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Using Adaptive Grazing to Improve Soil Health in Grazing Ecosystems

January 10, 2017 | Stan Boltz

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What is adaptive management?

- A systematic approach for improving resource management by learning from management outcomes.
- Not entirely new, similar to total quality management, continuous improvement, learning organizations, holistic resource management, and the 9 steps of conservation planning.
- Like trial and error, but management decisions are initially made using knowledge of ecological processes, models, previous experience, etc.




Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.; Holling, Crawford S. 1978. Adaptive Environmental Assessment and Management. John Wiley & Sons.

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Adaptive management

- **Ecological economics** – if it makes sense ecologically, it often makes sense economically.
- **Cannot separate the resource mechanisms from the social, institutional, and economic mechanisms.**
- **Economic feedback sometimes provides more complete, sustainable decision making and testing of assumptions, as long as it is measured and utilized in a timely manner, and includes monitoring of ecological processes.**
- **While science, assessment, and monitoring are important, and are often included, normal research is constrained by structured methodologies and does not always fit well in real-world adaptive management.**

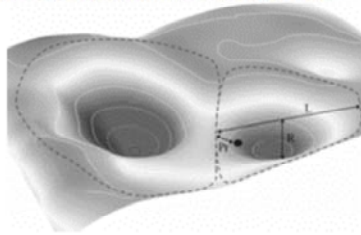
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Holling, Crawford S. 1978. Adaptive Environmental Assessment and Management. John Wiley & Sons.; Holling, Crawford S. 1973. Resilience and stability of ecological systems. Annual Review of Ecology and Systematics. 1-23.; Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. Ecology and Society 9(2): 5. Researchers often find it difficult to apply experimental design to grazing operations.

Systems/states (socio-ecological systems)

Future trajectory determined by:

- **Resilience**
 - **Latitude:** maximum amount a system/state can be changed before crossing a threshold, from which it may be impossible or very difficult to return
 - **Resistance:** the ease or difficulty to change a system
 - **Precariousness:** how close is it to a threshold
 - **Panarchy:** influences from outside of the immediate system/state, such as agency policies, market shifts, political changes, broad-scale climate change, etc.



Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society* 9(2): 5.

Systems/states (socio-ecological systems)

Future trajectory determined by:

- **Resilience**
- **Adaptability** – capacity of managers to influence resilience
- **Transformability** – capacity to create or function in a fundamentally new system when ecological, economic, or social conditions make the current system untenable



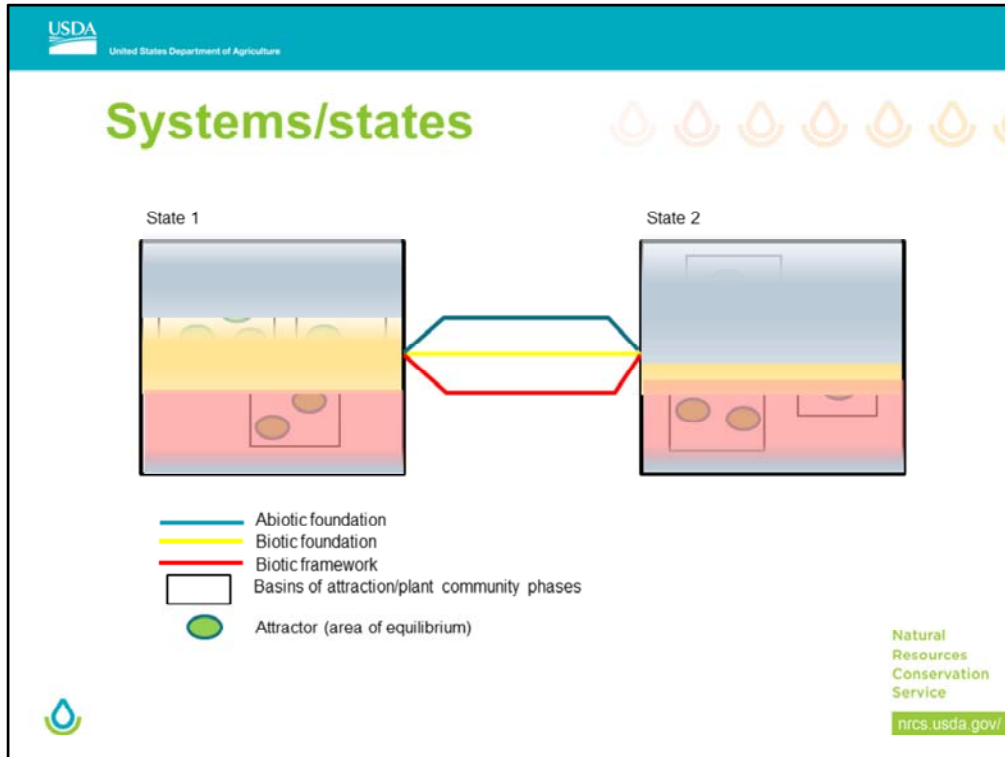
Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society* 9(2): 5.

System/states described/defined in terms of:

- **Abiotic foundation:** interaction of climate, soils, and topography that determine the quantity and quality of available water, air, nutrients, and energy.
- **Biotic foundation:** activity of the soil biota that influence the quantity and quality of the available water, air, nutrients and energy.
- **Biotic framework:** communities of living organisms, whose vital attributes competitively utilize the available water, air, nutrients, and space of the abiotic and biotic foundation.



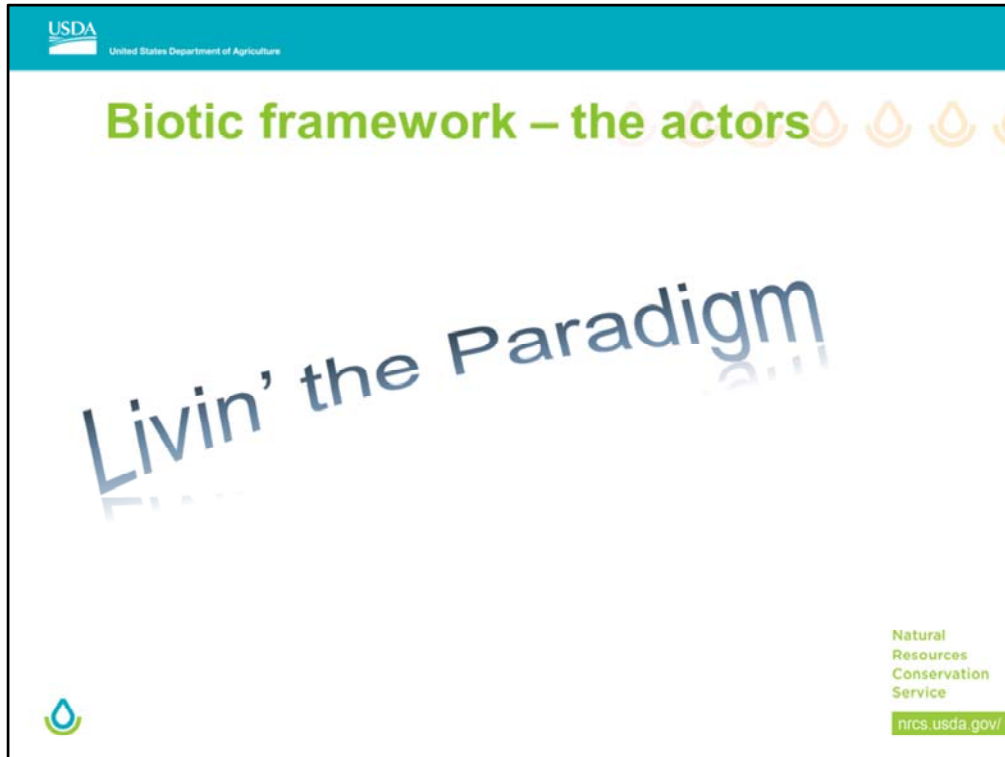
There are three underlying factors that define/determine the characteristics of the state (i.e., latitude & resistance). Meiman, Paul. 2000. Continued Development of Non-Equilibrium Ecology for Rangeland Applications. Presentation at the 2000 International Society for Range Management Annual Meeting.



This figure is used to illustrate the preceding concepts. Meiman, Paul. 2000. Continued Development of Non-Equilibrium Ecology for Rangeland Applications. Presentation at the 2000 International Society for Range Management Annual Meeting.



When we are looking at or measuring soil health, we are usually looking at characteristics of the abiotic foundation and the biotic foundation. We use or try to manipulate the biotic framework to manage for the characteristics we want to see in the abiotic foundation and the biotic foundation. In a given state, these three are in equilibrium at least temporarily, and whatever we do to one has an impact on the others.




Holling refers to managers as “actors”, and there are several general types of actors. The first are those who are “Livin’ the Paradigm”... Life is good, I know what I did yesterday, I know what I’m going to do today, and I know what I’ll be doing tomorrow. Or another viewpoint for these actors is “this is the way my grandpa did it, this is how my dad did it, and by golly this is how it’s gonna be done now.”

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Biotic framework – the actors

Reactive Management



“Spend too much time working in the business, and not enough time working on the business.” Stan Parsons

Fix it when it happens – reliance on technology

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A second type of management is reactive management. This is similar to “Livin’ the Paradigm”, but in this case the actors mainly only react to situations as they happen. So for instance, the manager realizes that the flies are really bad, so a decision needs to be made whether or not to treat the cattle. No thought before this occurs is given to what might be causing increases in flies, just how they’ll be treated if it happens. Some reactive management is necessary in every system though, as not all situations can be predicted ahead of time. Another thought process is the idea that we can just buy something to fix it, an amendment or pill.

Biotic framework – the actors

Adaptive management

- Passive – goal/outcome oriented
- Active – learning is a chief objective (usually results in better predictions over time)
 - Testing assumptions
 - Adaptation
 - Learning



Goal of most management is to reduce uncertainty, adaptive management attempts to use uncertainty as an opportunity, and embrace change – learn from it and utilize it to inform future direction.



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Then there are the actors who practice adaptive management.

Walters, Carl J. 1986. Adaptive Management of Renewable Resources. Macmillan Publishing Company, New York. 374 p.

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Adapting economically


“Government subsidies only serve to keep the poor managers in business.”

“If we didn’t do something to change the way we were doing things, we would have went broke.”

A lack of economic feedback can lead to poor decision making, and ultimately to uncoupling of the abiotic & biotic foundation, and the biotic framework.

Economic feedback can lead to questions and seeking solutions outside the normal operating mode.

<https://www.youtube.com/watch?v=fjdVQPBBqXQ>

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Luckily, according to the experts adaptive management can become a way of doing business even without formal training or perhaps without ever having heard the term adaptive management. Various feedback mechanisms can lead to operating in this fashion, but economic triggers are effective. Here are a couple quotes from producers that may serve to illustrate this. And if you don’t believe me on that last point, watch this video.


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Adaptive management & non-equilibrium ecology/state and transition modeling

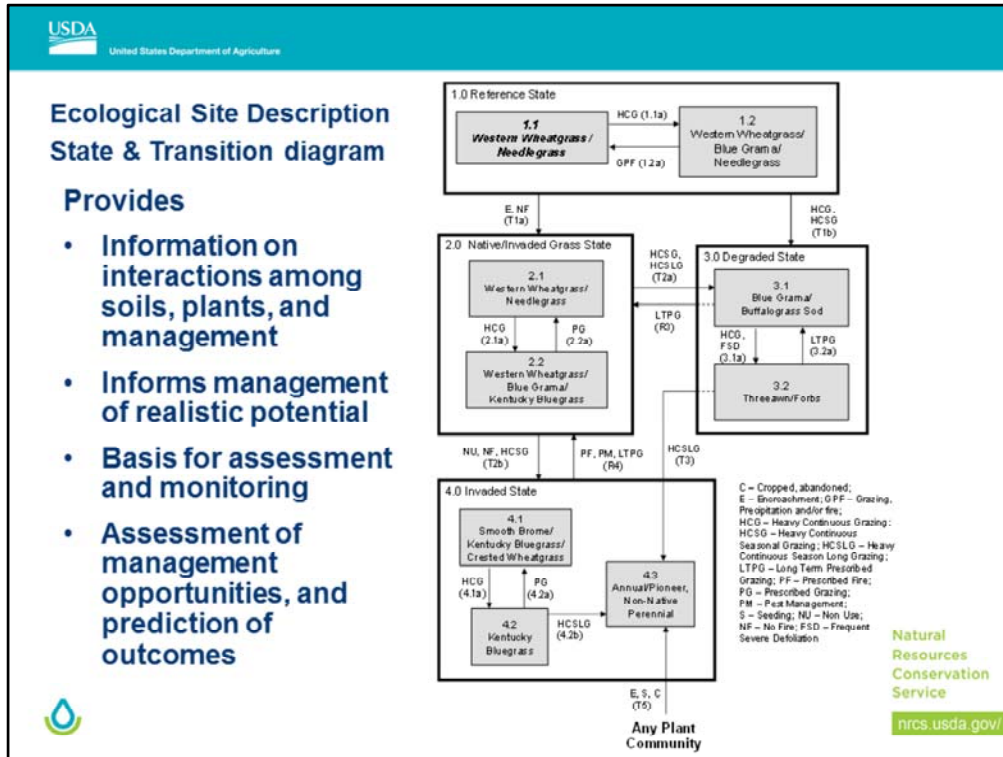
The non-equilibrium ecology approach and state and transition modeling (and associated tools) utilized in the development of ecological site descriptions can serve as an excellent tool for:

- learning about interactions of plants, soils, animals, and the ecological processes they influence
- informing managers about expected outcomes
- increasing ability to interpret and predict feedback from systems
- selecting monitoring tools to assess objective achievement

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The theories behind adaptive management and non-equilibrium ecology & state and transition models have many things in common. I suggest that state and transition diagrams could be used as a tool in the adaptive management process.



Peacock, George, and Stan Boltz. 2002. Ecological Sites: Understanding the Landscape. Rangelands 24 (5). 18-21.

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Assessing soil health – Rangeland Health Assessment

Principles of soil health:

1. Use *plant diversity* to increase diversity in the soil.
2. Manage *soils* more by *disturbing* them *less*.
3. *Keep plants growing* throughout the year to feed the soil.
4. Keep the *soil covered* as much as possible (*hydrology*).

➤ Rangeland Health attributes:

- Hydrologic function
- Soil and site stability
- Biotic integrity

Printz, Jeff, David Toledo, Stanley C. Boltz. 2014. Rangeland Health Assessment: The key to understanding and assessing rangeland soil health in the Northern Great Plains. *Journal of Soil and Water Conservation*. 69 (3), 73A-77A.

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Another tool incorporated with ecological site descriptions is the Rangeland Health Assessment. There is a strong linkage between the first four principles of soil health and the three attributes of the Range Health Assessment. Printz, Jeff, David Toledo, Stanley C. Boltz. 2014. Rangeland Health Assessment: The key to understanding and assessing rangeland soil health in the Northern Great Plains. *Journal of Soil and Water Conservation*. 69 (3), 73A-77A.

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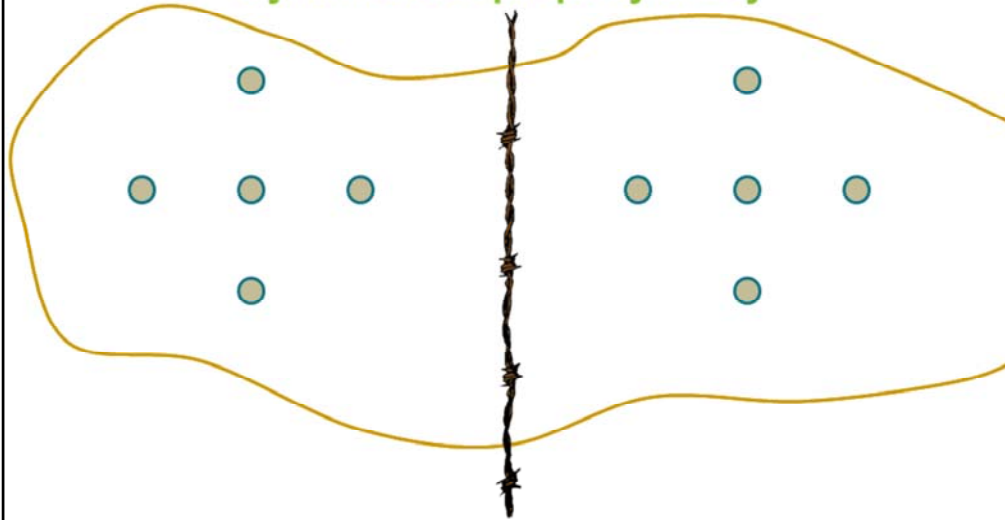
Assessing soil health – Rangeland Health Assessment

- **Established methodology, already in use by most land management related agencies.**
- **Good linkage to significant characteristics pertaining to soil health on grasslands (dynamic soil property study sites).**
- **Similar approach being considered for pasture (Toledo 2014).**
- **Ability to assess soil health characteristics using relatively simple field techniques.**

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Toledo, David, Matt Sanderson, Jeffrey Herrick, Sarah Goslee. 2014. An integrated approach to grazingland ecological assessments and management interpretations. *Journal of Soil and Water Conservation*. 69 (4). 110A-114A.

Dynamic soil property study



Paired sites are located on same soil, but widely different management





Barnes soil



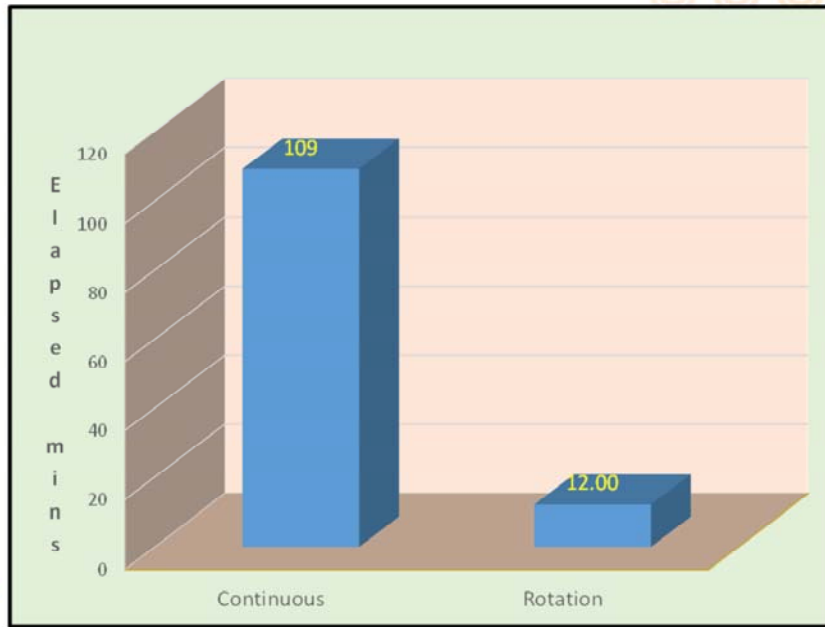
Heavy, continuous season-long grazing

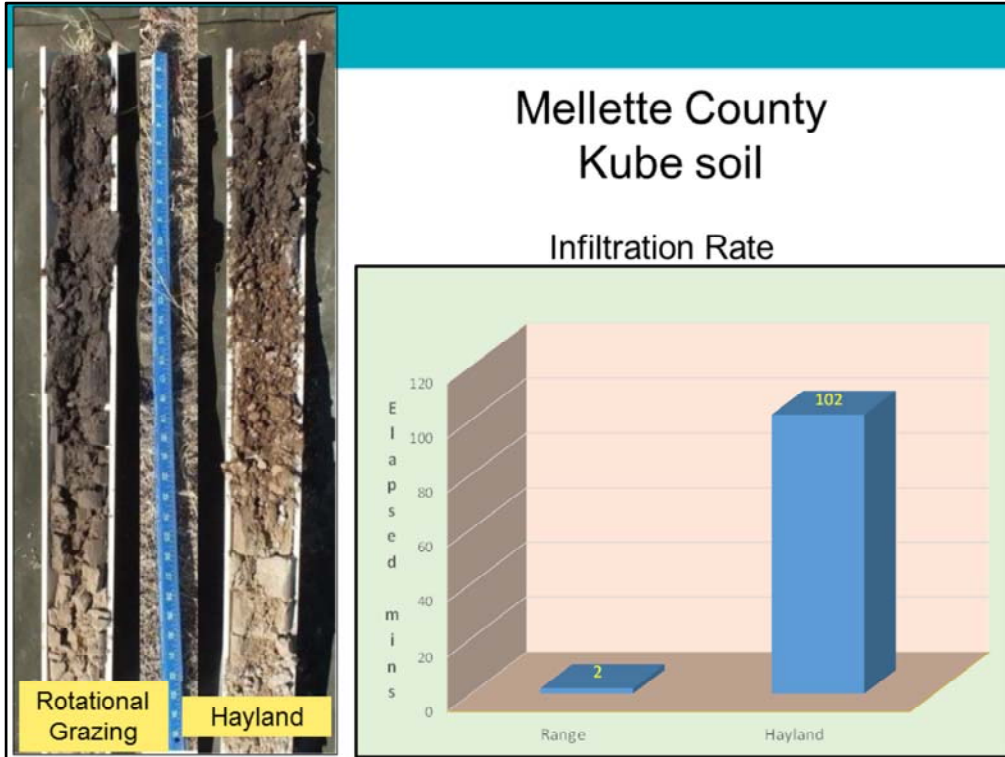


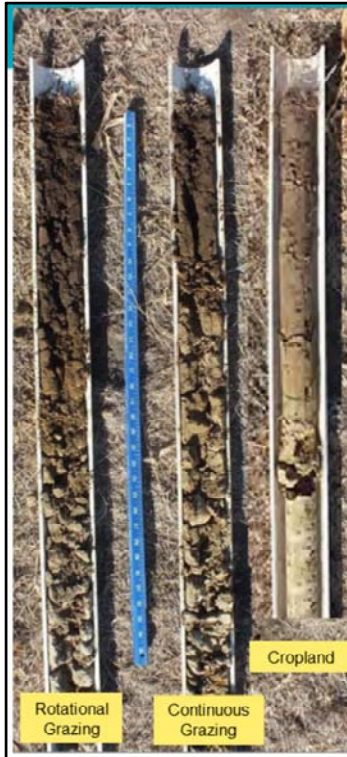
Moderate, rotationally grazed



Infiltration - Barnes

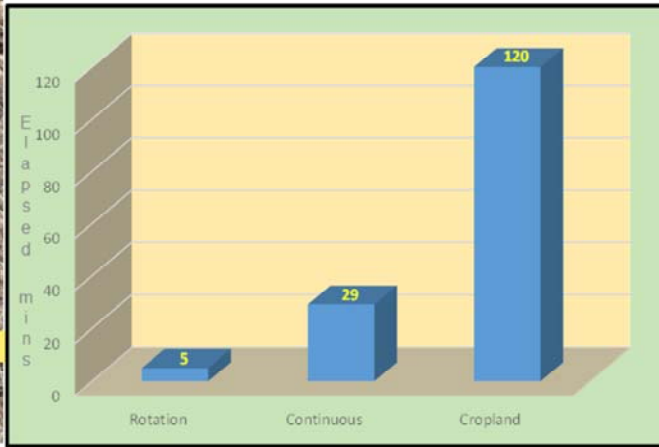






Hyde County Glenham soil

Infiltration Rate



Consistent results from DSP study

- Soil color (surrogate for organic matter)
- Soil structure
- Amount of compaction
- Soil aggregate stability
- Infiltration

These are the same soil health related indicators assessed in the Range Health assessment – plus they are evaluated using relatively simple field tests and observations.



Most of the standard field test/observations have been very consistent.

Adaptive grazing management – the actors

These are assessments that can be conducted by producers applying adaptive management with a minimal amount of training...

What are some key characteristics of those applying adaptive management and some of the grazing strategies they use?



Characteristics of successful operations

- **The most successful operations were determined by management's response to opportunities and challenges.**
- **Value individual education and growth.**
- **Flexibility.**
- **Understand that diversity is a critical element, in all aspects of the operation and system.**



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Dunn, Barry H.; Pruitt, Dick; Hamilton, Edward; and Griffith, Duane, "Factors Affecting Profitability of the Cow-calf Enterprise in the Northern Great Plains" (2005). South Dakota Beef Report, 2005. Paper 10. Dunn, Barry H. and Etheredge, Matthew, "Key Indicators of Success in Ranching: A Balanced Approach" (2005). Range Beef Cow Symposium. Paper 47.

Characteristics of successful operations

- **A lifelong approach to management needs to be both integrative and holistic.**
- **We must strive for continuous improvement of the key resources. On most ranches these will be land, livestock and people; but could expand to include wildlife or other resources.**
- **We must assemble and use good analysis and decision-making tools.**
- **We must wage war on cost.**
- **We must place an emphasis on marketing.**

Burke Teichert, retired vice president and general manager of Ag Reserves Inc. (a.k.a. Deseret)



Principles of grazing management

- **Proper utilization – “take half – leave half” – some species can tolerate heavier grazing, while others may be targeted to achieve resource objectives**
- **Adequate recovery periods – this changes throughout the season, shorter during rapid growth and longer during slow growth**
- **Change season of use – allows for recovery between years, especially important in mixed-grass prairies**



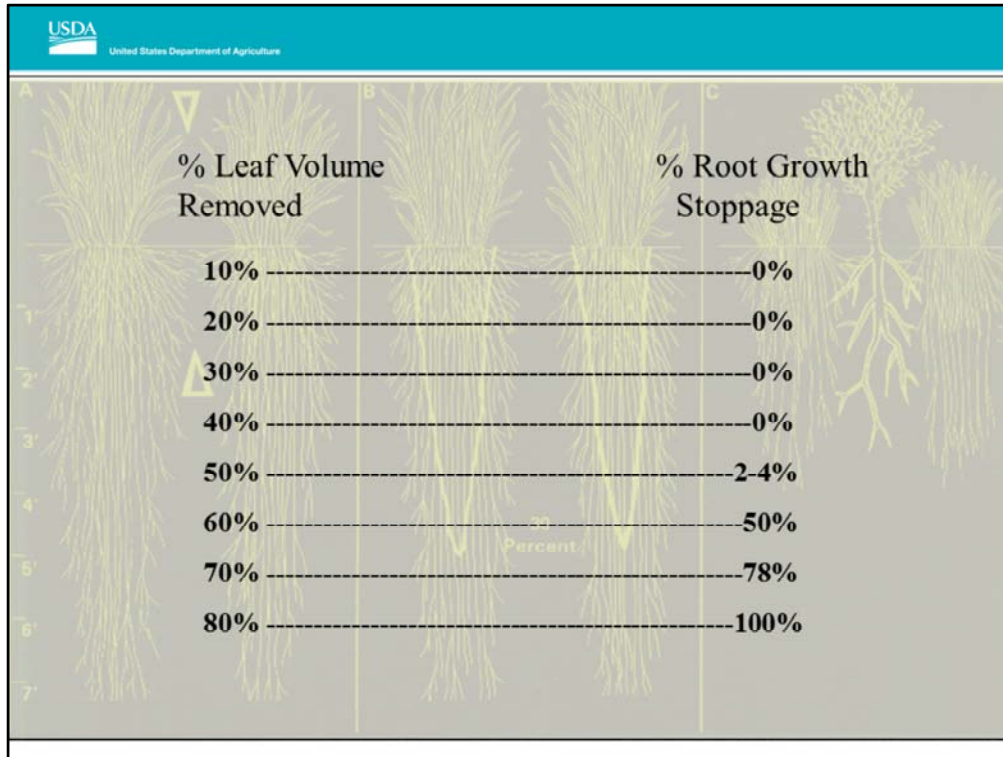
Now I'd like to talk about what some of the most successful producers are doing from my experiences. First, is an understanding and incorporation of some basic principles of grazing management.

Principles of grazing management

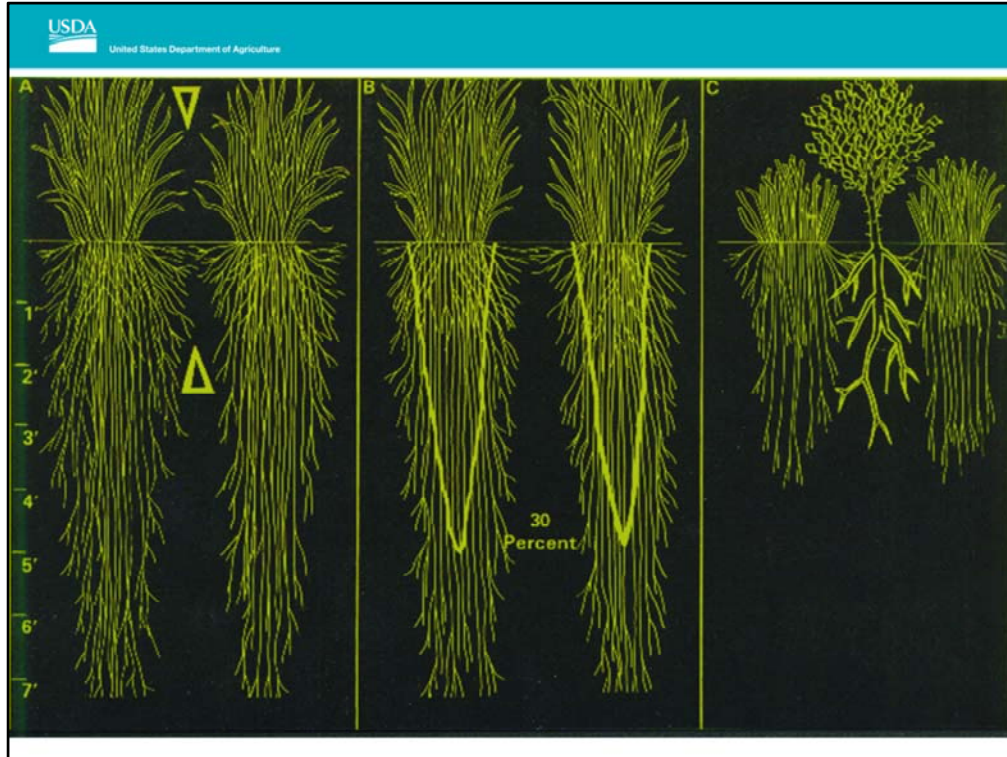
Take half – leave half?

- **Idea was first mentioned in the 1940's**
- **Landmark study done in 1955**
 - Many replications of grasses
 - Different levels of defoliation by weight
 - Measured effects on roots
- **Other studies have supported these findings**





From "Grass: The Stockman's Crop" - At 50% defoliation, 2-4% of the roots stop growing, for a period of time. With each successive level of defoliation, not only is the percentage increased, but the time that root growth stops also increases. This could effectively shut down a grass plant for the year depending on when the defoliation takes place. Crider, Franklin Jacob. 1955. Root-growth stoppage resulting from defoliation of grass. No. 1102. U.S. Department of Agriculture.



30-50% of grass roots disappear every year, and have to be replaced by the grass plant. So any root growth stoppage can have an impact on the grass plant.

Principles of grazing management

Leaves – the facts of growth

- Roots uptake and send water & nutrients to the leaves
- Roots **DO NOT** transport carbohydrates to the leaves
- Leaves need carbohydrates to respire
- 5-10% of new leaf growth is from residual sheath & crown carbohydrate reserves
- 90-95% of new leaf growth comes from the carbohydrates resulting from current photosynthesis
- **Bottom line – it takes leaves to make leaves**



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Grazing strategies



Graze cattle 12 months of the year

- **Cattle are much more efficient harvesters – minimize feed costs, but keep some on hand for emergencies**
- **Winter grazing on rangeland/pasture**
- **Develop alternative forage sources**
 - Crop aftermath
 - Cover crops
 - Utilize in a manner to retain soil health benefits
 - Limit percentage of Brassicas or provide grass
 - Establish grass in saline/sodic areas or other “odd areas” within cropland to provide balance
 - Annual forages



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I'm not going to take time to try and describe different grazing systems or promote one over the other – like a friend once said, grazing systems are like spider webs – no two are the same and they have to fit your operation. But I will cover some overall grazing strategies that some of the most successful operators I know are using.

Grazing strategies



Rotate cattle

- **Best way to control utilization and recovery periods**
- **Has been shown to reduce pest cycles, and can effectively be used to reduce “weeds”**
- **Portable fence and water systems can reduce costs**
- **Word of advice – start small**
- **Develop a drought/contingency plan – follow it**



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Grazing strategies



Winter grazing

- Continue to rotate cattle during the winter months
- Develop reliable, clean water sources
- Need to consider nutrient needs of growing animals, may need supplementation
- Leave cover for benefit of plants and other critters, also additional snow catch
- Monitor animal condition through the winter months
- Bale/swath grazing can reduce feeding costs & time



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Grazing strategies



Provide for flexibility

- **Maintain a portion (e.g., 1/4 to 1/3) of the herd as stockers/yearlings – can be quickly liquidated in case of drought or other emergencies**
- **“Stockpiling” – either in the normal sense of stockpiling forage in a field for later use, or in terms of deferment during the growing season as “insurance”**
- **Consider multiple species of livestock**



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Grazing strategies



Match animals to resources/environment

- **Nutrient requirements/maintenance needs of animal**
 - Maintenance requirements of animals may exceed the environment
 - Animals having difficulty may indicate mismatch
- **Timing of requirements vs. availability**
 - When do the native large herbivores give birth?
 - Adjust parturition timing to line up peak requirements as close as possible to peak forage quality and sufficient quantity



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Adaptive management tools

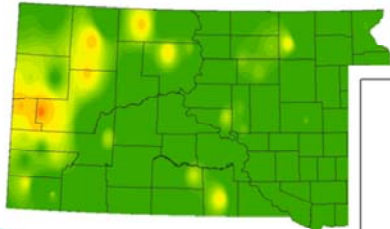
Calls for using models/tools to develop and refine management alternatives – examples:

- **Ecological Site Descriptions/state and transition models**
- **SD Range Tool/ND Grass Tool: develop a feed/forage – animal balance and grazing plan**
- **SD Drought Tool/ND Drought Calculator: determine effect of reduced precipitation and develop plan to address**
- **SD Monitoring Tool – Monitoring Manual for Grassland, Shrubland and Savannah Ecosystems – DIMA**
- **Rangeland Health Assessment**

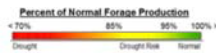


Adaptive management tools

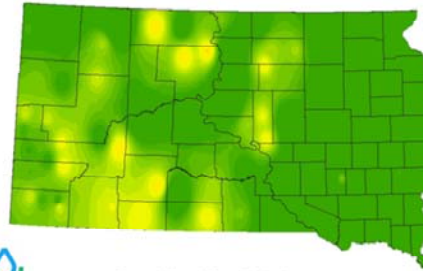
South Dakota Grasslands Drought Condition
Current Status - January 1, 2017



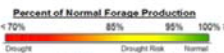
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South Dakota Grasslands Drought Condition
Projected Peak Production* (July 1) - January 1, 2017



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South Dakota



*Projected status assuming future average precipitation (30-50 year average).



Adaptive management tools

Calls for using models/tools to develop and refine management alternatives – examples:

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- **SD Range Tool/ND Grass Tool: develop a feed/forage – animal balance and grazing plan**
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- **Rangeland Health Assessment**



The Talk of Adapting



- **First to try swath grazing in this area**
- **Seed enough corn to graze cattle for the whole winter**
- **Bale grazing in the winter works in nearly all conditions, had to buy a pair of snowshoes, but have not used any diesel fuel**
- **Cut costs and maximize outputs**
- **Use the cattle to harvest the feed instead of doing it for them**
- **So much potential to make money in agriculture**
- **Meant to be a grazing animal, don't need to bring the feed to them**
- **Extend grazing 80 to 120 days each year**
- **Have to be flexible in our operation**

Alberta Agriculture: <https://www.youtube.com/playlist?list=PLOUwIF01x2YVXr2cBui0KqskBRwZsKwMr>



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Questions?

<https://www.youtube.com/watch?v=fjdVQPBBqXQ>

<https://www.youtube.com/playlist?list=PLOUwF01x2YVXr2cBui0KgskBRwZsKwMr>



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