Nebraska’s Rangelands: A valuable resource
Mitch Stephenson
Range and Forage Specialist
UNL Panhandle Research and Extension Center

What are Rangelands?

- Rangelands (n) uncultivated lands on which vegetation is predominantly native grasses, grass-likes, forbs, and shrubs. Rangelands include grasslands, savannas, shrublands, desert, alpine communities, and meadows.
Rangelands

47% of the World's land area is rangeland (17.3 billion acres)

36% of the United States is rangeland (876 million acres)

~ 46% of Nebraska is rangeland (23 million acres)
~ 1.9 million beef cows
Rangelands

- Blue grama
- Western wheatgrass
- Salt Desert Shrubland
- Short Grassy Plains
- Mixed Prairie
- Tall Grass Prairie
- Big bluestem

1,400 lbs per acre

Rangelands

Normal Annual Precipitation: 1981 - 2010

1,400 lbs per acre

3,500+ lbs per acre
Rangelands

Historical Perspective of Range Management

Heavy livestock buildup in the late 1800s

Classic example of the “Tragedy of the Commons”
Historical Perspective of Range Management

“Men of every rank were eager to get into the cattle industry. In a short time every acre of grass was stocked beyond its fullest capacity..... The grasses were entirely consumed; their very roots were trampled into the dust and destroyed. In their eagerness to get something for nothing, speculators did not hesitate at the permanent injury, if not the total ruin, of the finest grazing country in America”

(H.L. Bentley 1898 in Abilene, TX)
Definition

“Range management is the science and the art of planning and directing range use so as to obtain the maximum livestock production consistent with conservation of the range resources”

(Stoddart and Smith 1943)

Rangeland Management

“Range Management is a discipline and an art that skillfully applies an organized body of knowledge accumulated by range science and practical experience for two purposes: 1) protection, improvement, and continued welfare of the basic resources, which in many situations include soils, vegetation, endangered plants and animals, wilderness, water, and historical sites; and 2) optimum production of goods and services in combinations needed by society”

(Heady and Child 1994)
Importance of Rangelands

**Ecosystem Services**
- Carbon sequestration
- Air and water purification
- Wildlife and plant habitat
- Erosion control
- Recreation
- Aesthetics and cultural heritage

**Products**
- Food
  - Plants and animals
- Fiber
  - Wool, leather, etc.
- Lands for renewable energy
  - Wind, solar, etc.
- Mining
- Recreation
Rangeland Management

(a) General scheme of the range succession model

Westoby et al. 1989, Opportunistic management for rangelands not at equilibrium

Figure 2: State and transition model
MLRA 65 – Nebraska Sandhills – Sands Site (17-22” Precipitation)
Grazing Management

• Stocking Rate
• Distribution
• Timing of grazing

“…ungulates are important agents of change in ecosystems, acting to create spatial heterogeneity, modulate successional processes, and control the switching of ecosystems between alternative states.”

“Modifications of ecosystems by ungulates”, Hobbs 1996
Sustainably balancing forage supply with the nutrient demand from livestock and other animals

<table>
<thead>
<tr>
<th>Kind/class of animal</th>
<th>Animal Unit Equivalent (AUE)</th>
<th>Estimated air dry-matter intake (lbs/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cow (1000 lb) and calf in the first 3 months</td>
<td>1.00</td>
<td>28.6</td>
</tr>
<tr>
<td>Cow (1100 lb) and calf in the first 3 months</td>
<td>1.10</td>
<td>30.2</td>
</tr>
<tr>
<td>Cow (1200 lb) and calf in the first 3 months</td>
<td>1.20</td>
<td>31.8</td>
</tr>
<tr>
<td>Cow (1300 lb) and calf in the first 3 months</td>
<td>1.30</td>
<td>33.4</td>
</tr>
<tr>
<td>Cow (1400 lb) and calf in the first 3 months</td>
<td>1.40</td>
<td>34.9</td>
</tr>
<tr>
<td>Dry cow (1,000 lb)</td>
<td>0.92</td>
<td>23.9</td>
</tr>
<tr>
<td>Calf (Spring calving, 3 months of age to weaning)</td>
<td>0.30</td>
<td>7.8</td>
</tr>
<tr>
<td>Weaned calf to yearling (6 - 12 months)</td>
<td>0.60</td>
<td>15.6</td>
</tr>
<tr>
<td>Yearling (12 - 17 months)</td>
<td>0.70</td>
<td>16.2</td>
</tr>
<tr>
<td>Yearling (18 - 24 months)</td>
<td>0.80</td>
<td>18.2</td>
</tr>
<tr>
<td>Young Bulls (1 - 2 years)</td>
<td>1.20</td>
<td>36.2</td>
</tr>
<tr>
<td>Mature Bulls (2+ years)</td>
<td>1.50</td>
<td>39.0</td>
</tr>
<tr>
<td>Horses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yearling horse</td>
<td>0.75</td>
<td>19.5</td>
</tr>
<tr>
<td>Young horse (1 - 2 years)</td>
<td>1.00</td>
<td>26.0</td>
</tr>
<tr>
<td>Mature light horse</td>
<td>1.25</td>
<td>32.5</td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mature ewe</td>
<td>0.20</td>
<td>5.2</td>
</tr>
<tr>
<td>Lamb (weaned to yearling)</td>
<td>0.12</td>
<td>1.1</td>
</tr>
<tr>
<td>Yearling lamb</td>
<td>0.15</td>
<td>3.9</td>
</tr>
<tr>
<td>Ram</td>
<td>0.25</td>
<td>6.5</td>
</tr>
<tr>
<td>Goats</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mature ( doe or buck)</td>
<td>0.15</td>
<td>3.9</td>
</tr>
<tr>
<td>KID (yearling)</td>
<td>0.10</td>
<td>2.6</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deer (White-tailed)</td>
<td>0.15</td>
<td>3.9</td>
</tr>
<tr>
<td>Deer (White)</td>
<td>0.20</td>
<td>5.2</td>
</tr>
<tr>
<td>Antelope</td>
<td>0.20</td>
<td>5.2</td>
</tr>
<tr>
<td>Bison cow, Mature</td>
<td>0.80</td>
<td>22.4</td>
</tr>
<tr>
<td>Bison bull, Mature</td>
<td>1.50</td>
<td>38.0</td>
</tr>
<tr>
<td>Elk</td>
<td>0.80</td>
<td>15.4</td>
</tr>
</tbody>
</table>
Stocking Rate

“Relationship between the number of animals and the grazing management unit utilized over a specified time period”

(AU/Area/Time)

Stocking Density

“Relationship between the number of animals and a specific unit of land being grazed at any one point in time”

(AU/Area)

Grazing Pressure

“Animal-to-forage relationship” (AU/weight of available forage)

Carrying Capacity

The number of animals that a piece of land can support on a long-term basis without causing damage to the ecosystem
Stocking rate

Herbage production is one of the most important and variable factors for livestock production on rangelands.

Study Site Location

- 5,500 acres upland Sandhills range
Study Site Location

2001 to present
- ¼ m² quadrats at 4 different topographic positions

Harvests
- Mid-June
- Mid-August

Plants separated
- Warm-season grasses
- Cool-season grasses
- Forbs
- Shrubs
- Sedges

Results: Annual Precipitation

Data from the High Plains Regional Climate Center from Ainsworth, NE: climod.unl.edu
Herbage yields in mid-August

Peak Herbage Production at the Barta Brother Ranch: Mid-August
Peak Herbage Production at the Barta Brother Ranch: Mid-August

\[ y = 68.982x - 9.1089 \]
\[ R^2 = 0.6734 \]

Stocking Rate

- Available AUMs
- Mean AUMs
How do I manage under this kind of variability?

- “Maintaining grazing flexibility was determined to be very important for managing variable forage conditions, and its importance increases with the level of variability.” Torell et al. 2010

- Including yearlings in the operation:
  - “As forage variability increased to levels observed on the arid rangelands of the western United States, a 50:50 forage allocation between cow-calf and yearling enterprises was found to be optimal” Torell et al. 2010

- Maintaining a reserves of forage:
  - Stock conservatively to always maintain a stockpile of forage that can be used when in need

Stocking Rate

“The combination of heavy grazing and drought is the primary cause of decline in range condition”

Reece et al. 2008
Discussion: Climate change – 2050

Carbohydrate reserves (••••) and perennial plant yield (••••) in relation to growth stage

Polley et al. 2013, “Climate change and North American rangelands: Trends, projections, and implications”
Carbohydrate reserves (●) and perennial plant yield (○) in relation to growth stage

Stocking Rate

Utilization measurements to determine if stocking rates are appropriate in each year
**Grazing Intensity**

- **Overgrazing** = repeated heavy grazing such that damage to the plant community occurs

**Stocking Rate**

<table>
<thead>
<tr>
<th>Grazing Intensity</th>
<th>% Use</th>
<th>% studies showing:</th>
<th>↓</th>
<th>=</th>
<th>↑</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy</td>
<td>51-65</td>
<td>90</td>
<td>10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>40-50</td>
<td>23</td>
<td>30</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>&lt; 40%</td>
<td>5</td>
<td>21</td>
<td>74</td>
<td></td>
</tr>
</tbody>
</table>

Summary of 25 studies evaluating the effects of grazing intensity on rangeland condition in North America (Holechek et al. 1999)
Stocking Rate

Stocking rates vs. forage production

<table>
<thead>
<tr>
<th>Utilization (%)</th>
<th>Heavy</th>
<th>Moderate</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>57</td>
<td>43</td>
<td>32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Avg. forage production (lb/acre/yr)</th>
<th>Heavy</th>
<th>Moderate</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,175</td>
<td>1,473</td>
<td>1,597</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forage production drought years (lb/acre/yr)</th>
<th>Heavy</th>
<th>Moderate</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>820</td>
<td>986</td>
<td>1,219</td>
</tr>
</tbody>
</table>

Summary of 25 studies evaluating the effects of grazing intensity on rangeland condition in North America. (Holchek et al. 1999)

Economic importance of productive rangelands

- Subirrigated
- Saline subirrigated, silty overflow, sandy lowland
- Sandy, Sand, Silty
- Clayey, choppy sand, limy upland
- Shallow clay, shallow limy, savannah
- Saline upland, panspots

12-15 acre/ Cow-calf Pair

50-55 acres/ Cow-calf Pair

75% reduction in productivity

# of acres needed for the 5 month growing season

Stubbendieck and Reece 1992, "Nebraska Handbook of Range Management"
Grazing Management

- Stocking Rate
  - Most important variable to get right
- Distribution
- Timing of grazing
Distribution

“Many of the concerns regarding livestock grazing on rangelands are the result of uneven livestock distribution rather than inappropriate stocking rates.” (Bailey 2005)
Grazing Distribution

- Gudmundsen Sandhills Lab near Whitman, NE
- 1423 acres, 5 tracked cows in a herd of ~100 grazing from mid-July to October

Grazing Distribution

- UNL Barta Brothers Ranch
- 60 cow/calf pairs 140 acres Early-June
**Grazing Distribution**

<table>
<thead>
<tr>
<th>Distance from Water</th>
<th>Utilization(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 0.5 miles</td>
<td>50</td>
</tr>
<tr>
<td>0.5 – 1.0 miles</td>
<td>38</td>
</tr>
<tr>
<td>1.0 – 1.5 miles</td>
<td>26</td>
</tr>
<tr>
<td>1.5 – 2.0 miles</td>
<td>17</td>
</tr>
<tr>
<td>2.0 – 2.5 miles</td>
<td>12</td>
</tr>
</tbody>
</table>

Cattle often avoid:
- Steep slopes
- High elevations
- Areas far from water

(Muegler 1965)
(Roath and Kraeger 1982)
(Vallentine 1947)
Grazing Distribution

Panhandle Experimental Range
186 yearling heifers – May 15 to July 16

1 pasture = 730 acre

Grazing Distribution

Key Grass Species
Stubble Heights

- 8.52901571 - 11.10502134
- 11.10501135 - 14.09020531
- 14.10653652 - 16.8470148
- 16.8470148 - 20.68836465
- 20.68836465 - 22.52693646
- 22.52693646 - 25.37075864
Grazing Distribution

- Heavy Grazing Utilization
- Moderate Grazing Utilization
- Light Grazing Utilization

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**Figure 1.** Responses of grassland birds in shortgrass steppe to a vegetation structure gradient (modified from Keogh 1996).
Grazing Distribution

J. E. Weaver 1950 – Effects of different intensities of grazing on depth and quantity of roots of grasses

Grazing Rotations

Deferred Rotation Growing Season Grazing

<table>
<thead>
<tr>
<th>Pasture</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>4</td>
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<td>5</td>
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<tr>
<td>6...</td>
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</tbody>
</table>

4 pasture = 150 to 200 acres each
Grazing Management

- Stocking Rate
  - Most important variable to get right
- Distribution
  - Smaller pastures and/or more water locations increases harvest efficiency and reduces areas of over and under use
- Timing of grazing

Grazing Rotations

A practice of grazing planning that provides pastures with deferment, rest, and rotation

- **Deferment**, Delay grazing in a pasture until seed maturity of key forage species
- **Rest**, Pasture receives no use for one full year
- **Rotation**, Scheduled movement of livestock from one pasture to another

Distribution and Timing of Grazing

Grazing rotations - Simple

mid May to late July

late July to early October

Grazing rotations - Complex

Annual warm-season forage
September to mid-October

Pasture mid-May to mid-July through October
Stocking Rates with 25, 30, and 40% harvest efficiency

“A guide for planning and analyzing a year-round forage program”. Waller et al. 1986

Grazing rotations

One of the major benefits of rotational grazing strategies is providing the livestock manager with options to alter the time of grazing in subsequent years = Flexibility
Timing of Grazing

Effect of time of defoliation on belowground biomass of Sand bluestem
(Engel et al. 1998)
Timing of Grazing

- Subsequent year yield when tillers were clipped at 0, 40%, and 80% utilization in a drought year (2002; precipitation 40% below average)

Range Plant Physiology
Timing of Grazing

Change from continuous summer grazing to a rotational grazing system
- Increased water locations
- Smaller pasture size
- Altered time of grazing

“Annually rotating pastures within a deferred rotation appears to be an excellent grazing method to avoid directional changes of vegetation on Nebraska Sandhills grazing lands.”
Grazing Management

- Stocking Rate
  - Most important variable to get right
- Distribution
  - Smaller pastures and/or more water locations increases grazing efficiency and reduces areas of over and under use
- Timing of grazing
  - Grazing rotations provide managers flexibility in adjusting the time during the growing season when grazing occurs and provides options for increased recovery time

"Using livestock as ecosystem engineers to achieve conservation grazing objectives and outcomes......provides land managers with opportunity to reduce conflicts between conservation and livestock production goals."

"Livestock as ecosystem engineers for grassland bird habitat in the western Great Plains of North America" - Derner et al. 2009
Thank You

Mitchell B. Stephenson, Ph.D.
Range and Forage Management Specialist
Panhandle Research and Extension Center
University of Nebraska - Lincoln
4502 Avenue I
Scottsbluff, NE 69361
mstephenson@unl.edu

(308) 632-1355 - Work
(307) 321-5827 - Cell

UNL Range & Forage
@UNLRangepForage