

RANGELAND SOIL HEALTH

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Service

Impact of management on cropland hydrologic processes

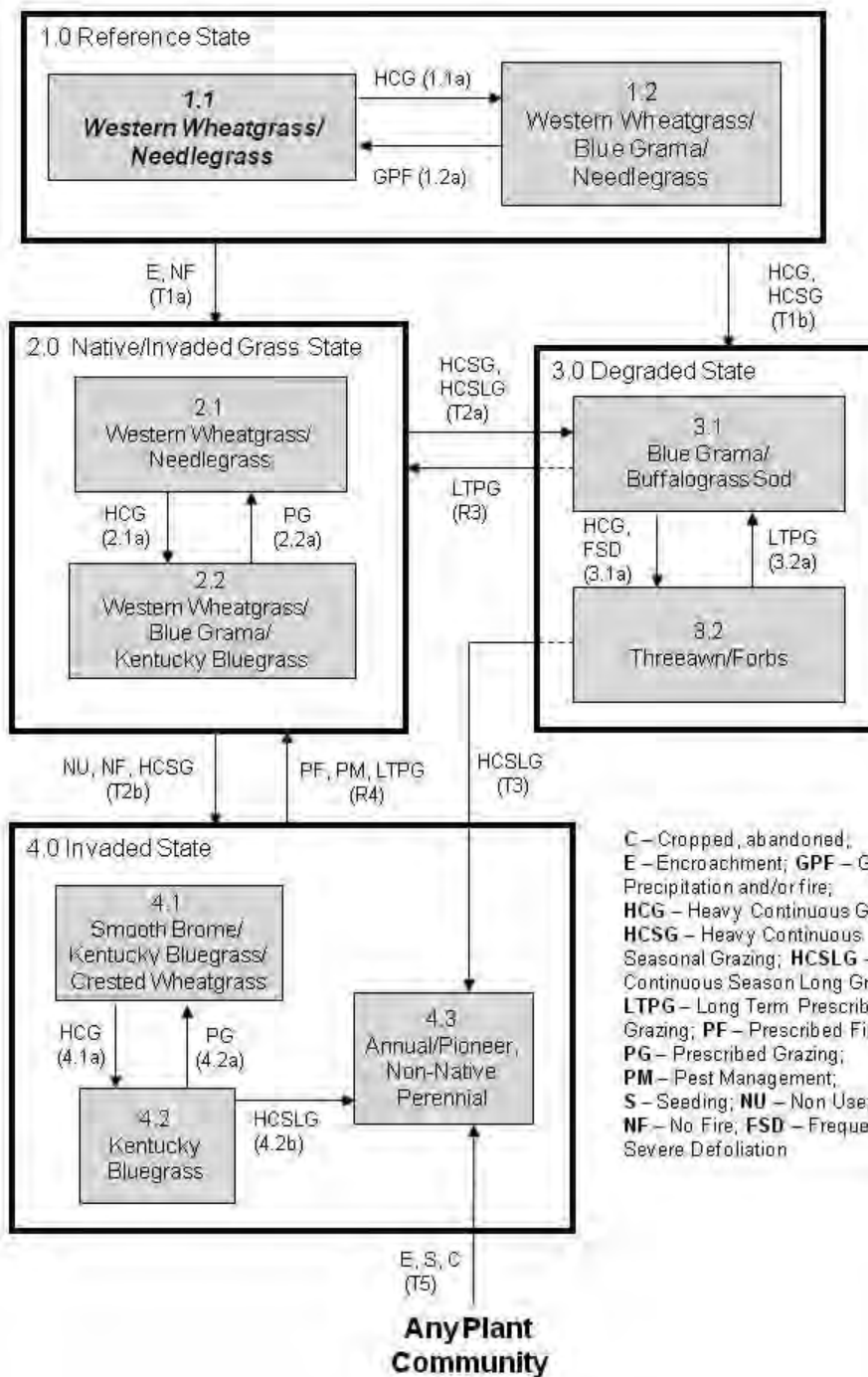


Ecological processes on rangelands

- ▣ Assessing the effects that management and/or invasive species have on the ecological processes is an effective way to evaluate soil health on rangelands.
- ▣ Rangeland ecological processes can be grouped into three categories, or attributes:
 - Hydrologic function
 - Soil and site stability
 - Biotic integrity

Effect of invasive species

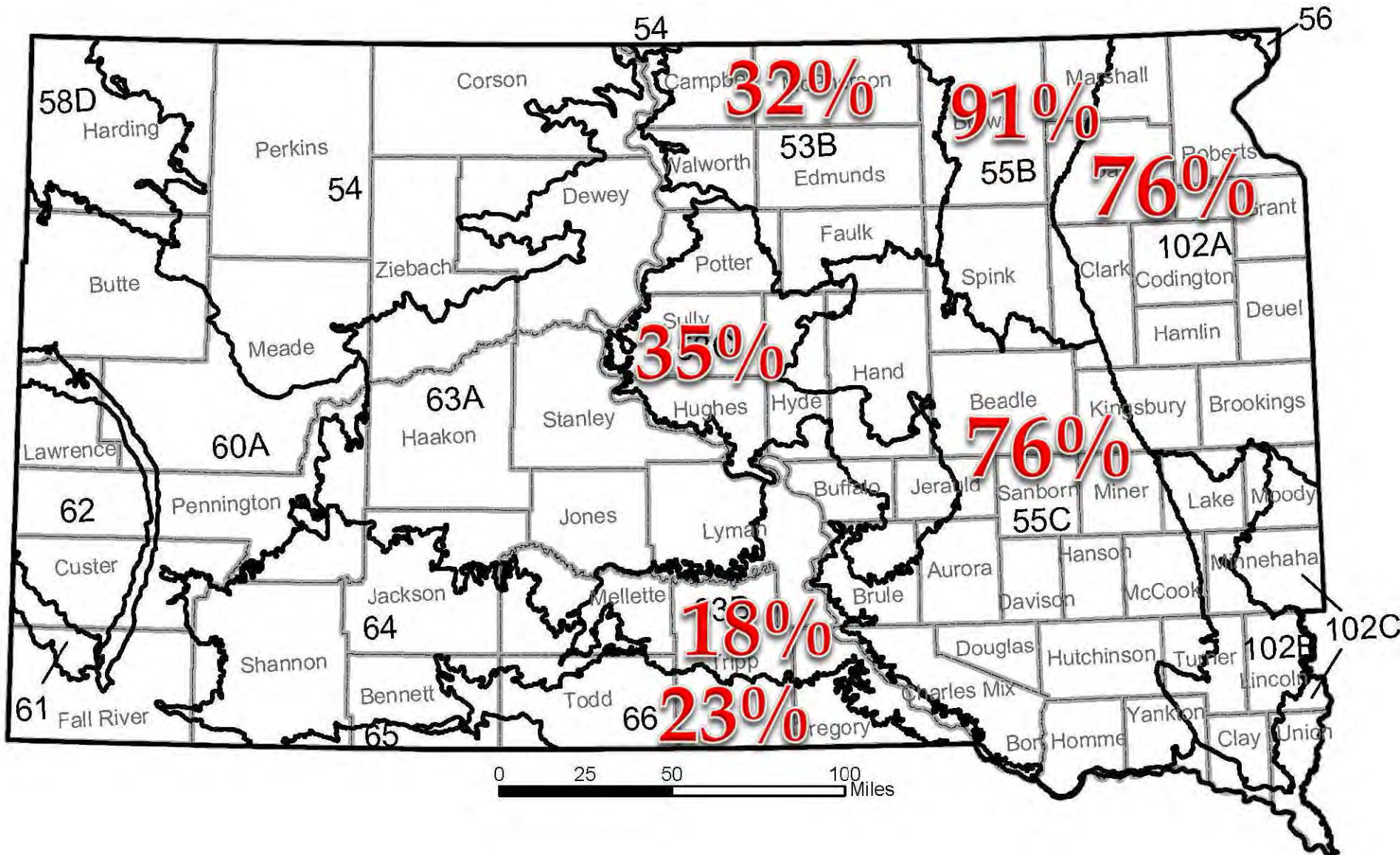
- ▣ More will be discussed later about the relationship between soil health and the three major attributes considered during a Range Health assessment.
- ▣ Before we continue, let's look at some of the specific impacts that invasive species can have on rangelands and soil health.
- ▣ Consider states and thresholds on rangeland ecological sites:



Kentucky bluegrass threshold in the Northern Plains

- ▣ Proposed threshold between the Native/Invaded State and the Invaded State occurs when native grasses decline to $< 40\%$ of the plant community and invasives (e.g. Kentucky bluegrass) increase to $>30\%$ of the plant community

Extent of invaded state in SD



Extent of Kentucky bluegrass

▣ North Dakota

- On non-federal grasslands, Kentucky bluegrass was present on > 50% of randomly sampled points.

▣ South Dakota

- For the eastern half of the state on non-federal grasslands, Kentucky bluegrass was present on >50% of randomly sample points.
- On 5 to 25% of random points in the western half of the state.

Hydrologic effects

LOAMY SITE

MLRA 106 Nebraska and Kansas Loess-Drift Hills

	I (Native)	II (75% Kbg; 25% Sb)	III (75% Sb; 25% Kbg)
Precipitation	25"	25"	25"
Interception	.13	.10	.15
Surface Runoff	5.00	11.25	7.50
Infiltration	19.25	13.00	17.00

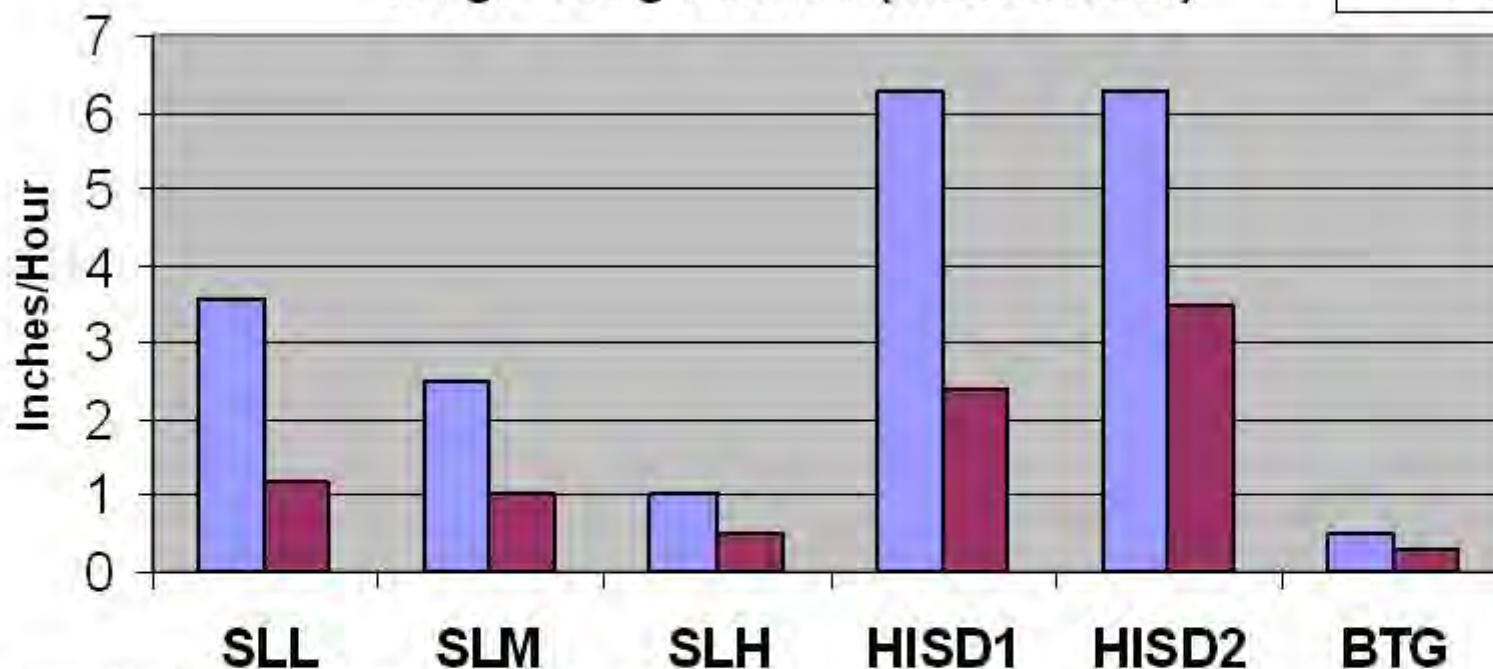
*** Kbg - Kentucky bluegrass; Sb - smooth brome grass**

Grassland Grazing Systems Water Infiltration Rates

Loamy Ecological Site (Williams Loam)

Single Ring Method (Inches/Hour)

First Inch
Second Inch



SLL- Kentucky bluegrass dominated

SLM- Kentucky bluegrass dominated

SLH- Kentucky bluegrass dominated

HISD1- Diverse native community

HISD2- Diverse native community

BTG- Brome Tame Grass Pasture

Dr. Jimmy Richardson
and Dr. Jay Volk

* SL – season-long; HISD – high intensity, short duration

WEPP Studies

- ▣ Based on WEPP Studies and other research in the Great Basin, infiltration and production of sediment/runoff is impacted by the similarity index of the site.

Blackburn, W.H., and C.M. Skau. 1974. Infiltration rates and sediment production of selected plant communities in Nevada. *Journal of Range Management*, Vol. 27(6), p. 476-480.

Why do invasive species alter hydrology?

- ▣ Soil Modification by Invasive Plants: Effects on Native and Invasive Species of Mixed-Grass Prairies, 2008, Nicholas Jordan, Diane Larson, and Sheri Huerd
 - Loss of soil microflora and microfauna, specifically the native mycorrhizal fungi
 - Impact to native species – alters soil to make it uninhabitable for native grass species

Dynamic Soil Properties

- ▣ Study was initiated to look at
 - Effect of management/invasive species on soils
 - Further define causes of transitions between states
- ▣ What are the dynamic soil properties
 - Color/organic matter
 - Soil aggregate stability
 - Bulk density/porosity
 - Microflora and microfauna
 - Carbon:Nitrogen ratio
 - Infiltration

Dynamic Soil Properties

Barnes – Loamy ecological site



Barnes soil

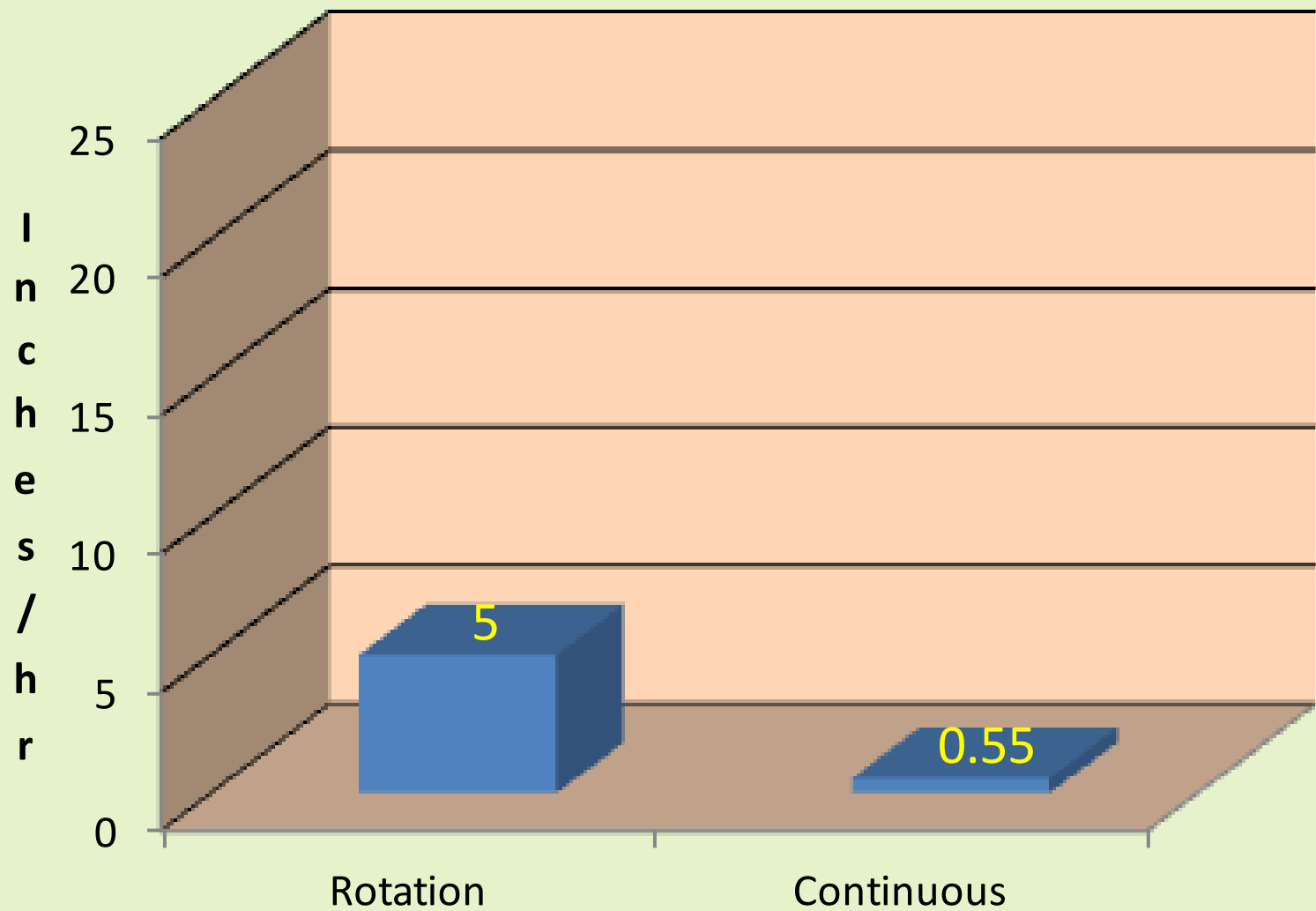


Heavy, continuous season-long grazing

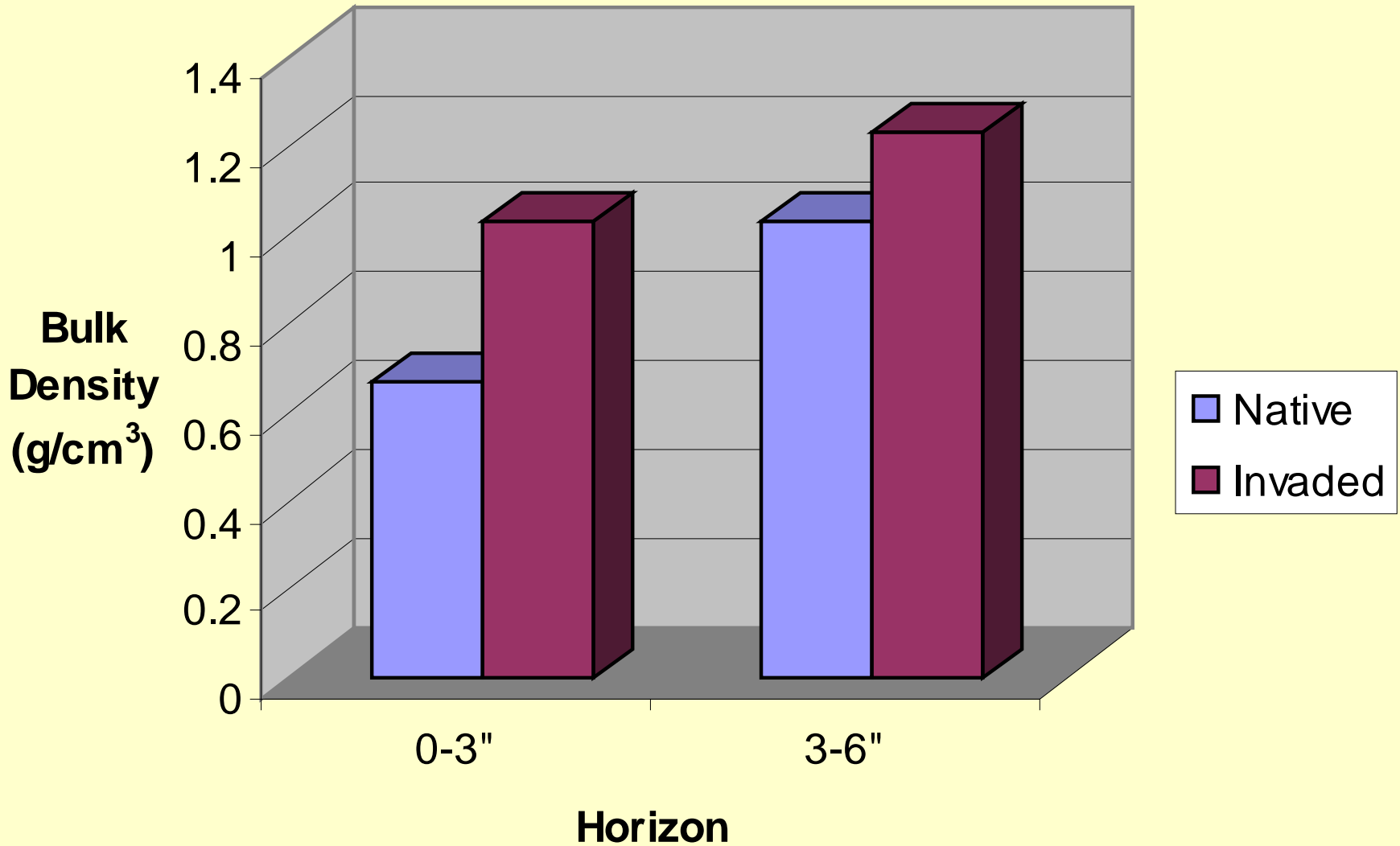


Moderate, rotationally grazed

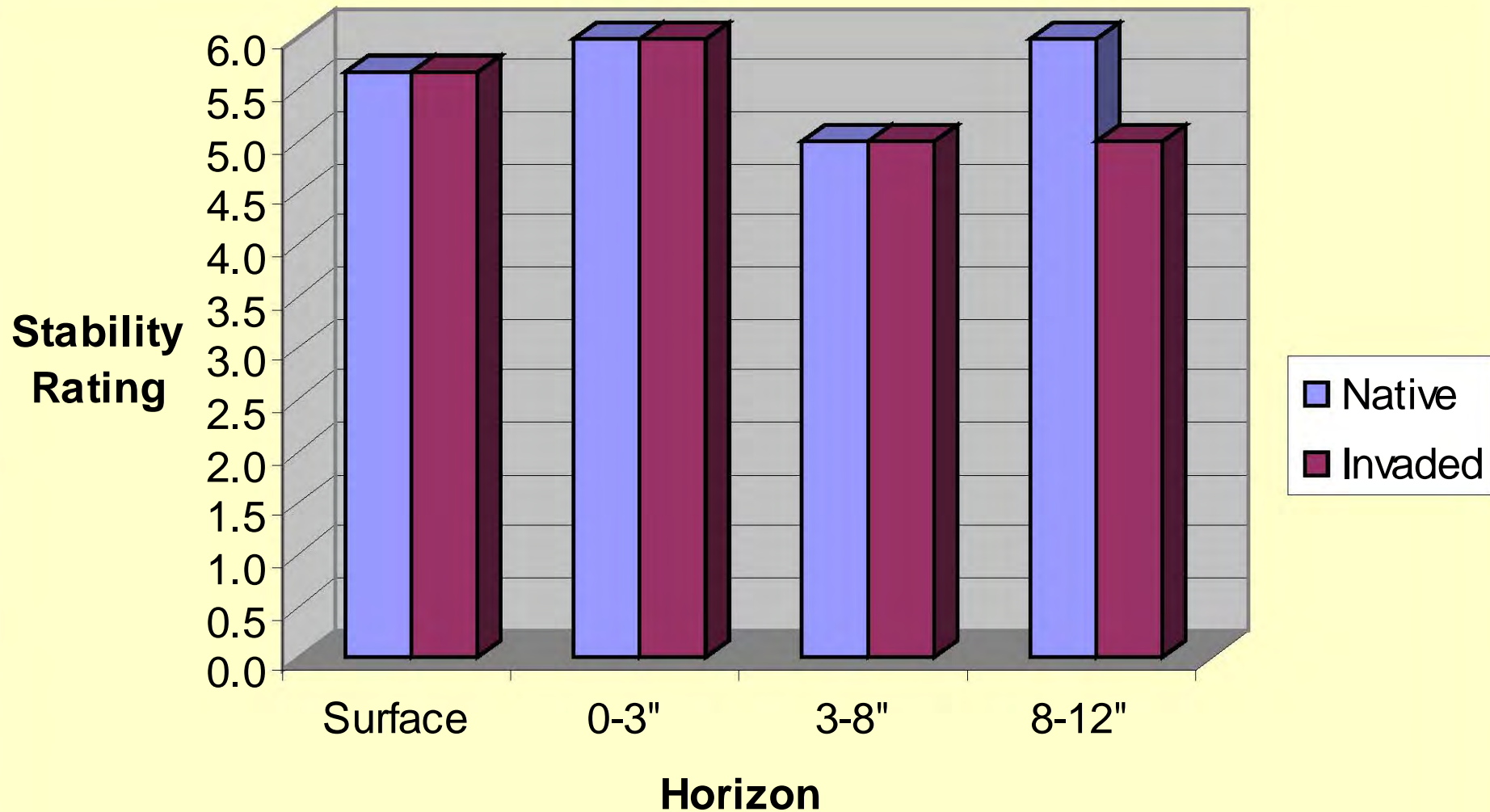
Infiltration



Bulk Density



Soil Aggregate Stability



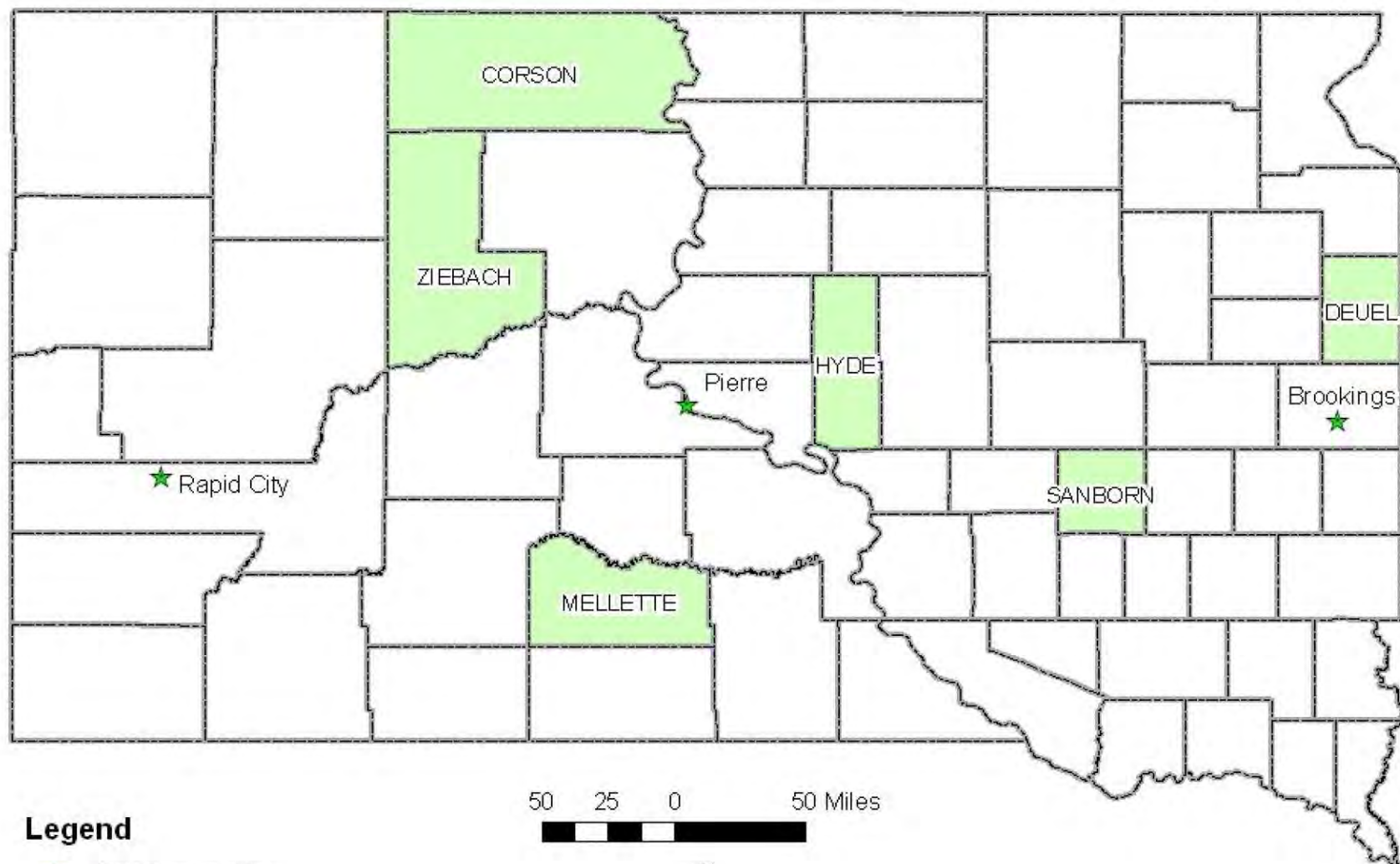
Carbon/Nitrogen Ratio

- ▣ No appreciable difference
- ▣ Organic matter
 - Total amount not greatly different
 - Distribution significantly different – better distribution of organic matter in the soil profile under rotationally grazed

Glomalin

- ▣ An indicator of arbuscular mycorrhizal fungi activity.
- ▣ Native grass site had 20% more glomalin in the soil profile compared to the invaded grass site.
 - Is this enough of a difference to be considered a trigger for the effect on infiltration?
 - Would the change in glomalin be sensitive enough to use as an early warning sign?

Dynamic Soil Properties Study Sites

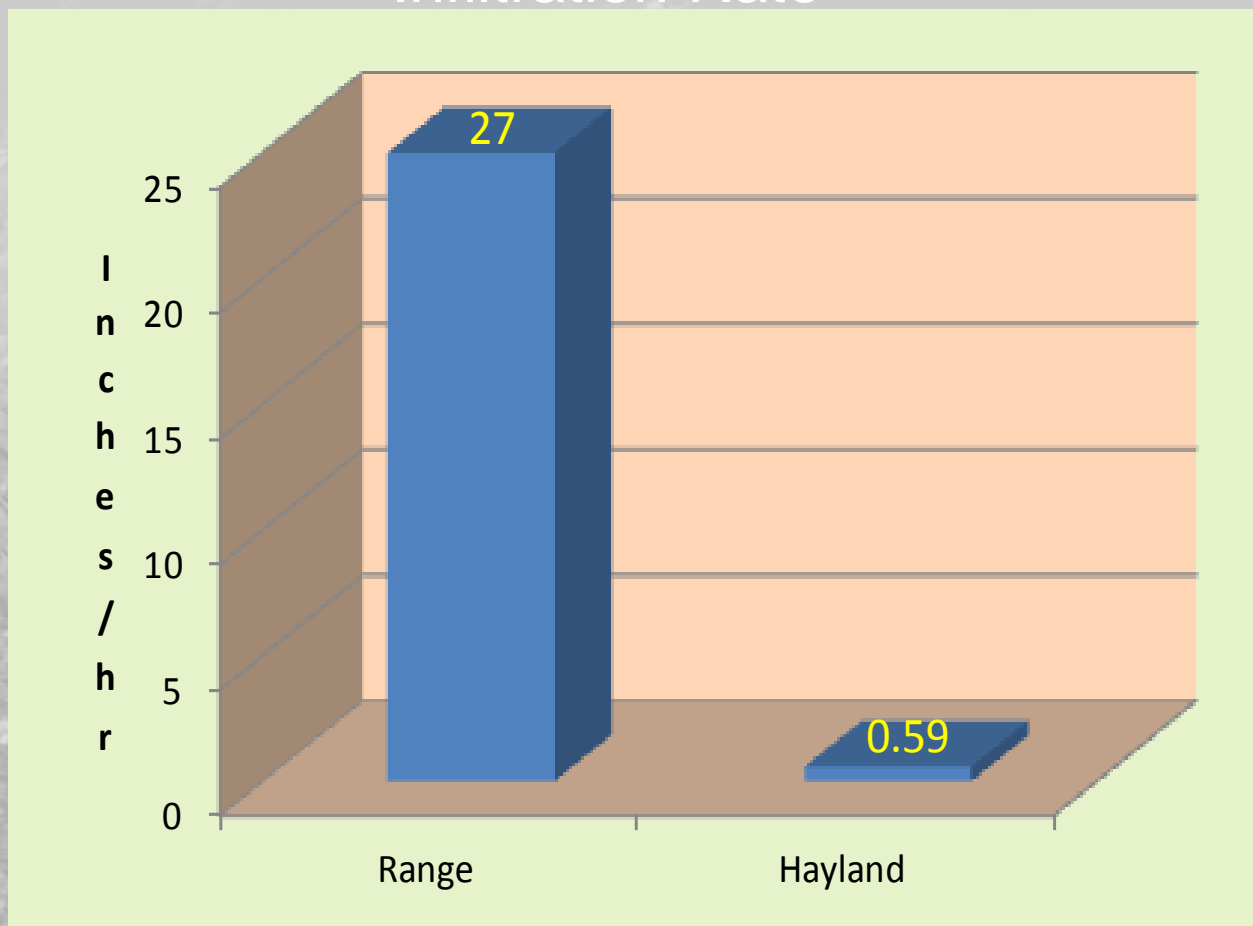
**Legend**

- ★ Field Support Office
- DSP Study Sites
- County Boundary

Source: USDA-NRCS
South Dakota State Office
GIS Branch
Projection: Mercator
Date: February 2013

Mellette County Kube soil

Infiltration Rate



Rotational
Grazing

Hayland

Kube Soil - Native Range site

Infiltration Rates

SD002-1 30 sec.
SD002-2 2 min.25 sec.
SD002-3 34 sec.
SD002-4 50 sec.
SD002-5 6 min. 47
sec.
Average - 2 min. 13
sec.

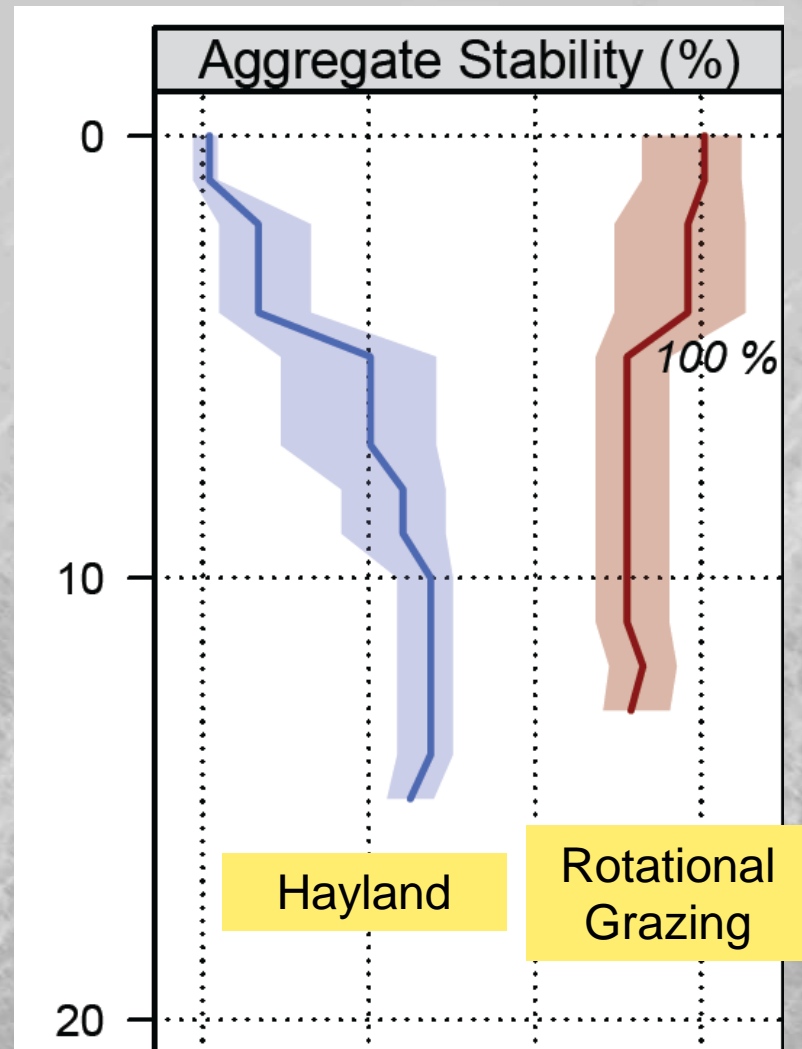


Kube Soil - Cropland site

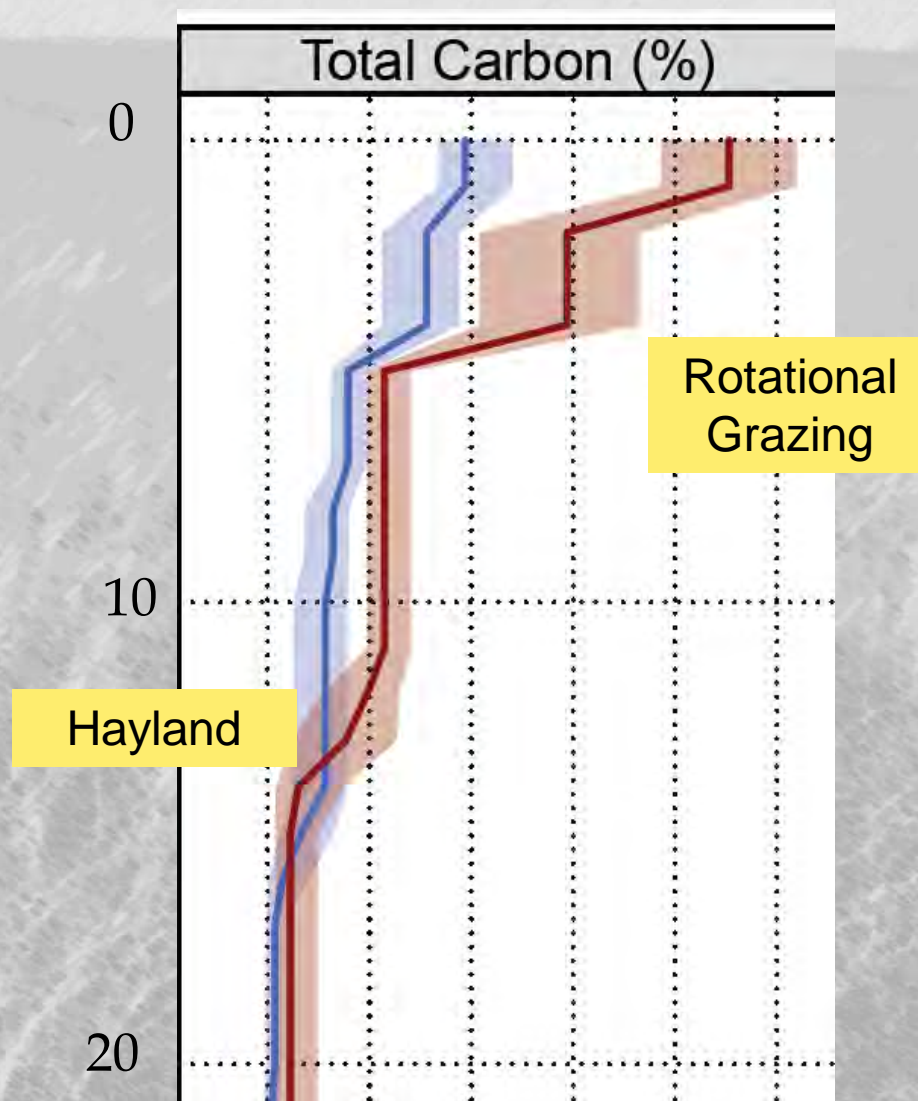
Infiltration Rates

SD001-1 3hr. 57 min.
SD001-2 34 min.
SD001-3 37 min.
SD001-4 52 min.
SD001-5 2 hr. 29 min.
Average - 1hr. 41 min. 48
sec.

Mellette County Kube soil

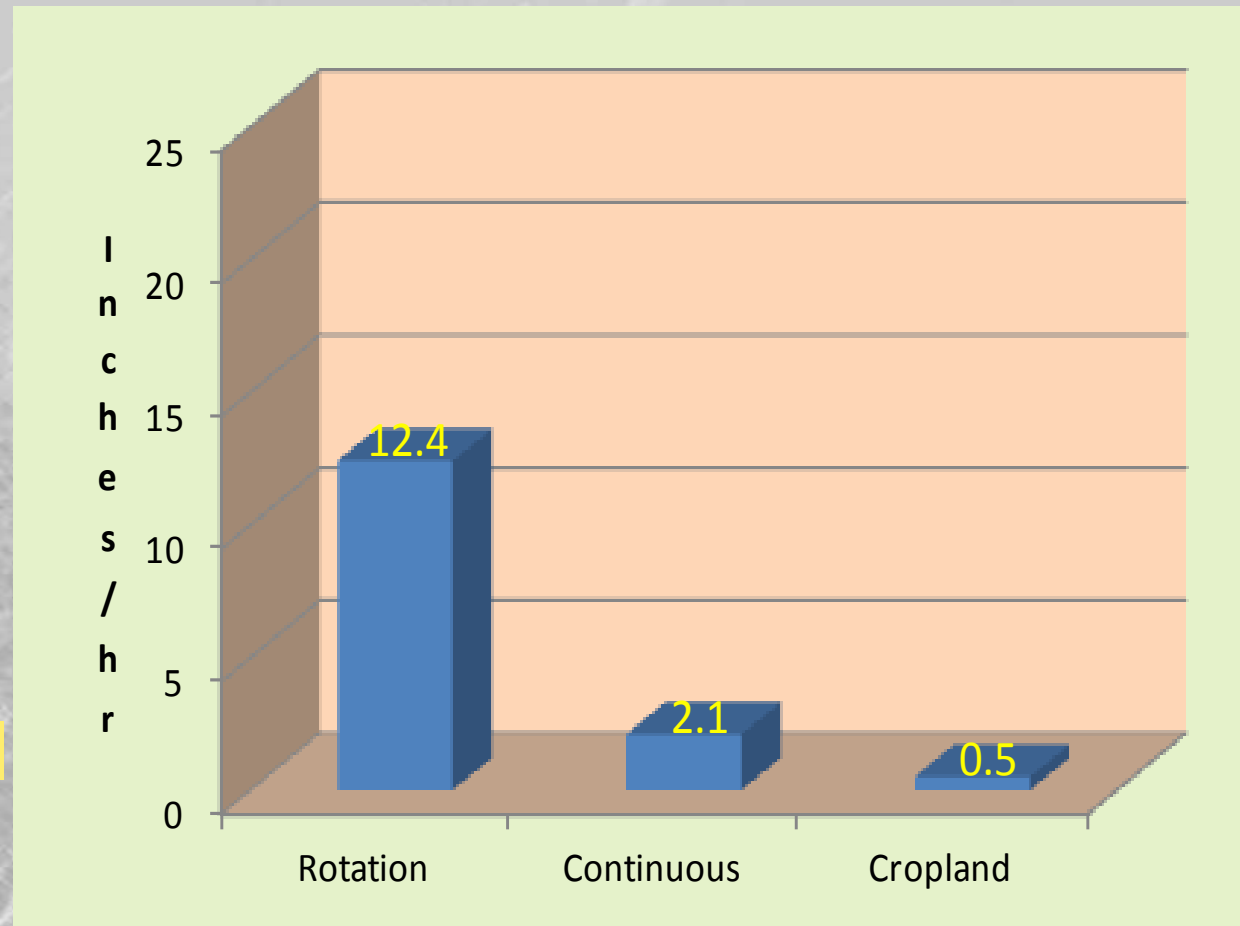


Mellette County Kube soil



Hyde County Glenham soil

Infiltration Rate



What we “know” so far

- ▣ Management of cropland and grassland has a potentially large effect on infiltration/runoff.
- ▣ Invasive species impair hydrologic functions, and are spreading at an increasing rate.
- ▣ Management actions can be taken to improve soil health – more emphasis needs to be placed on this.
- ▣ More study is needed on underlying cause of hydrologic impairment due to invasive species and management differences.

How do we assess rangeland soil health?

- ▣ The four principles of soil health:
 - Use *plant diversity* to increase diversity in the soil.
 - Manage *soils* more by *disturbing* them *less*.
 - *Keep plants growing* throughout the year to feed the soil.
 - Keep the *soil covered* as much as possible (*hydrology*).

- ▣ Rangeland Health attributes:
 - *Hydrologic function*
 - *Soil and site stability*
 - *Biotic integrity*

Rangeland Health

- ▣ Well established, scientifically based.
- ▣ Mostly qualitative (so fairly rapid), but able to apply quantitative methods as well.
- ▣ Well accepted by the range science discipline and all natural resource related agencies, and supported by the National Academy of Sciences.
- ▣ Designed to systematically evaluate processes.
- ▣ Capability of using the assessment as a teaching tool.
- ▣ Reference based on specific ecological site/soil

Rangeland Health – 17 indicators

▣ The three attributes are difficult to evaluate as a whole, so 17 indicators have been established:

- Rills
- Water flow patterns
- Pedestals or terracettes
- Bare ground
- Gullies
- Wind scoured, depositional areas
- Litter movement
- Soil surface resistance to erosion
- Soil structure & organic matter
- Plant community composition relative to infiltration and runoff
- Compaction layer
- Functional/structural groups
- Plant mortality and/or decadence
- Litter amount
- Annual production
- Invasive species
- Plant reproductive capability

Relationship of indicators to soil health principles

- ▣ Use plant diversity to increase diversity in the soil.
- ▣ Related Rangeland Health indicators:
 - Plant community composition relative to infiltration and runoff
 - Functional/structural groups
 - Plant mortality and/or decadence
 - Annual production
 - Invasive species
 - Reproductive capability

Relationship of indicators to soil health principles

- ▣ Manage soils more by disturbing them less.
- ▣ Related Rangeland Health indicators:
 - Soil surface resistance to erosion (soil aggregate stability)
 - Soil structure and organic matter content
 - Compaction layer
 - Rills
 - Gullies

Relationship of indicators to soil health principles

- ▣ Keep plants growing throughout the year to feed the soil.
- ▣ Related Rangeland Health indicators:
 - Plant functional/ structural groups
 - Invasive plants
 - Annual production

Relationship of indicators to soil health principles

- ▣ Keep the soil covered as much as possible.
- ▣ Related Rangeland Health indicators:
 - Bare ground
 - Water flow patterns
 - Litter amount
 - Litter movement

Rangeland Health

Rills



Rangeland Health

Water flow
patterns



Rangeland Health

Pedestals or
terraces



Rangeland Health

- ▣ Bare ground
- ▣ Gullies – basically just large rills
 - Headcuts
 - Are they “healing”
- ▣ Wind scoured, blowouts, depositional areas
- ▣ Litter movement

Rangeland Health

- ▣ Soil surface resistance to erosion
 - Soil aggregate stability
 - Reference sheet:

8. Soils surface (top few mm) resistance to erosion (stability values are averages – most sites will show a range of values): Soil aggregate stability ratings should typically be 5 to 6, normally 6. Surface organic matter adheres to the soil surface. Soil surface fragments will typically retain structure indefinitely when dipped in distilled water.

Rangeland Health

- ▣ Soil surface loss or degradation
- ▣ Color/organic matter and structure
- ▣ Reference sheet:

9. Soil surface structure and SOM content (include type of structure and A-horizon color and thickness): A-horizon should be 3 to 9 inches thick with mollic (dark) colors when moist. Structure typically is medium to fine granular at least in the upper A-horizon.

Rangeland Health

- ▣ Plant community composition and distribution relative to infiltration and runoff
- ▣ Reference sheet:

10. Effect of plant community composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff: Combination of shallow and deep rooted species (mid & tall rhizomatous and tufted perennial cool-season grasses) with fine and coarse roots positively influences infiltration. Estimated elapsed time for one inch to infiltrate is 2 to 4 minutes (using the single-ring method).

Rangeland Health

- ▣ Compaction layer
- ▣ Reference sheet:

11. Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site): None – when dry, B horizons can be hard and appear to be compacted, but no platy structure will be present.

Rangeland Health

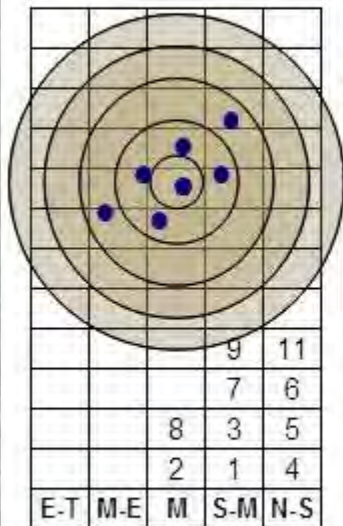
- ▣ Plant functional/structural groups
- ▣ Plant mortality and/or decadence
- ▣ Litter amount
- ▣ Annual production
- ▣ Invasive plants
- ▣ Perennial plant reproductive capability (vigor)

Application

- ▣ Infiltration using the single ring “infiltrometer”
- ▣ Observing soil characteristics
 - Structure
 - Color (an indicator of organic matter)
- ▣ Compaction layers

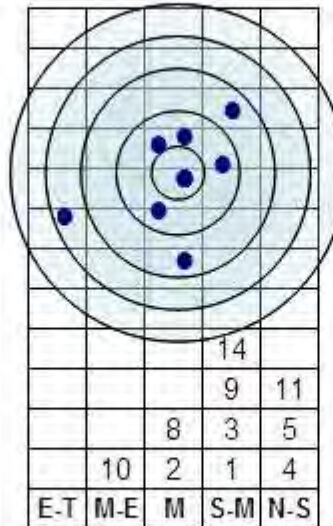
Rangeland Health

16. Invasive plants		B	
		M-E	
17. Reproductive capability of perennial plants		B	
		S-M	



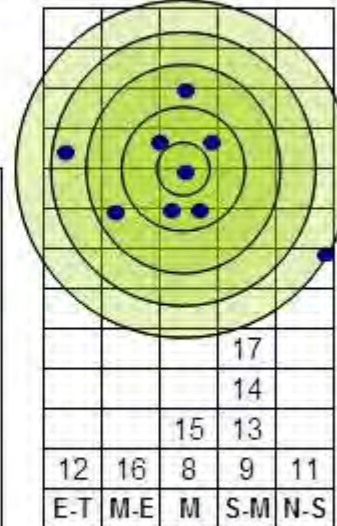
Attribute Rating
Justification
Soil & Site
Stability

S (10 indicators):
Soil & Site Stability
Rating: **S-**



Attribute Rating
Justification
Hydrologic
Function:

H (10 indicators):
Hydrologic Function
Rating: **S-M**



Attribute Rating
Justification
Biotic
Integrity:

B (9 indicators):
Biotic Integrity
Rating:

Questions/Discussion

The background of the slide is a grayscale photograph of a vast, flat landscape. The foreground and middle ground consist of a textured, light-colored surface that appears to be a dry lake bed or a desert floor, with subtle variations in tone and texture. A low, dark horizon line separates the land from a sky filled with soft, diffused clouds. The overall mood is quiet and expansive.

