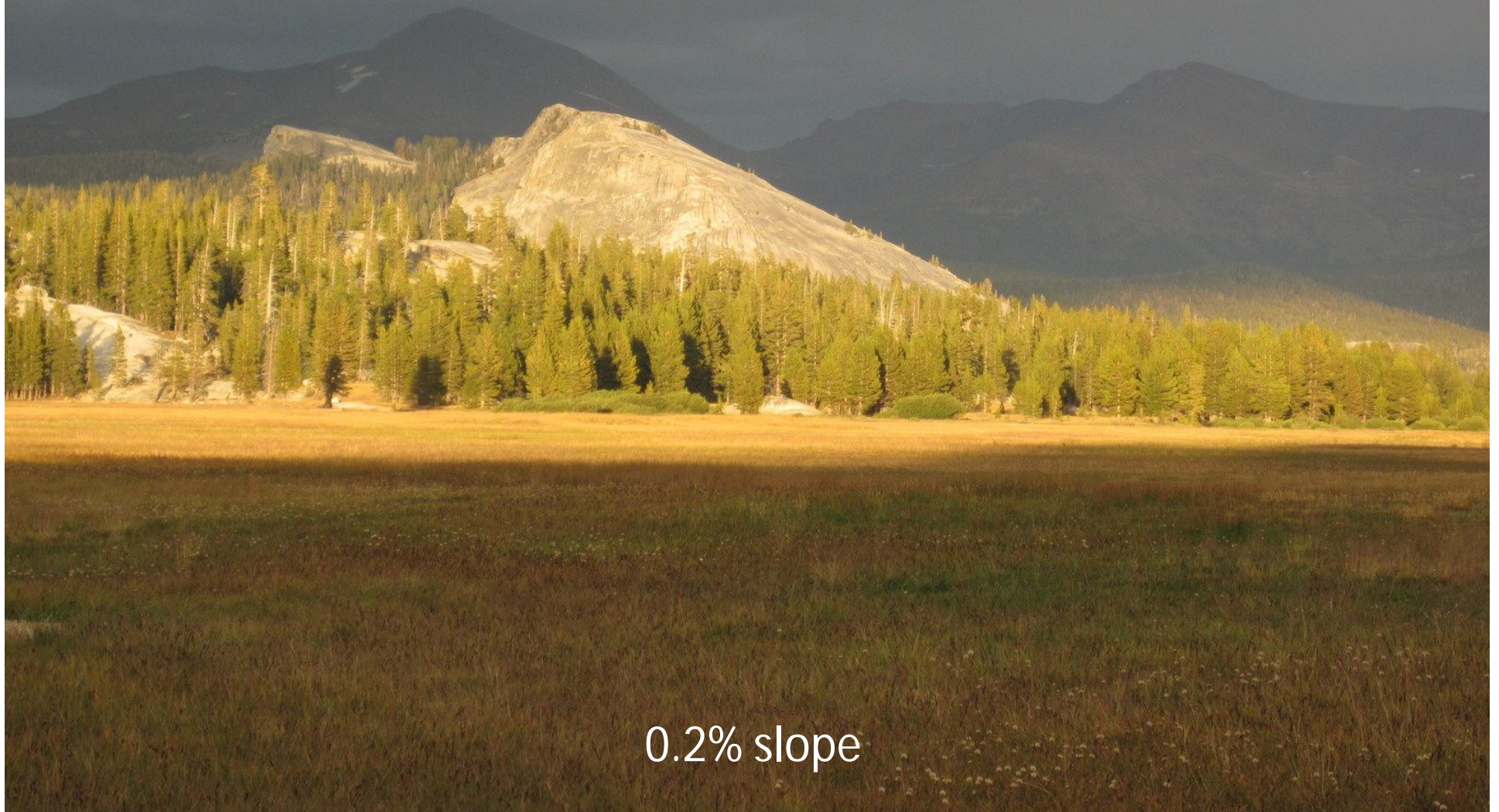
2011



# Soil + water + plants

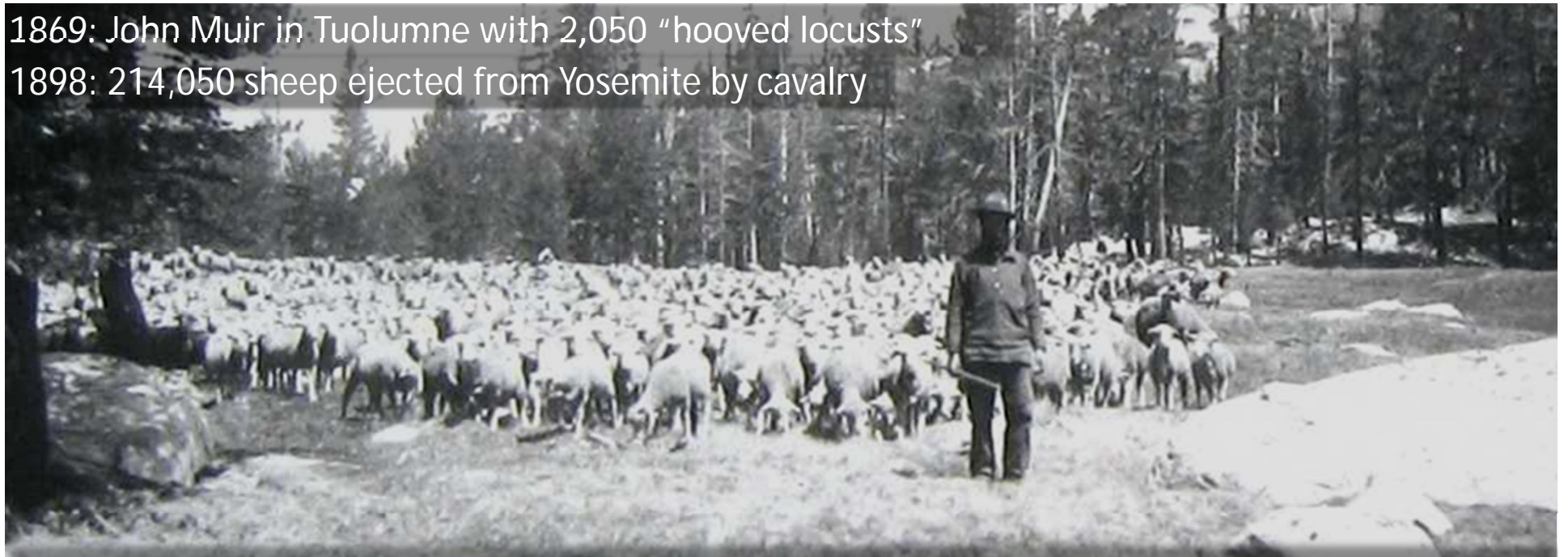


# Tuolumne Meadows, Yosemite



0.2% slope

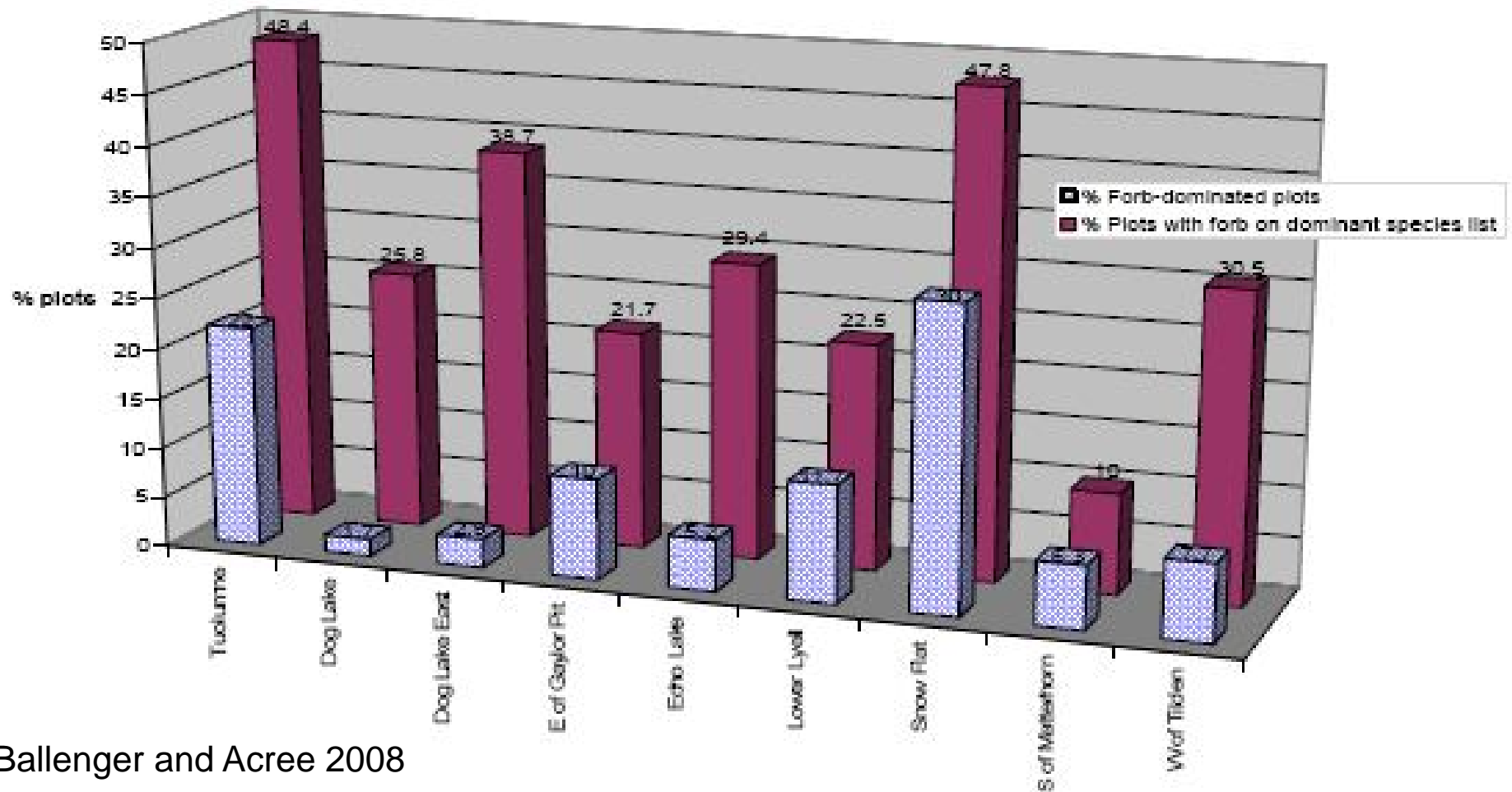
1869: John Muir in Tuolumne with 2,050 "hooved locusts"  
1898: 214,050 sheep ejected from Yosemite by cavalry



Tuolumne Meadows, Yosemite National Park, ca. 1890



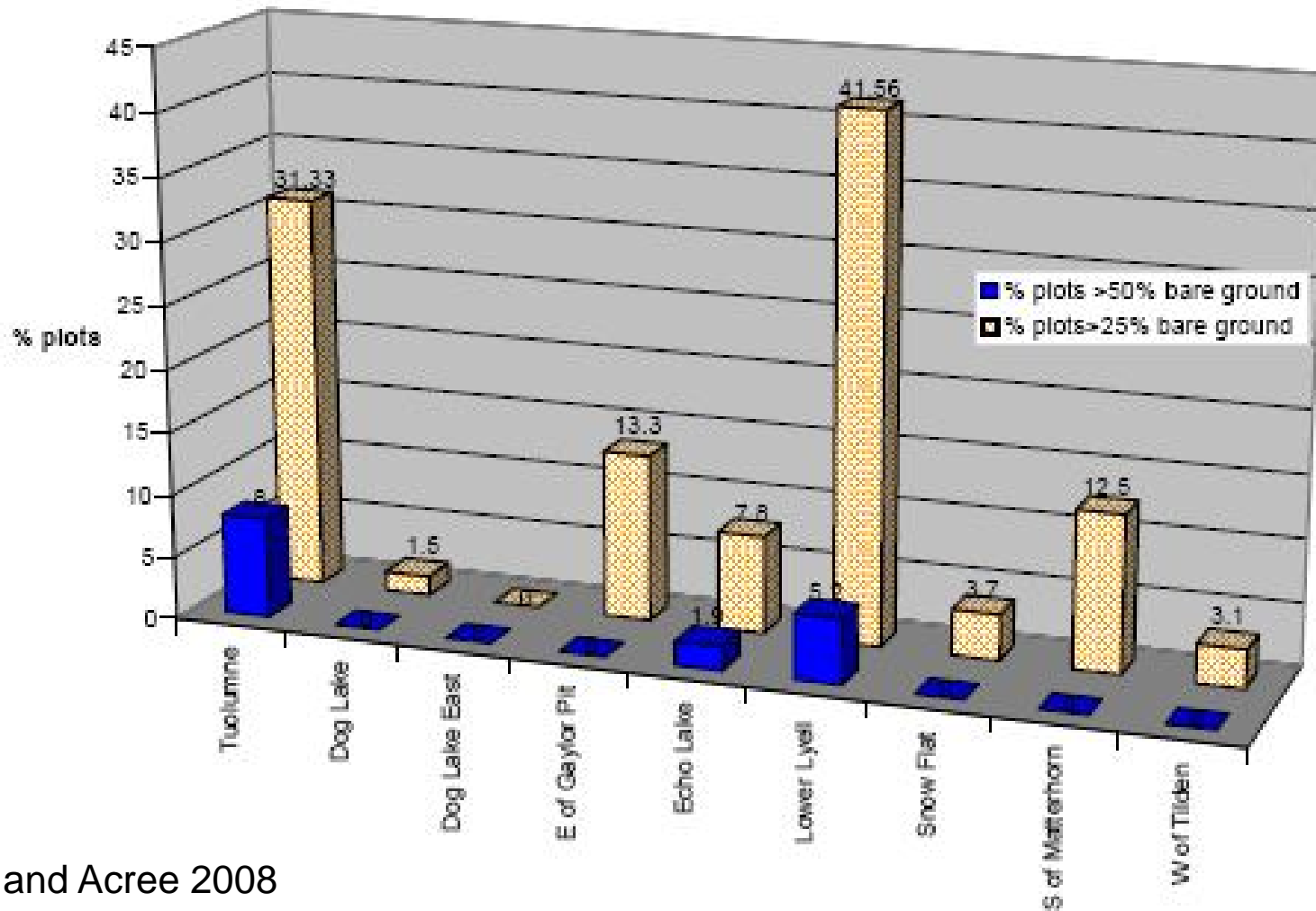
# Why are sedges missing from Tuolumne? Does this effect meadow ecosystem function?



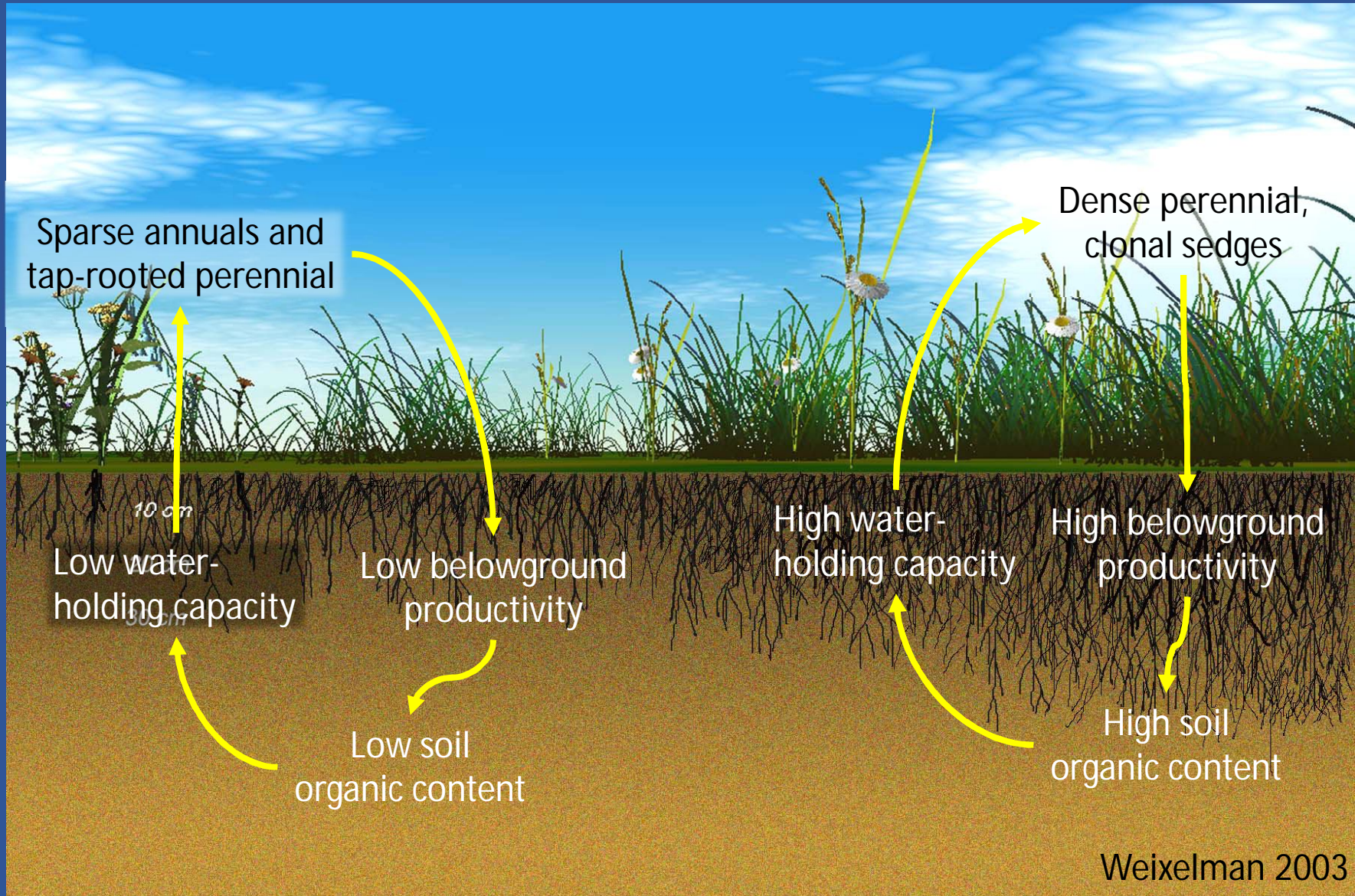
Ballenger and Acree 2008



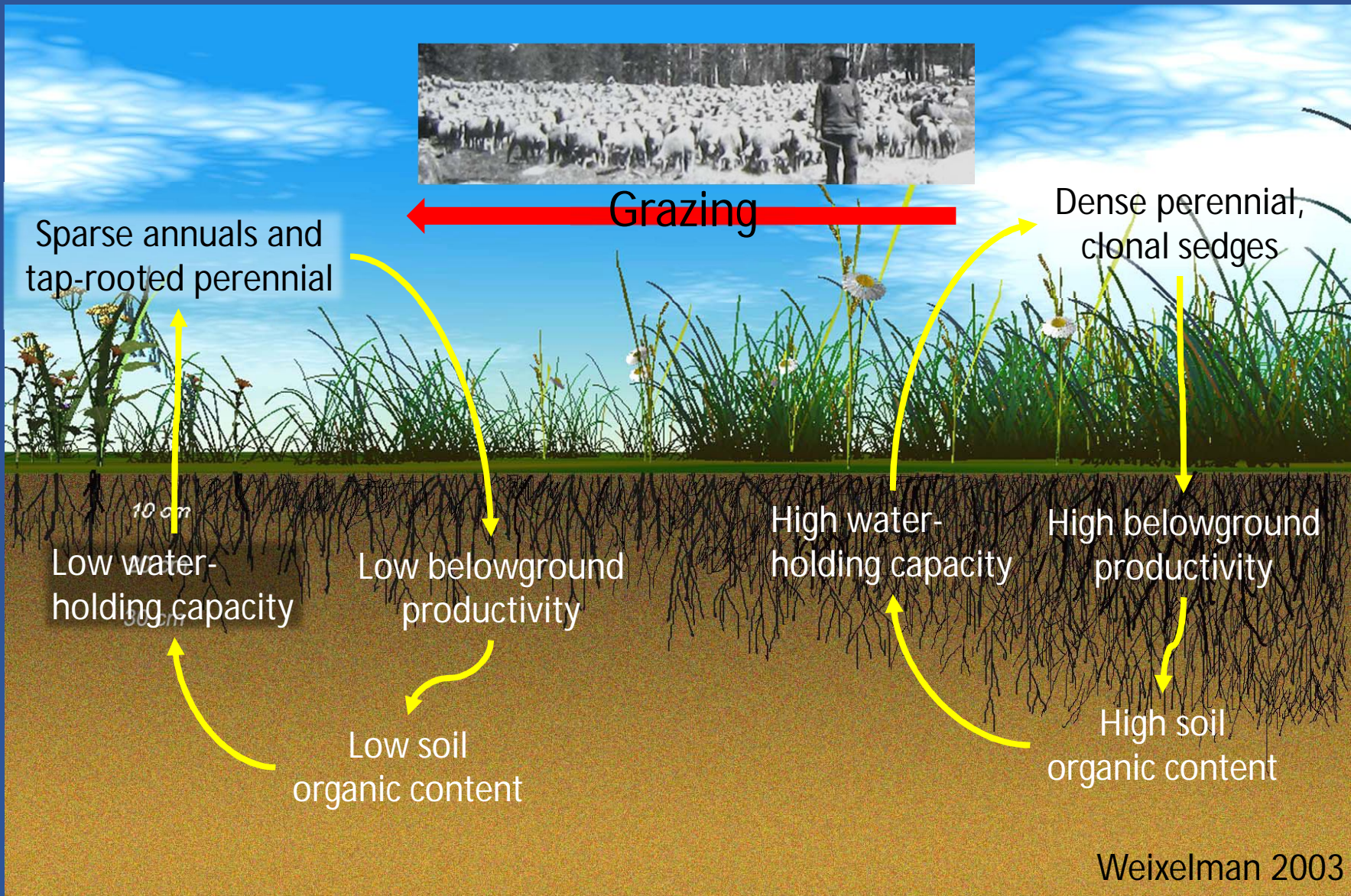
# Why is there so much bare ground? Does this effect meadow ecosystem function?



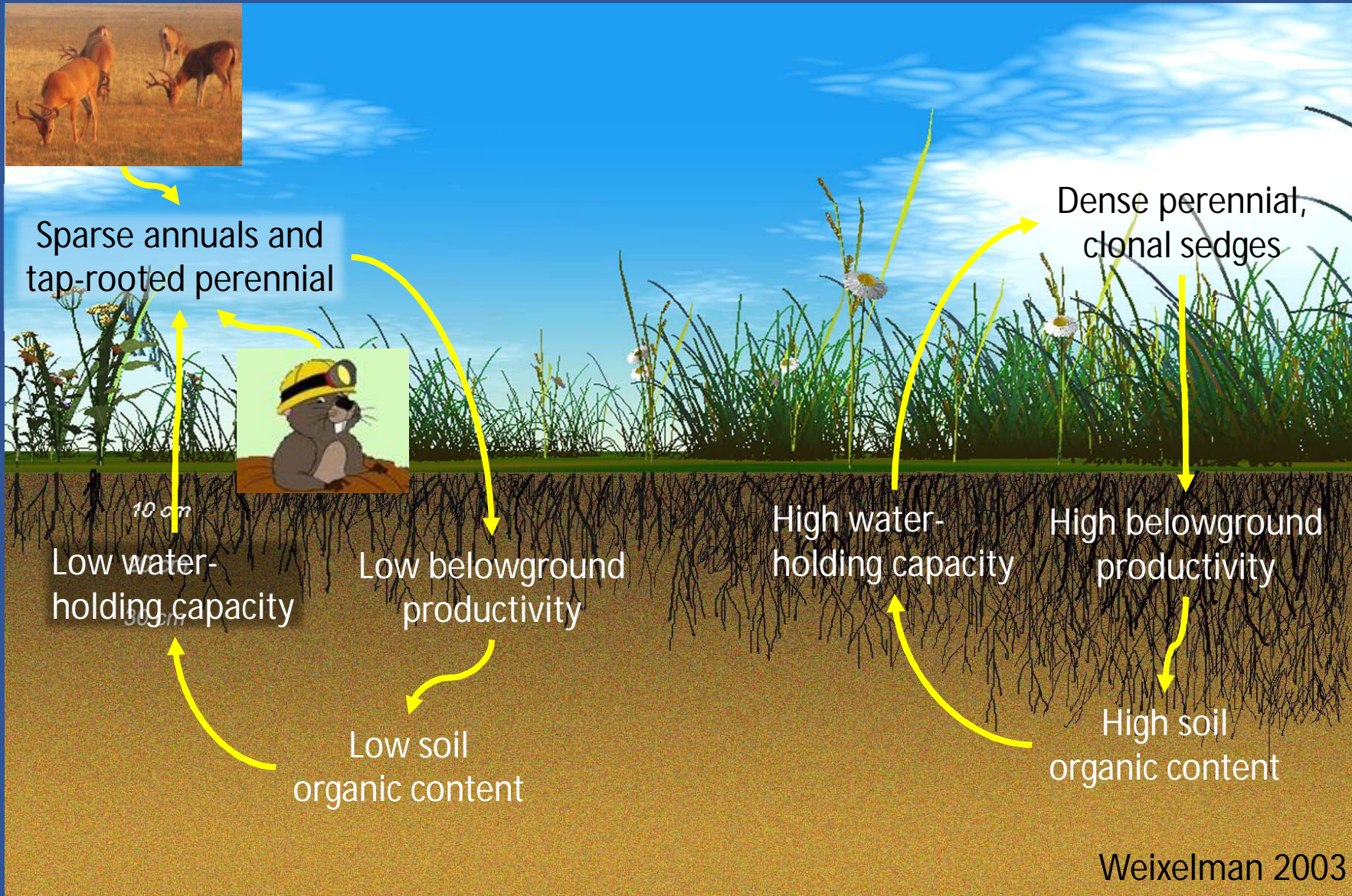
# Soil + water + plants



# Soil + water + plants



# Soil + water + plants



Weixelman 2003

# Exclosed patches of meadow vegetation from herbivores

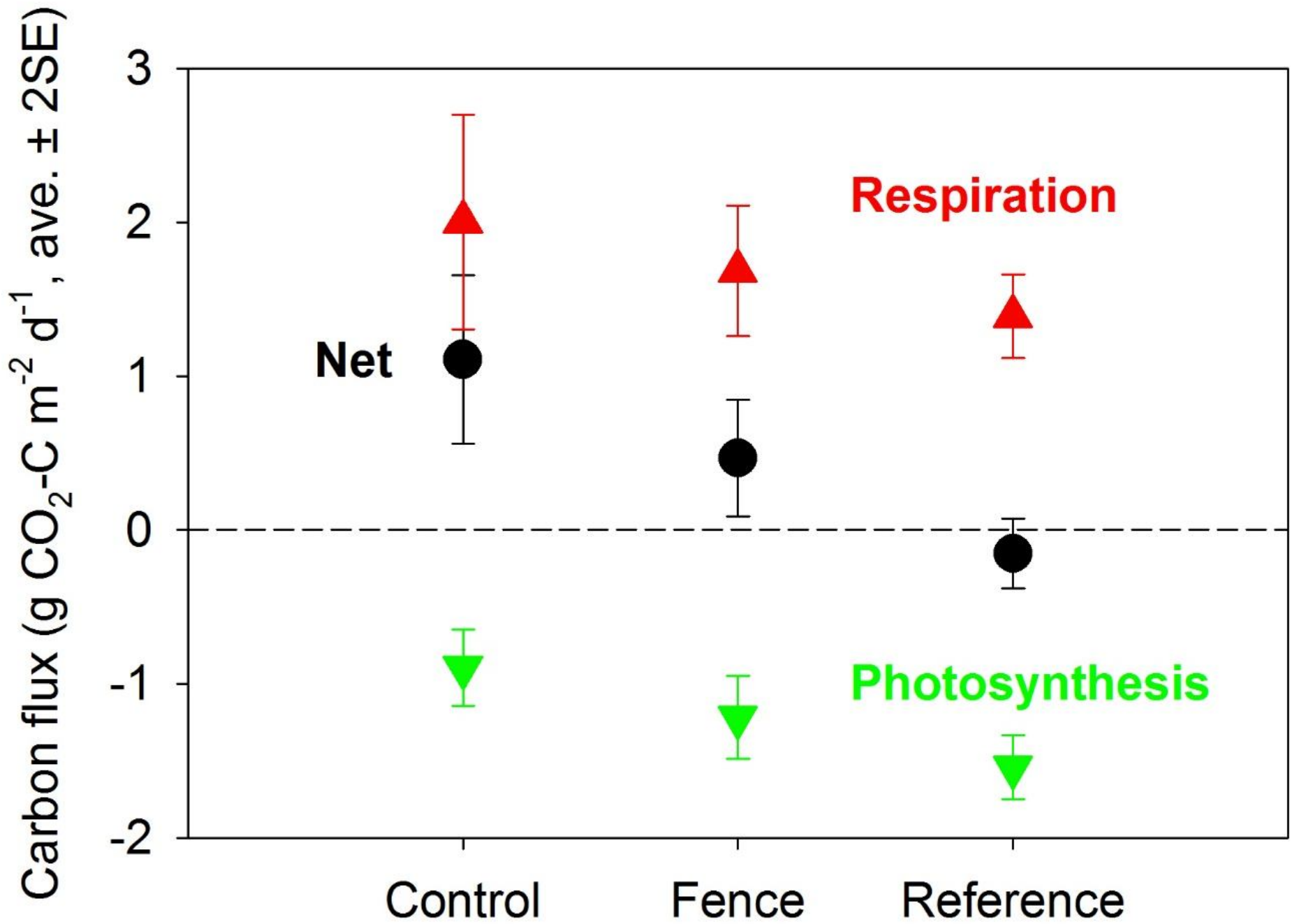


Outplanted clonal sedges, *Carex scopulorum* and *Carex subnigricans*, into herbivore exclosures and controls.

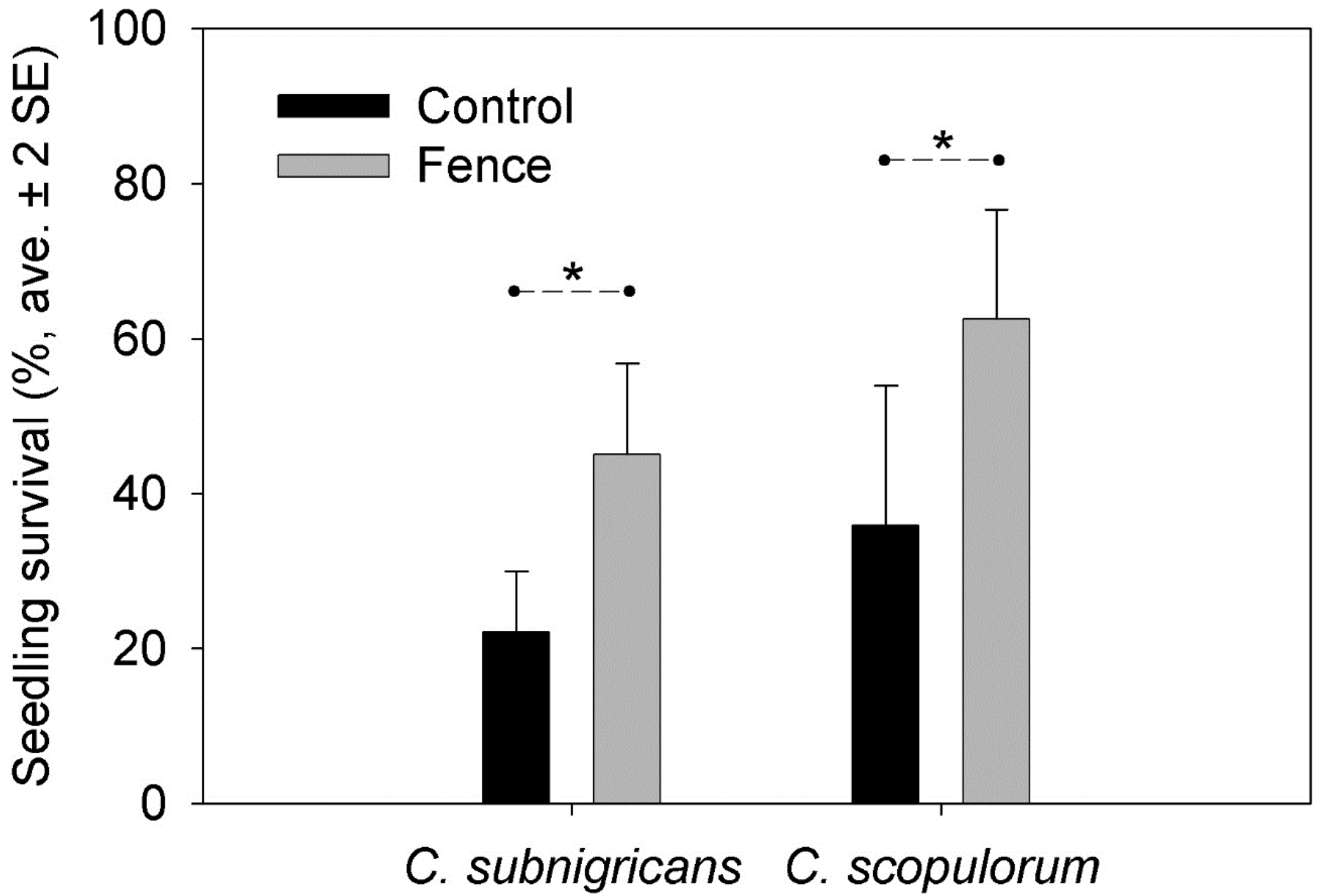


Measured C flux @ 10 Tuolumne treatment reps and 2 reference meadows.

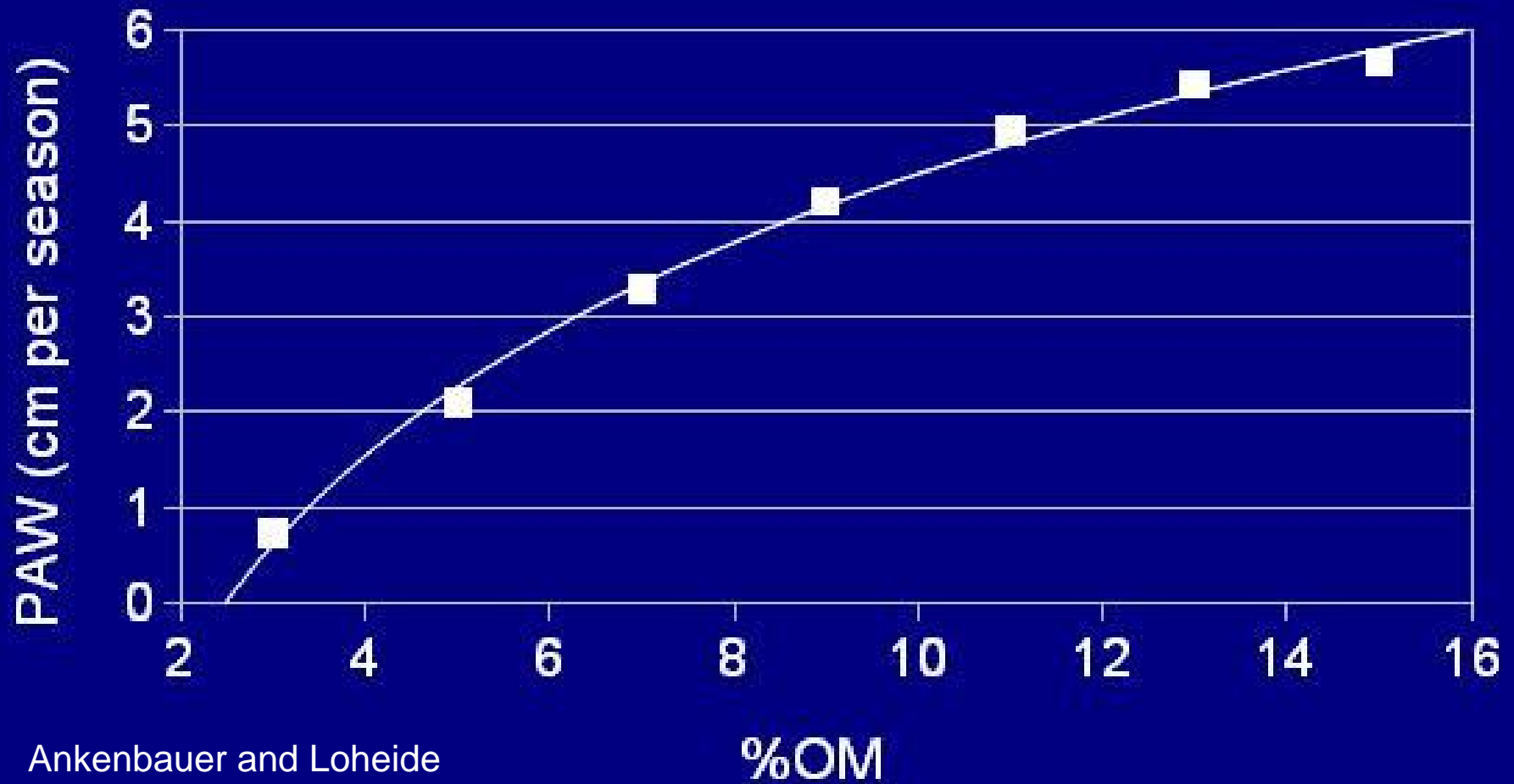




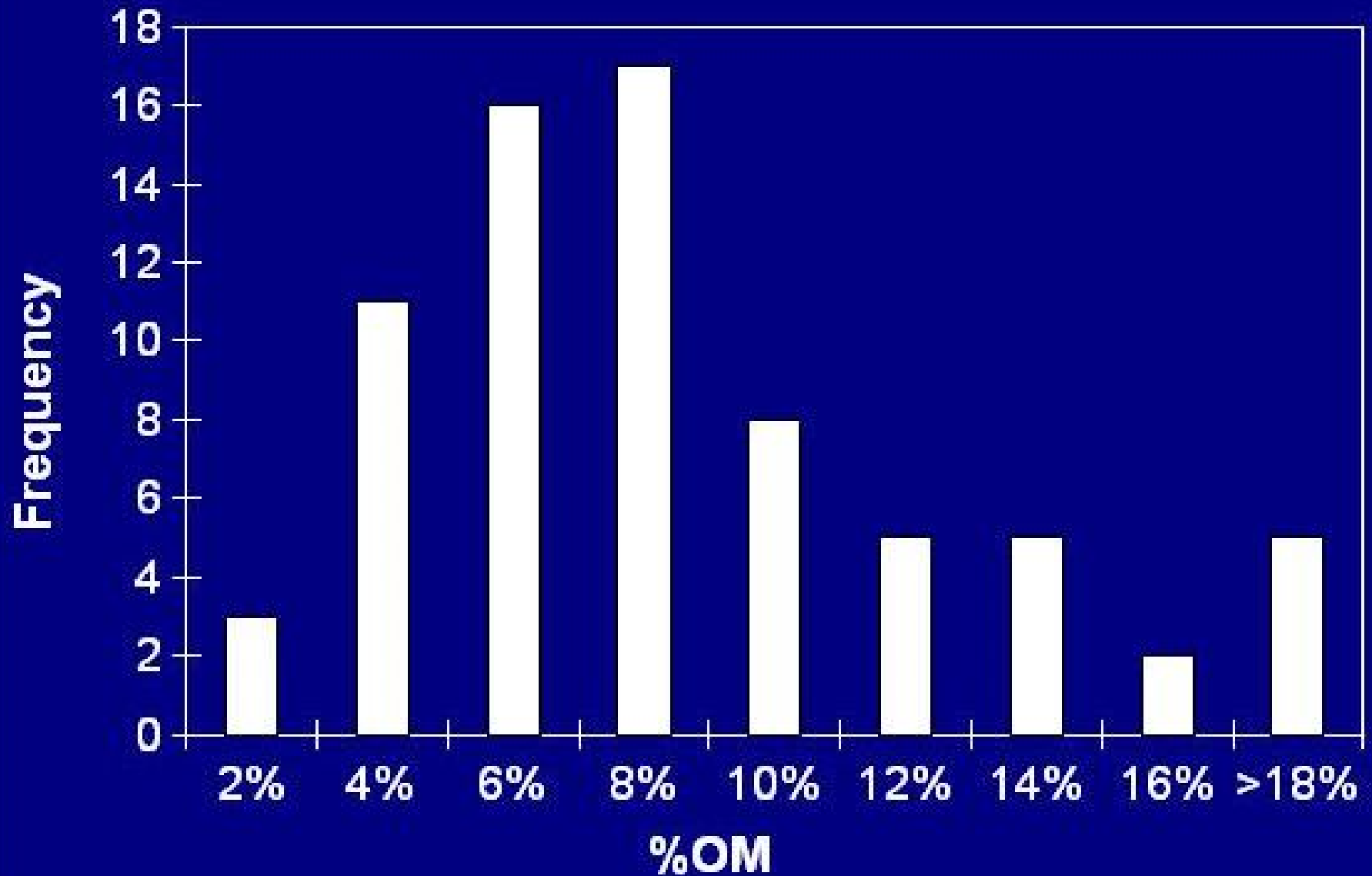




Soil OM – soil moisture model: non-linear,  
increased declines below ~8%.



30 of 72 Tuolumne sites below 8% OM



# The plants make the meadow

Dense, rhizomatous, clonal sedges

- 1) Prevent erosion in sloping wetlands
- 2) Build soil organic content through belowground production
- 3) Slow down burrowing rodents
- 4) Are wetland plants that need high soil moisture

