Integrating plant and animal processes in grazing system models.

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How many ungulates should there be?



Is this a difficult question?

Stocking Rate = (Production * Allowable Use) / Animal Intake



- Variable forage base
- Variable intake rate



Sources of Variation

- Weather
- Soils
- Topography
- Hydrology
- Grazing Behavior
- Population Management
- Grazing Management





Savanna Model, M. Coughenour, NREL



Why Model Grazing Systems?

• Aid understanding – complex problems

fuzzy notions -> Data + Algorithms

• Evaluate logical outcomes of our beliefs



Why Model Grazing Systems?

- Aid understanding complex problems
 fuzzy notions -> Data + Algorithms
- Evaluate logical outcomes of our beliefs
- Scenario modeling for assessing management alternatives (forecasting)
- Knowledge transfer

− SCIENTIST ← MANAGER

- Why model grazing systems?
- Types of grazing system models
- Spatial heterogeneity and scale
- Management models
- Where do we go from here?







Integrated Grazing Models and Spatial Heterogeneity

- Animal distribution, seed dispersal
- Dynamic climate variables as drivers
- Climate interpolated over a spatially heterogeneous landscape
- Linkages to underlying GIS (soils, vegetation, topography)







Modeling Herbivore Distribution Patterns

- -Difficult to validate
- -Time-dependent
- -Dependent on factors other than forage





(Weisberg and Coughenour, 2003



More Facts of Nature: As part of nature's way to help spread the species throughout their ecological niche, bison often utilize a behavior naturalists have described as "ballooning."

Larsen, G. 1988. The Far Side When grazing system models are integrative and spatially-explicit:

- We improve our ability to make predictions about the real world, IF
 - Good data
 - Understanding of how processes and data translate across spatial and temporal scales



Herbivore → Vegetation:

-one bite at a time -effects may amplify over large areas and long time periods

Vegetation → Herbivore:

-influences over multiple scales
-coarse scale effects constrain
finer scale herbivore processes



$$I = \frac{R_{MAX}S}{R_{MAX}h + S}$$

Linking models across scales







Linking models across scales



When grazing system models are integrative and spatially-explicit:

• We are working in the realm of limited theory, limited observations (often at the wrong scales)



After Holling 1978, from Starfield and Bleloch 1986

- Why model grazing systems?
- Types of grazing system models
- Spatial heterogeneity and scale
- Management models
- Where do we go from here?

- Management models are especially difficult...
 - Focus is integration not abstraction
 - Management decisions often made over heterogeneous landscape or regional units
 - Objective is accurate forecasts



Management Model Requirements

- Accessibility and transparency
- Strong connections to real-world data



Model-Data Linkages

We need **more**:

- Data collected over extensive areas
- Historical data to validate models for current conditions
- Experimental,longterm controlled grazing studies



Management Model Requirements

- Accessibility and transparency
- Strong connections to real-world data
- Stakeholder and End-User interaction during model development

Manager-Scientist Interaction in the Modeling Process



Institutionalized Model-Making

- Emphasizes process over product
- Facilitates and structures manager-scientiststakeholder interactions
- Integrates and organizes knowledge
- Guides research direction
- Placeholder for continuing development



Sage, Patten & Salmon. 2003. J. Nat. Cons. 10:280-294.

How can Models Support Decision Making?

- "Process over Product"
 - Decision-maker involvement a must
 - Requires transparency, "gaming"

OR

- Accurate Predictions
 - Elusive target
 - Only useful product of "black box" models

ABSTRACTION

- Isolate system
 components of
 particular interest
- Assume homogeneity, equilibrium
- Incremental approach, limited scope
- Easier to do good science

INTEGRATION

- Inclusive of relevant system components;
 Focus on interactions and linkages
- Incorporate & explain contingency
- "reverse reductionism"
- Fuzzy "answers" to big-picture questions

For Management Models: Need cross-fertilization of the two approaches

Happy Holidays!!!



