Drought and rangeland management in Oklahoma

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Oklahoma State University
No one expected another drouth like that of ’33. And the really big dries like 1918 came once in a lifetime. Why worry? They said. It would rain this fall. It always had. But it didn’t. And many a boy would become a man before the land was green again.

Prologue, The Time It Never Rained, by Elmer Kelton
Annual Precipitation History with 5-year Tendencies
Oklahoma Statewide: 1895-2014

- Wetter periods
- Drier periods
- Annual precipitation value
Historic studies of rangeland and pasture response to drought
What factors contribute to variable rangeland conditions and productivity?
Principles for managing pastures and rangelands during drought
Conclusions- Climate change.
Historic studies of rangeland and pasture response to drought

- Production changes - additive and interactive with stocking rate
Drought

Livestock production

Year

1 5 10

Fuhlendorf, Briske and Smeins 2001
Historic studies of rangeland and pasture response to drought

- Production changes - additive and interactive with stocking rate
- Compositional changes - more productive to less productive plants
Longterm studies of Compositional Changes

• Changes are complex
• Mid-grasses more productive than short-grasses
• Generally slow
• Grazing X Drought Interaction
• Most improvement occurred immediately after the drought
Historic studies of rangeland and pasture response to drought

- Production changes - additive and interactive with stocking rate
- Compositional changes - more productive to less productive plants
- Practices to increase forage production almost never pay – especially in drought
Historic studies of rangeland and pasture response to drought

- Production changes - additive and interactive with stocking rate
- Compositional changes - more productive to less productive plants
- Practices to increase forage production almost never pay – especially in drought
- Management should focus on factors that are ACTUALLY important to sustainable production
What factors are ACTUALLY important to sustainable production?

- Weather, weather, weather, weather, weather
Figure 3. Forage production from a tallgrass prairie site on the OSU Research Range near Stillwater averaged 6,360 lbs/acre during an 11-year period, but production fluctuated yearly from 2,000 to more than 9,000 lbs/acre.
What factors contribute to variable rangeland conditions and productivity?

- Weather, weather, weather, weather, weather
- Woody plant invasion - cedar and mesquite are long term serious issues
No Grazing & No Fire

Potential Livestock Production (% of max)

Year

Fuhlendorf et al., 2008
Figure 4. Plot-level herbaceous biomass as a function of eastern redcedar canopy cover in tallgrass prairie.
What factors contribute to variable rangeland conditions and productivity?

- Weather, weather, weather, weather, weather
- Woody plant invasion—cedar and mesquite are long term serious issues
- Stocking rate, stocking rate, stocking rate, stocking rate
ADG, lbs
Stocking rate, steer - days/A (H)

ADG
R
G

Optimum

Profit/A, $ (R)
Gain/A, lb (G)

ADG, lbs

Light
Moderate
Heavy

Stocking rate, steer-days/A (H)
Ecosystem: Sunlight, Rainfall, Rangeland Production
Management: Forage per animal, Stocking rate, Other things, Cost of management, Weight Gain per acre
Economics: $ Profit $, Socio-political stuff
Principles for managing pastures and rangelands during drought

1. Monitor weather and forage more than cattle
   - Oklahoma Mesonet (http://www.mesonet.org/)
     - Greenness index
     - Soil moisture
     - Rainfall
Principles for managing pastures and rangelands during drought

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2. Stocking rate, Stocking rate, Stocking rate
   - Rapid response – but not too rapid?
   - Long term plan with conservative stocking rate
Rapid Response

Percent of Average rainfall between March and May

Stocking Rate Reduction

David J. Kraft
Rangeland Management Specialist
NRCS, Emporia, Kansas
Principles for managing pastures and rangelands during drought

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3. Help invasive brush to die
Weight Gains by Stocker Cattle on Mixed Prairie
Limb et al. (2011)

Gain/animal (kg · animal$^{-1}$· year$^{-1}$)

Year

1999 2001 2003 2005 2007 2009

(B) Klemme

Fire
No Fire

70 lbs Per animal
Principles for managing pastures and rangelands during drought

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   - Oklahoma Mesonet (http://www.mesonet.org/)
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     - Soil moisture
     - Rainfall

2. Stocking rate, Stocking rate, Stocking rate
   - Rapid response – but not too rapid?
   - Long term plan with conservative stocking rate

3. Help invasive brush to die

4. Do not spend money on magic silver bullets
Killing weeds on rangelands rarely increases livestock production - Fuhlendorf et al. 2009

Fig. 5. Gain of stocker cattle (gain per area) and growing-season precipitation (March to October) from 2000 to 2005 on the Marvin Klemme Range Research Station. Herbicide was applied in April 2001 and May 2004 (indicated by vertical arrows) to the herbicide treatment pastures. Error bars are 1 SE. Treatments did not differ ($P > 0.337$) in any year.
Synthesis Paper

Rotational Grazing on Rangelands: Reconciliation of Perception and Experimental Evidence

D. D. Briske, 1 J. D. Derner, 2 J. R. Brown, 3 S. D. Fuhlendorf, 4 W. R. Teague, 5 K. M. Havstad, 6 R. L. Gillen, 7 A. J. Ash, 8 and W. D. Willms 9

Authors are 1 Professor, Department of Ecosystem Science and Management, Texas A&M University, College Station, TX 77843-2138, USA; 2 Rangeland Scientist, USDA-ARS High Plains Grasslands Research Station, Cheyenne, WY 8209, USA; 3 Research Scientist, USDA-NRCS Jornada Experimental Range, New Mexico State University, Las Cruces, NM 88003-0003, USA; 4 Professor, Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK 74078, USA; 5 Professor, Texas A&M University System, Texas Agricultural Experiment Station, Vernon, TX 76384, USA; 6 Supervisor, USDA-ARS Jornada Experimental Range, New Mexico State University, Las Cruces, NM 88003-0003, USA; 7 Head, Kansas State University, Western Kansas Agricultural Research Center, Hays, KS 67601-9228, USA; 8 Program Leader, CSIRO, Sustainable Ecosystems, St. Lucia, Queensland 4067, Australia; and 9 Research Scientist, Agriculture and Agri-Food Canada, Lethbridge, AB T1J 4B1, Canada.

Abstract

In spite of overwhelming experimental evidence to the contrary, rotational grazing continues to be promoted and implemented as the only viable grazing strategy. The goals of this synthesis are to 1) reevaluate the complexity, underlying assumptions, and ecological processes of grazed ecosystems, 2) summarize plant and animal production responses to rotational and continuous grazing, 3) characterize the prevailing perceptions influencing the assessment of rotational and continuous grazing, and 4) attempt to direct the profession toward a reconciliation of perceptions advocating support for rotational grazing systems with that of the experimental evidence. The ecological relationships of grazing systems have been reasonably well resolved, at the scales investigated, and a continuation of costly grazing experiments adhering to conventional research protocols will yield little additional information. Plant production was equal or greater in continuous compared to rotational grazing in 87% (20 of 23) of the experiments. Similarly, animal production per head and per area were equal or greater in continuous compared to rotational grazing in 92% (35 of 38) and 84% (27 of 32) of the experiments, respectively. These experimental data demonstrate that a set of potentially effective grazing strategies exist, none of which have unique properties that set one apart from the other in terms of ecological effectiveness. The performance of rangeland grazing strategies are similarly constrained by several ecological variables establishing that differences among them are dependent on the effectiveness of management models, rather than the occurrence of unique ecological phenomena. Continued advocacy for rotational grazing as a superior strategy of grazing on rangelands is founded on perception and anecdotal interpretations, rather than an objective assessment of the vast experimental evidence. We recommend that these evidence-based conclusions be explicitly incorporated into management and policy decisions addressing this predominant land use on rangelands.
CONCLUSION:
What factors influence production

![Bar chart showing factors influencing production]

- **Strong Influence**
  - Weather
  - Woody Plants
  - Stocking rate
  - "Improve" Utilization

- **No Influence**
  - Weed Control
  - Fertilization
  - Rotational Grazing
Evidence for global warming?
Projections for YR2085 are based on the A2 emissions scenario and an ensemble of climate change models (Data source: www.climatewizrd.org)
Summary of 25 studies of grazing intensity on native rangeland in North America

<table>
<thead>
<tr>
<th></th>
<th>Heavy</th>
<th>Moderate</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forage Use (%)</td>
<td>57</td>
<td>43</td>
<td>32</td>
</tr>
<tr>
<td>Forage production (lbs/ac)</td>
<td>1,175</td>
<td>1,473</td>
<td>1,597</td>
</tr>
<tr>
<td>Range Trend</td>
<td>down (92%)</td>
<td>up (52%)</td>
<td>up (78%)</td>
</tr>
<tr>
<td>Calf Crop (%)</td>
<td>72</td>
<td>79</td>
<td>82</td>
</tr>
<tr>
<td>Weaning wt (lbs.)</td>
<td>381</td>
<td>415</td>
<td>431</td>
</tr>
<tr>
<td>ADG (lbs.)</td>
<td>1.83</td>
<td>2.15</td>
<td>2.30</td>
</tr>
<tr>
<td>Gain per acre (lbs.)</td>
<td>40</td>
<td>33.8</td>
<td>22.4</td>
</tr>
<tr>
<td>Net $ per animal</td>
<td>38.06</td>
<td>51.57</td>
<td>58.59</td>
</tr>
<tr>
<td>Net $ per acre</td>
<td>1.29</td>
<td>2.61</td>
<td>2.37</td>
</tr>
</tbody>
</table>

Holechek et al. 1999
## Prior Grazing System Summaries

<table>
<thead>
<tr>
<th>Author</th>
<th>Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampson 1951</td>
<td>“…two fairly distinct viewpoints (conservationists and operators) regarding merits of rotational grazing”</td>
</tr>
<tr>
<td>Heady 1961</td>
<td>“…specialized grazing system has no advantage in livestock production over continuous grazing”</td>
</tr>
<tr>
<td>Van Poollen and Lacey 1979</td>
<td>“…land managers should place more emphasis on proper stocking intensity, and less on grazing system implementation.”</td>
</tr>
<tr>
<td>O’ Reagain and Turner 1992</td>
<td>“…relative to [stocking rate], the grazing system employed is of minor importance.”</td>
</tr>
</tbody>
</table>
Bodine et al. 1998

![Bar graph showing gain and gain per acre](chart.png)
Experimental Findings: Animals

McCollum et al. 1999
Research from over 30 years on rangelands has concluded that rotational grazing resulted in:

1. decrease in individual animal performance
2. no improvement of diet quality
3. cast doubt on theory that SDG improves distribution
4. no positive or negative impact on brush species
5. no positive influences on germination or establishment
6. no improvement of range condition
7. a reduction of water infiltration
8. no increase in standing crop
9. expenses that did not justify the return
10. animal yield was equivalent to stocking rate differences
11. increase in stocking rate was not feasible

Bryant et al. 1987
Thurow 1991
Briske et al. 2008
Derner and Hart, in press
Brown-Brandi et al. 2006
Seasonal distribution of current-year herbage by species on sandy range sites in good to excellent range condition with average precipitation. (Nosal 1983)

Figure 1. Relationship between maximum daily temperature and the drinking rate of sheep.
Fig. 4. Changes in basal cover (per cent) and percentage composition of dominant grasses of the little bluestem-big bluestem community from 1932 to 1961, inclusive.
% Mortality of Cedar

- Small (< 1.5 m)
- Large (> 1.5 m)

- 1958
- 2011
Experimental Findings: Animals

![Graph showing the relationship between ungrazed herbage and animal gain per hectare, with different stocking rates and gain rates.](image-url)
Types of Grazing Systems

- **Continuous Grazing (CG)** - livestock remain in the same pasture throughout the grazing season

- **Deferred Rotation (DR)** - multi-pasture, multi-herd; example 4-pasture, 3 herd

- **Rest-Rotation (RR)** - several-pasture, usually single herd; example 3-pasture, 1 herd

- **High Intensity-Low Frequency (HILF)** - many-pasture, single herd; example 8-pasture, 1-herd- rotated less frequently than SD

- **Short Duration (SD)** - similar to HILF except rotated frequently with very high stock densities
Does science suggest that it will work?
Summary of 15 studies of grazing system on native rangeland in North America

<table>
<thead>
<tr>
<th></th>
<th>Continuous</th>
<th>Rotational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg forage use (%)</td>
<td>41.8</td>
<td>42.4</td>
</tr>
<tr>
<td>Avg forage production</td>
<td>-</td>
<td>+7%</td>
</tr>
<tr>
<td>Range trend (%)</td>
<td>up=61, stable=31, down=8%</td>
<td>up=69, stable=8, down=23%</td>
</tr>
<tr>
<td>Average calf crop (%)</td>
<td>89.4</td>
<td>85.9</td>
</tr>
<tr>
<td>Calf weaning wt. (lbs.)</td>
<td>504.6</td>
<td>494.1</td>
</tr>
<tr>
<td>Net returns ($/acre)</td>
<td>6.60</td>
<td>6.37</td>
</tr>
</tbody>
</table>

Holechek et al. 1999
solutions

• Monitor weather and forage more than cattle
  – Oklahoma Mesonet (http://www.mesonet.org/)
    • Greenness index
    • Soil moisture
    • rainfall

• Rapid response- but not too rapid?
• Long term plan that includes conservative stocking rate
• Kill brush
• Don’t follow gimmicks
What about Grazing Systems?

- Specialization of grazing management that defines reoccurring periods of grazing and non-grazing (rest, deferment) for 2 or more pastures

- **General goal:** increase production by:
  - Improve species composition
  - Reduce animal selectivity
  - Promote uniform animal distribution
  - Manage forage quality and quantity
Synthesis Key Points on Grazing Systems
Briske et al. 2008

- 87% of experiments
  - Plant production = or > with continuous grazing

- 92% of experiments
  - Animal production per head = or > with continuous grazing

- 84% of experiments
  - Animal production per land area = or > with continuous grazing
Fire in Stillwater OK
% Mortality following Drought Events

- Live oak
- Shin oak
- Persimmon

1958 vs 2011
What is good Range Management?

1920

Poor Grazing Management (no fire)

Proper Grazing Management (frequent fire)

1993
Derner and Hart, in press
Figure 1. Classical model of cattle feed intake as a function of environmental temperature.
What factors contribute to variable rangeland conditions and productivity?

- Weather, weather, weather, weather
- Woody plant invasion—cedar and mesquite are long term serious issues
- Stocking rate, stocking rate, stocking rate
- There are many gimmicks that do not influence production
Complexities of Drought

• Lack of water
• Low productivity
• Heat
• Fire
• Dust
• etc
“Reckon what one of them head doctors’d say about a man who drouthed out in the mornin’, drowned out in the afternoon an’ was already thinkin’ about gettin’ back in the cow business before nightfall?”
"I ain't gunna say a word,... Th'last time I complained 'bout th'weather we had a 5 year drought!"