Considerations when applying thresholds to management
Outline

• Relationships between thresholds and ecosystem health
• Using S&T models to help make policy and management decisions [ranking the likelihood of autogenic (and non-autogenic) recovery]
Thresholds and Ecosystem Health

• Thresholds are an indicator of ecosystem health (not vice versa)
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• Some ecosystem health indicators may also serve as threshold indicators (both reflect changes in ecological processes)
• IIRH helps understand processes associated with threshold and non-threshold transitions
• IIRH can be used to identify processes that have been modified
  - To decide if management action is required
  - To select appropriate management actions AND the appropriate scale and location in the landscape (rills and water flow patterns)
Ecological threshold crossed?
Ecological threshold crossed?
Yes, probably

Fenced and ungrazed since ca. 1960
Ecological threshold crossed?
Ecological threshold crossed?
No, probably not

Nov. 1971
BLM photo point

Nov. 1990
Ecological threshold crossed?
No, probably not
State transition: Non-eroding grassland $\rightarrow$ eroding shrubland
Pattern
(of plants, soil carbon & nutrients)

Soil nutrients become increasingly concentrated under shrubs (Valentine, 1941)
Pattern/Process

Soil & water runoff and erosion increase during shrub invasion as interspace infiltration.
Pattern/Process threshold

Wind erosion thresholds are crossed as gap sizes increase due to grass mortality (often, but not always, associated with shrub invasion).

Threshold Velocity for Saltation (50-200cm)

[km/h @ 2m vs. Gap Diameter (cm)]
Applying S&T Models to Policy and Management
State transition: Non-eroding grassland → eroding shrubland
Resilience begins to decline – increasing probability of transition (Briske et al. 2006 – NFB’s vs. PFB’s)
Probability of autogenic recovery

"THRESHOLD"

Status of key process (wind erosion) or property (gap size)
"THRESHOLD" Depends on:

- Things we know and can accurately measure or predict (soil erodibility $= f$(soil texture and aggregation))
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- Things we know and can accurately measure or predict (soil erodibility = f(soil texture and aggregation))

- Things we know but can't accurately measure or predict (gap size distribution temporal dynamics = f(precipitation, etc.))
Probability of autogenic recovery depends on:

- Things we know and can accurately measure or predict (soil erodibility = f(soil texture and aggregation))
- Things we know but can't accurately measure or predict (gap size distribution temporal dynamics = f(precipitation, etc.))
- Things we don't know (???)
"THRESHOLD" Conclusion

Our level of certainty about the probability that a threshold transition has occurred is highly variable.
But we DO have some control... over whether a threshold is crossed, and whether or not post-threshold recovery occurs.
Probability of autogenic recovery

Status of key process (wind erosion) or property (gap size)

Limit dry season

grazing (limits large gaps during highest winds)
Probability of autogenic recovery

Limit dry season grazing

Herbicide program

Status of key process (wind erosion) or property (gap size)
Probability of autogenic recovery vs. Status of key process (wind erosion) or property (gap size). The graph shows curves for Limit dry season grazing and Herbicide program.
Decision Constraints

• Regulatory and political (incl. public perception – e.g. fire)
• Technical
• Financial
  – Resources available
  – Opportunity cost
    • Cost of *not* taking action
    • Benefit:cost relative to other projects to which resources could be allocated
Conclusions

• Need to indicate uncertainty associated with probabilities
• We know more, and less, than we think we know
• Recovery potential is stochastic - be ready to act
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