MEADOW RESTORATION ON NATIONAL FORESTS IN CALIFORNIA: A headwaters approach to water-resources protection during climatic change
WATER-RESOURCE CHALLENGES RELATED TO CLIMATE CHANGE:

- Rain will replace snow at mid-elevations in Sierra
- Larger and more frequent floods
- Decreased duration and volume of base flows
- Increased water temperature
- Increased sediment loads
FOREST MANAGEMENT ACTIVITIES WITH POTENTIAL TO IMPROVE WATER RESOURCES IN RESPONSE TO CLIMATE CHANGE

- Vegetation management
- Fire/fuels management
- Road drainage improvements
- Groundwater storage → meadow restoration
HOW DO MEADOWS AFFECT HYDROLOGIC PROCESSES?

- High flows spread across meadows
- Sediment retained on meadow surfaces
- Alluvial meadow aquifers store runoff
- Meadow plants use stored groundwater
- Slow release of cool, clean water during summer
MEADOWS ON NATIONAL FORESTS IN THE SIERRA NEVADA

- 11,700 meadows within NF boundaries
- 222,000 acres including inholdings
- Roughly another 100,000 acres outside NFs
- Located on streams important for water supply
HISTORICAL LAND USES

- Unrestricted grazing from 1860’s to 90’s
- Road and railroad construction for logging, mining
- Managed livestock and pack stock grazing continues
- Current USFS guidelines provide protection for meadows
MEADOW EROSION

• Gullies have eroded many meadows throughout the Sierra
• Erosion linked to historical land uses
• Climate change and intrinsic thresholds may be factors
EFFECTS OF EROSION

- Floods move quickly through incised gully channels
- Groundwater drains rapidly to gullies
- Streamflow changes from perennial to intermittent
- Meadow vegetation is replaced with woody shrubs, conifers
- Bank erosion accelerates when meadow sod is lost
- Sediment loads increase
- Fish and wildlife habitat threatened
MEADOW RESTORATION ON NATIONAL FORESTS

• USFS restoration began ca. 1940 using check dams
• “Plug and pond” is now commonly used
• Rate of progress controlled by funding
HYDROLOGIC EFFECTS OF MEADOW “PLUG AND POND” RESTORATION

From this Condition ..
Old channel (2000) at 45 CFS

To this condition...
New channel (2007) at ~ 20-25 CFS
POTENTIAL WATER STORAGE IN SIERRAN MEADOWS

- Storage = meadow area \times gully depth \times specific yield
- Restoration benefits could range from 50,000 to 500,000 ac-ft annually
- Additional data collection needed to refine estimates
RECENT RESEARCH

• Studies completed or in progress at UCD, CSUS, Stanford, others
• Results support potential for groundwater storage and flood attenuation
• Higher evapotranspiration after restoration
• Mixed results on baseflow regimen
RESTORATION COSTS

- Roughly $100 to $250 per acre-foot over 10 years based on recent projects
- Little or no long-term maintenance costs
- Limited risk of failure
MAJOR QUESTIONS REMAINING

- Regional potential for groundwater storage
- Hillslope/meadow hydrologic relations
- Sediment budgets and erosion processes
- Effects on baseflow regimen
- Water rights
PLANNED ACTIVITIES

• San Joaquin watershed study begins this year
• Proposal for regional survey submitted to NFWF
• New plug&pond project on Tahoe NF
OUTLOOK

• California has a critical need for additional high-quality water
• Meadow restoration can be a part of the solution
• USFS is interested in developing partners to expand and accelerate restoration efforts
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