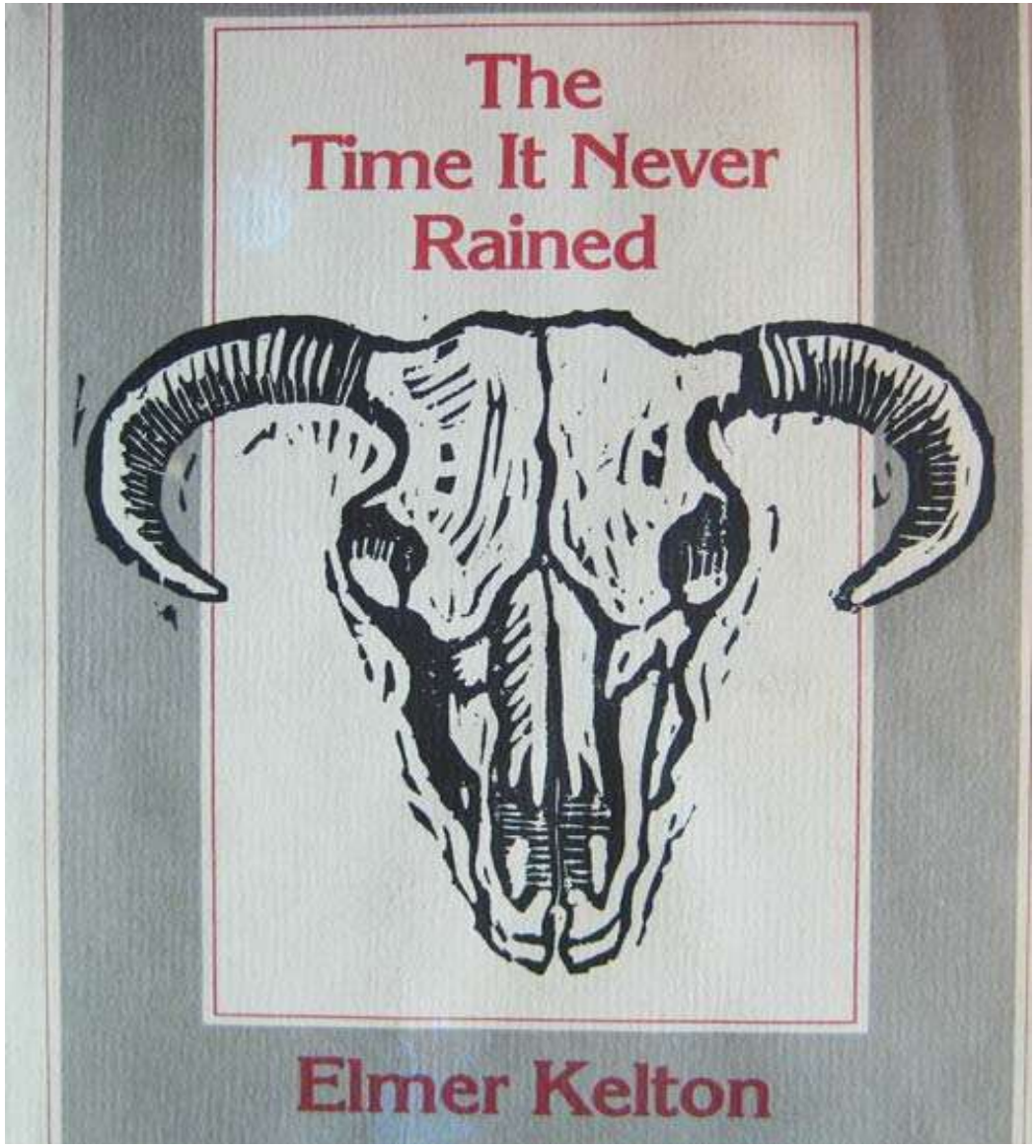
Drought and rangeland management in Oklahoma

Sam Fuhlendorf

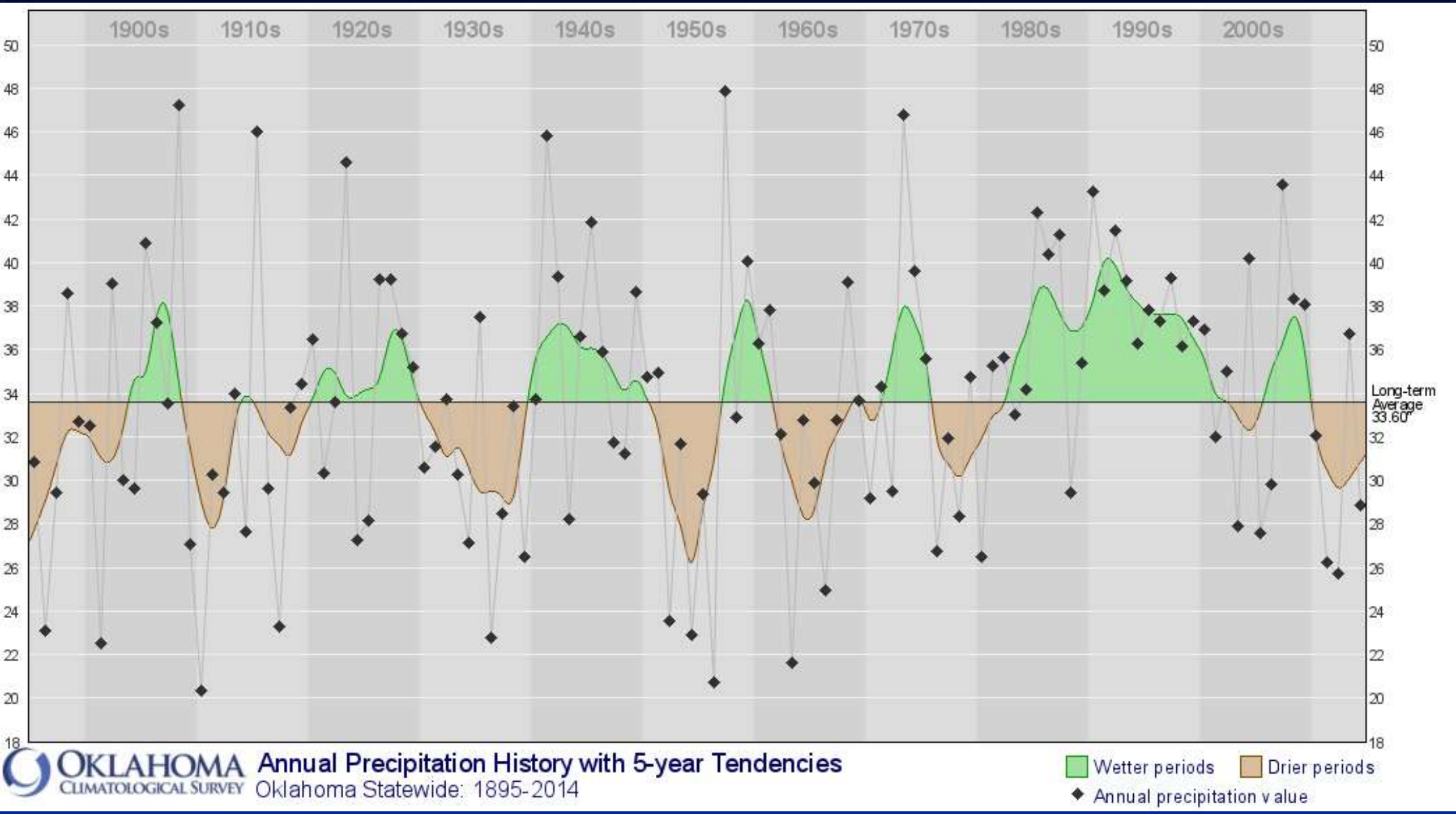
Regents Professor and Groendyke Chair in Wildlife Conservation

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

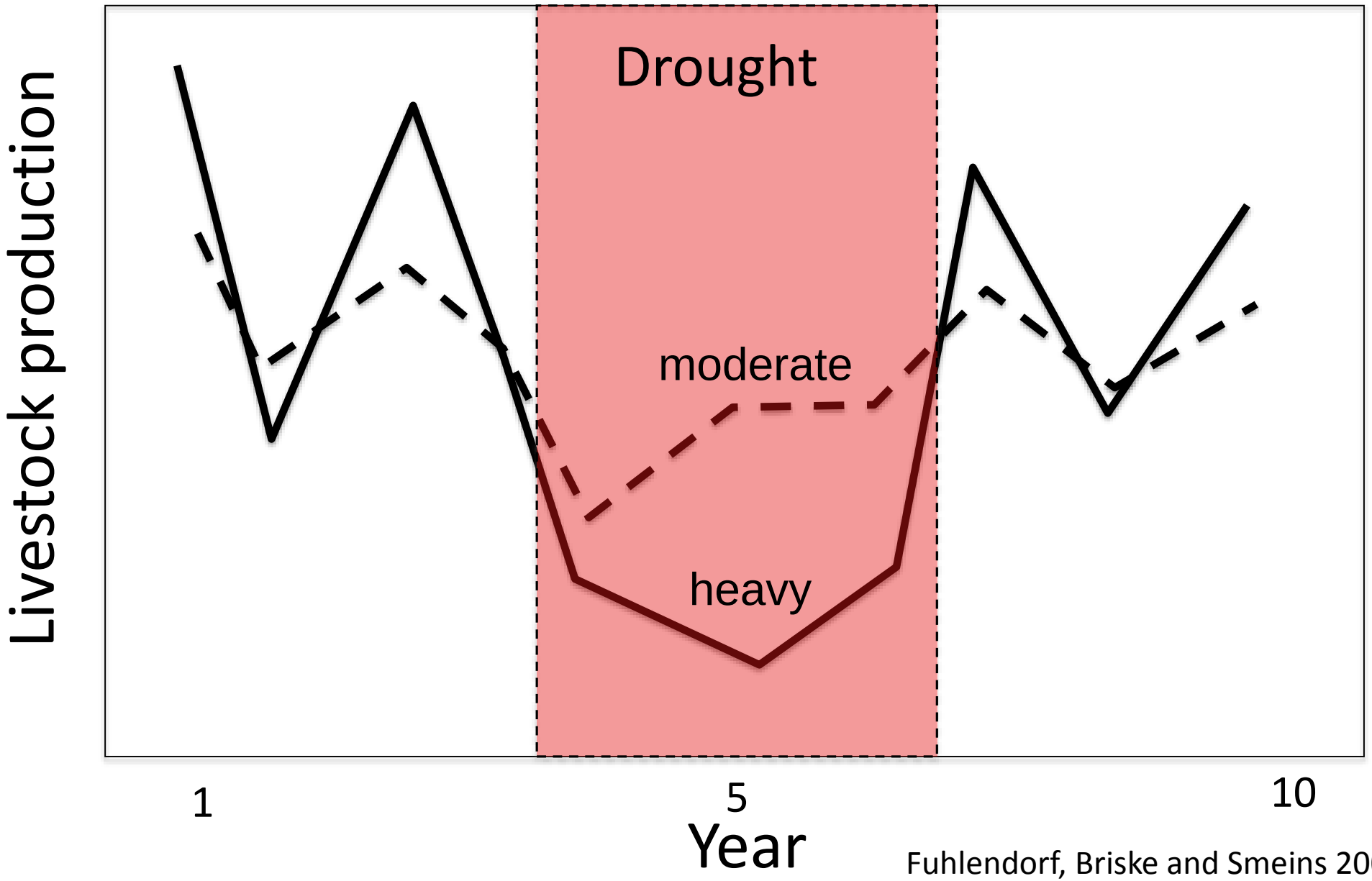

1900s
1910s
1920s
1930s
1940s
1950s
1960s
1970s
1980s
1990s
2000s
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
Long-term Average 33.60"
OKLAHOMA CLIMATOLOGICAL SURVEY
Annual Precipitation History with 5-year Tendencies
Oklahoma Statewide: 1895-2014
Wetter periods
Drier periods
Annual precipitation value

Outline

- 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

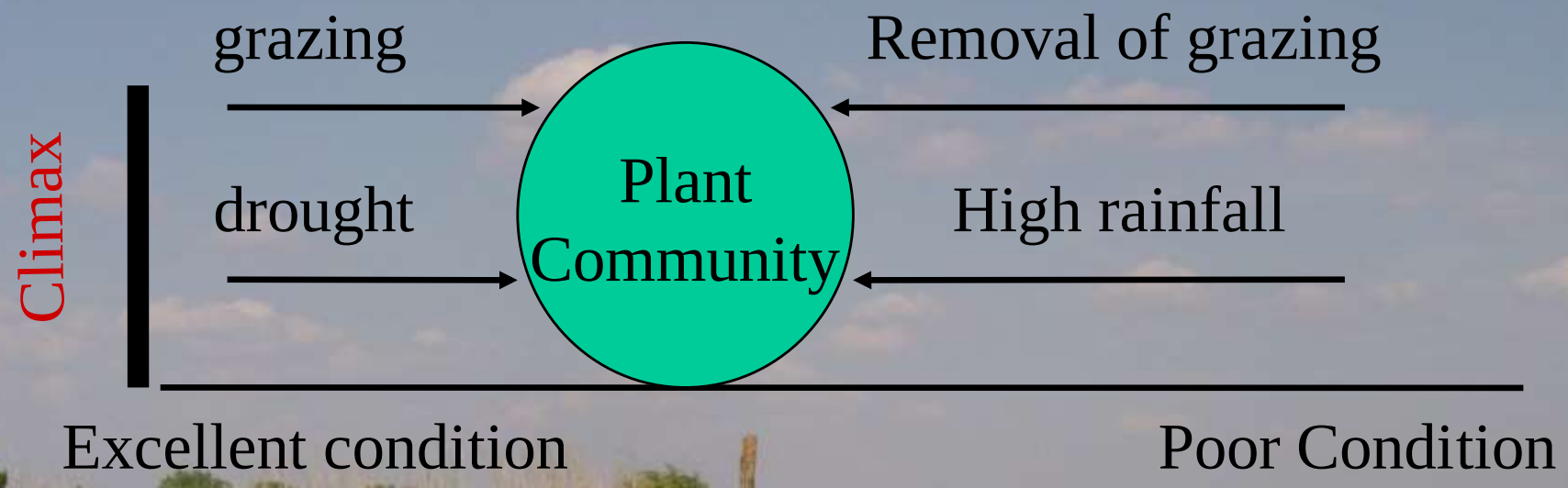
- Production changes- additive and interactive with stocking rate



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

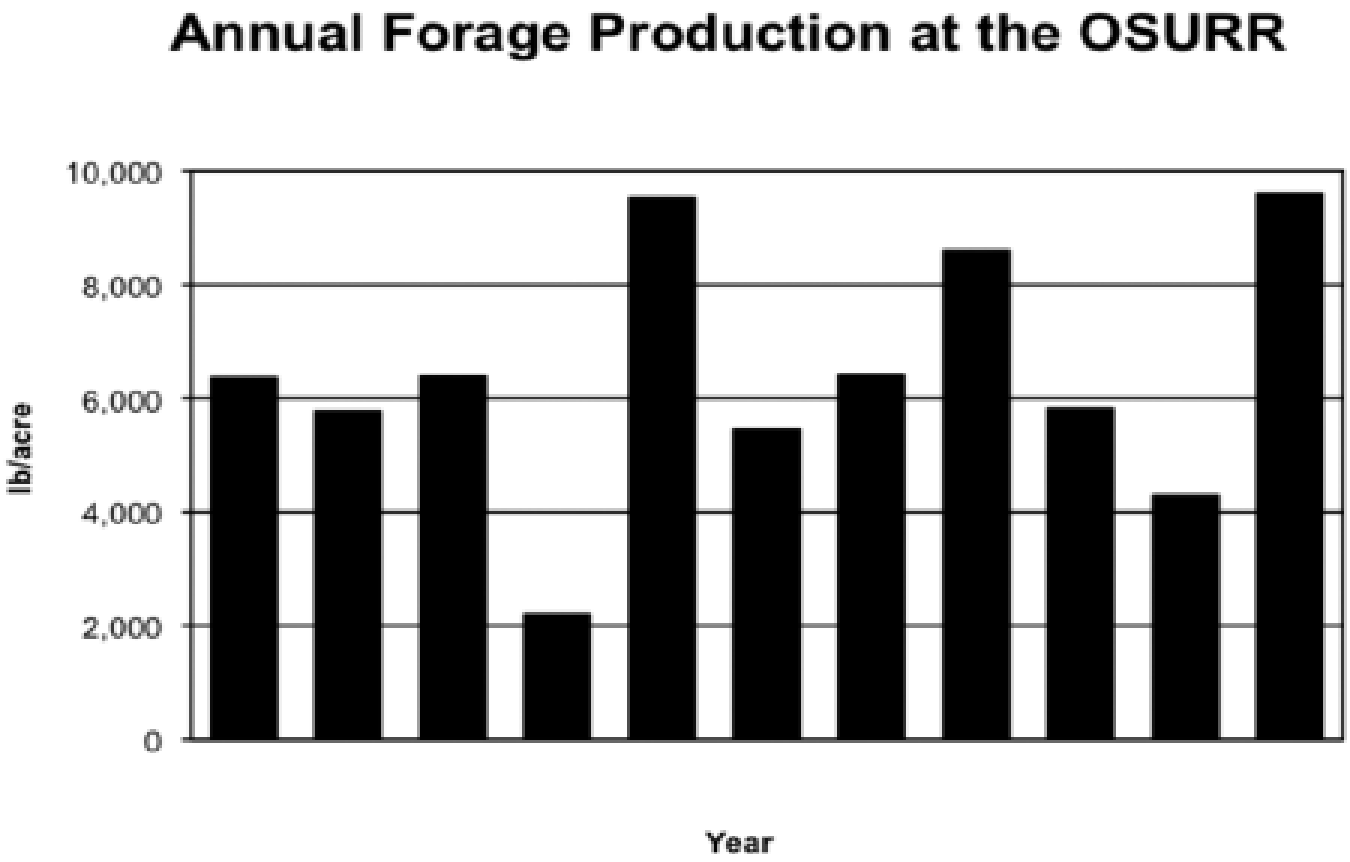


Figure 3. Forage production from a tallgrass prairie site on the OSU Research Range near Stillwater averaged 6,360 lbs/acre during an 11-year period, but production fluctuated yearly from 2,000 to more than 9,000 lbs/acre.

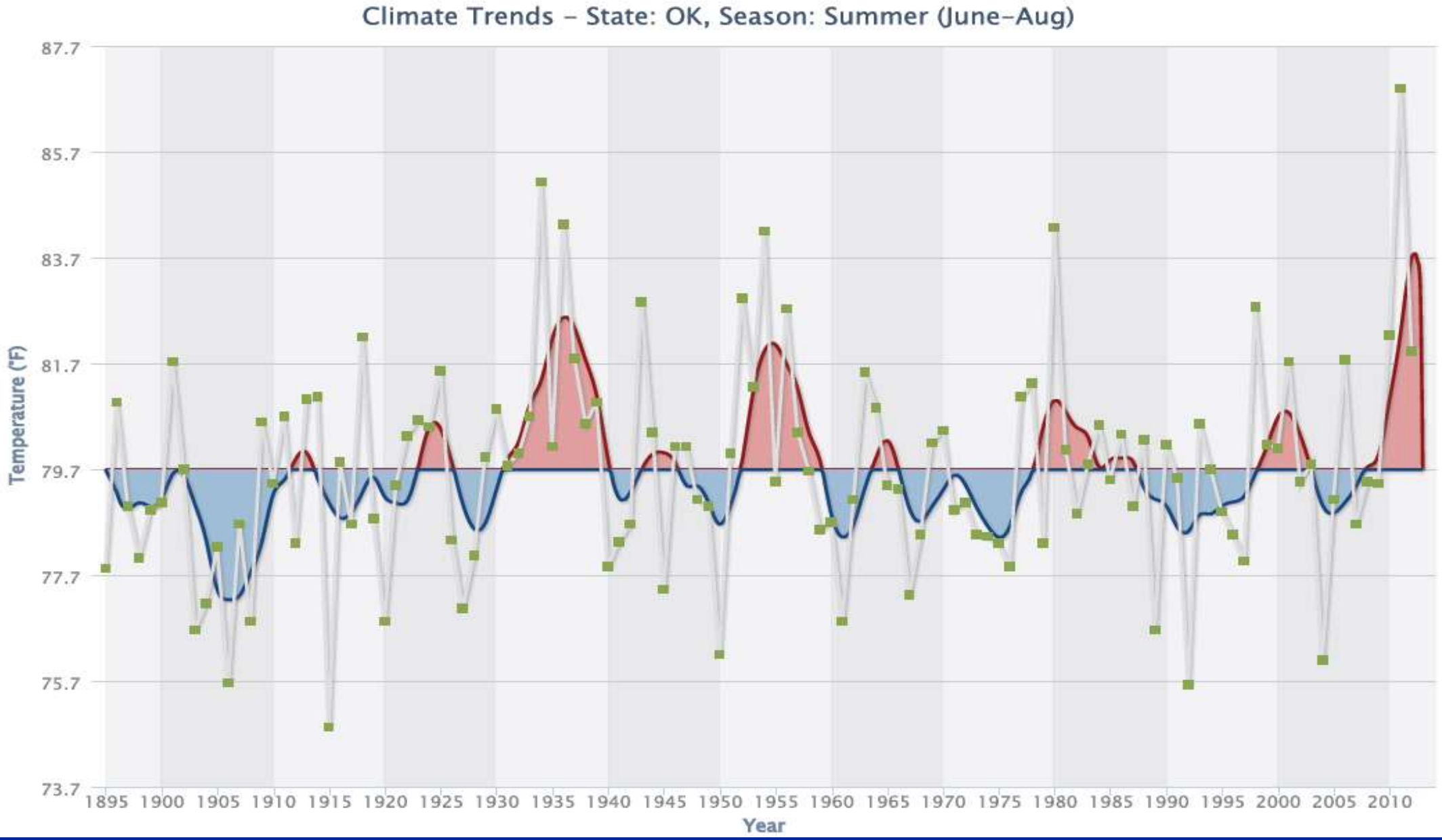
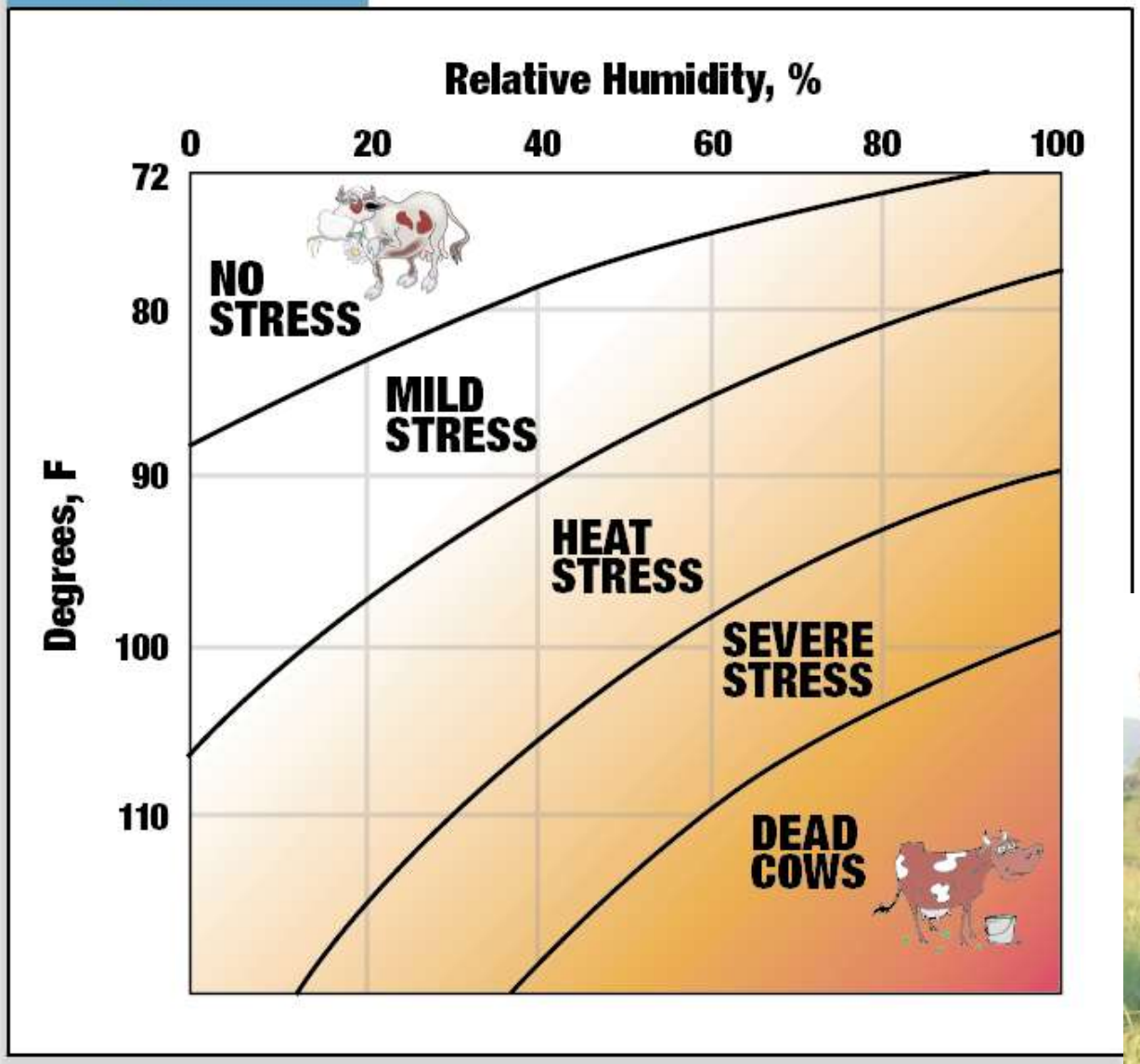

Climate Trends – State: OK, Season: Summer (June–Aug)
87.7
85.7
83.7
81.7
79.7
77.7
75.7
73.7
Temperature (°F)
1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
Year

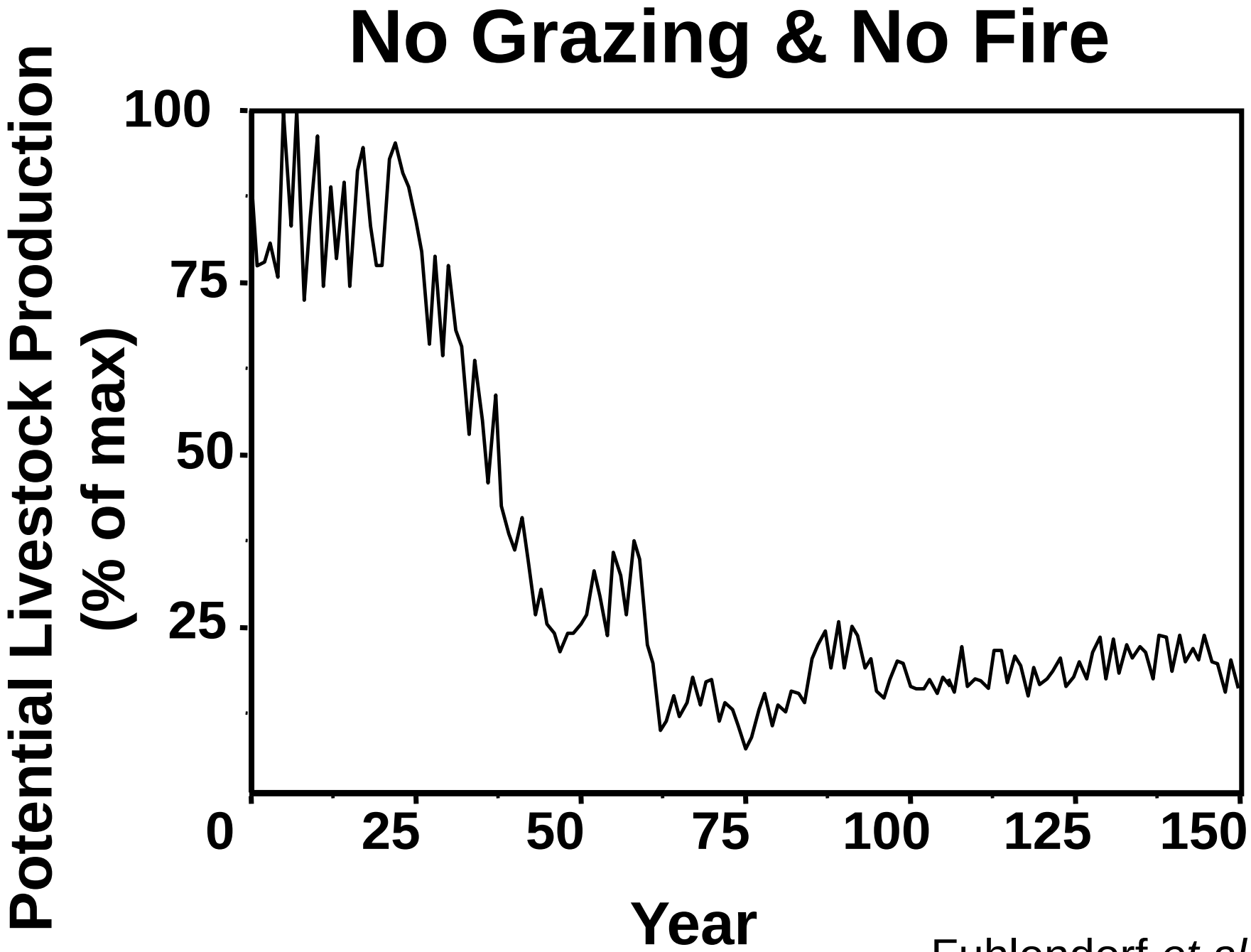
Figure 1



Robert Graves, http://www.progressivedairy.com/pd/features/2008/0608/0608_graves.html

What factors contribute to variable rangeland conditions and productivity?

- Weather, weather, weather, weather
- Woody plant invasion- cedar and mesquite are long term serious issues



Fuhlendorf *et al.*, 2008

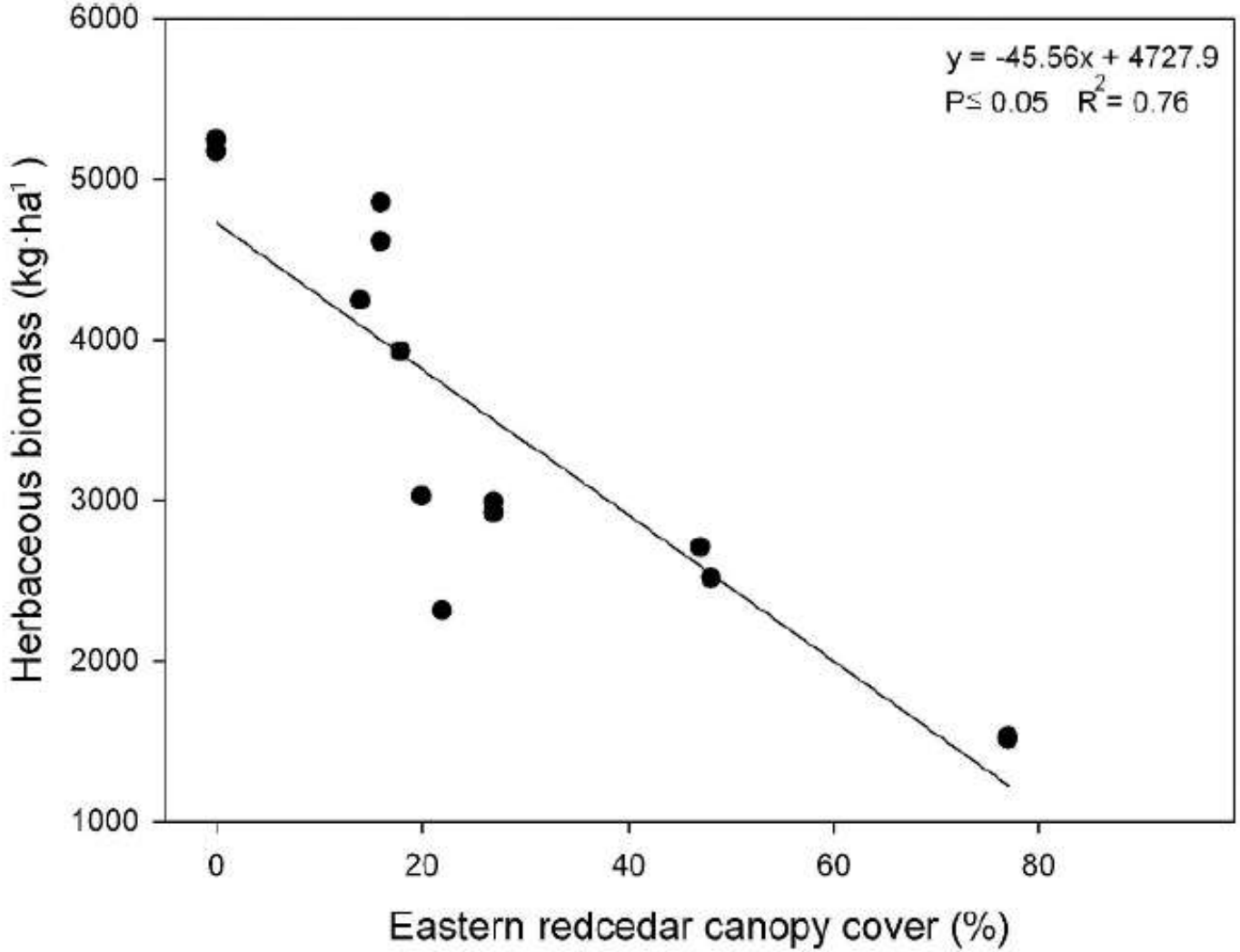
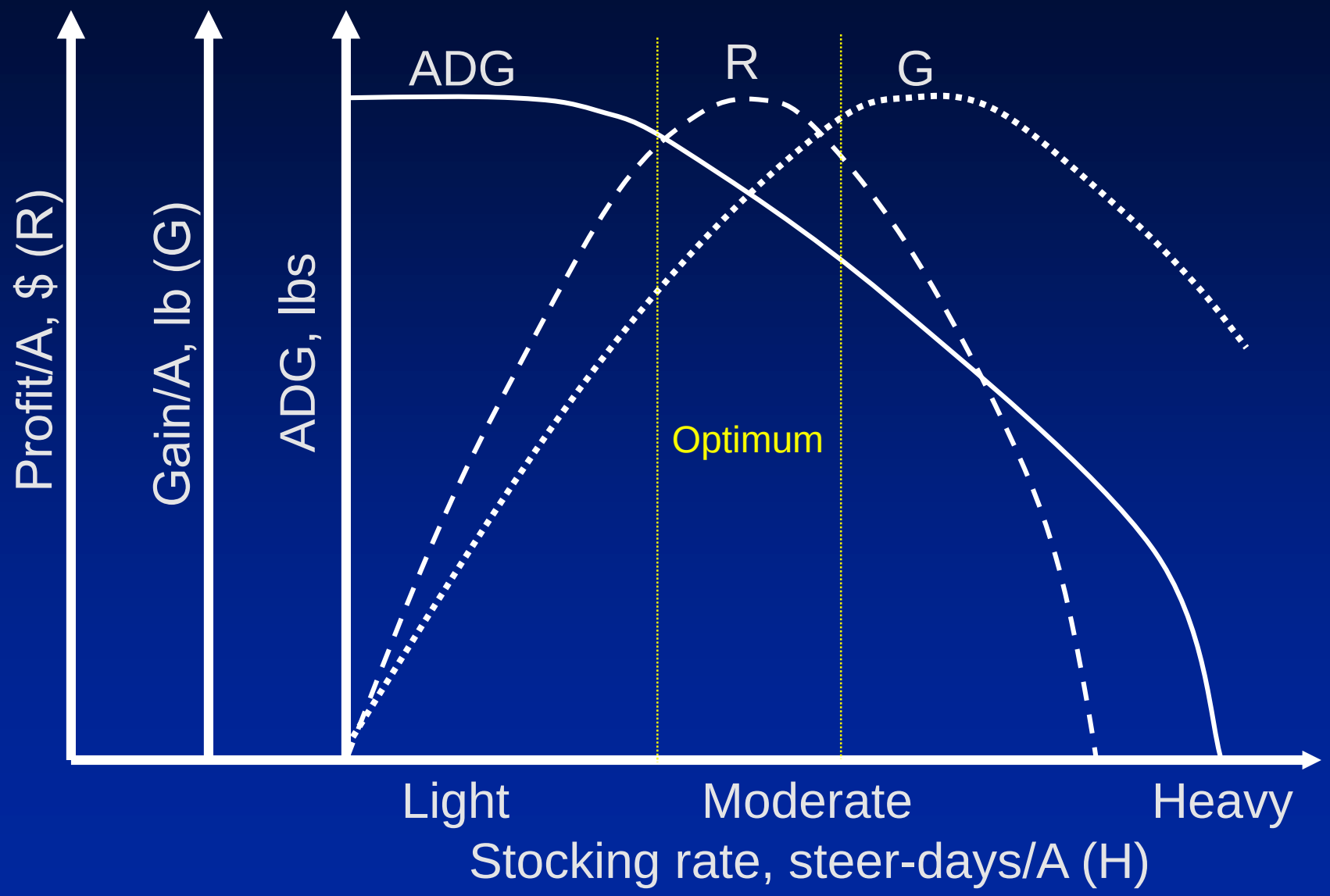


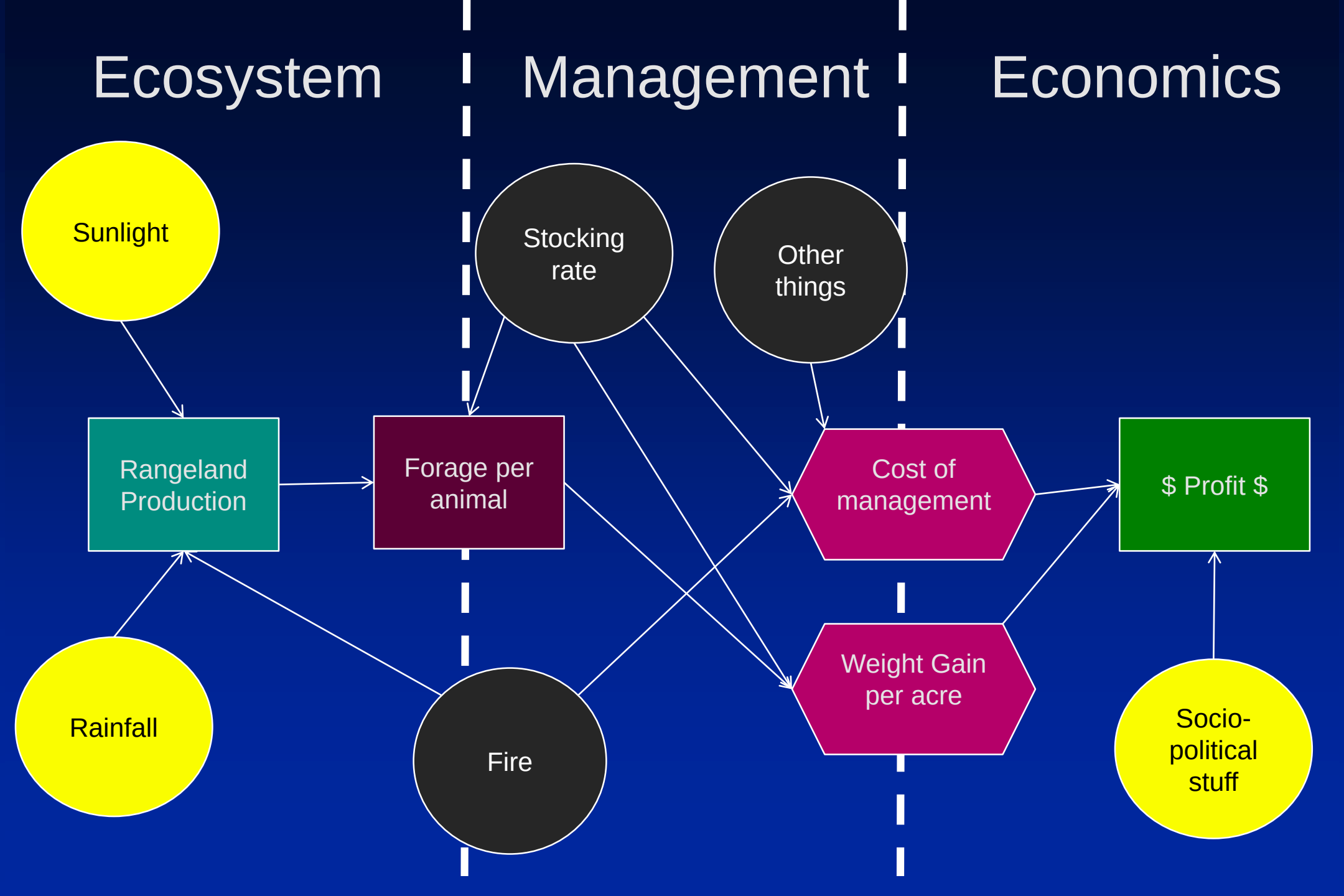
Figure 4. Plot-level herbaceous biomass as a function of eastern redcedar canopy cover in tallgrass prairie.

Limb et al. 2010

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, stocking rate


ADG
R
G
Profit/A, $ (R)
Gain/A, lb (G)
ADG, lbs
Optimum
Light
Moderate
Heavy
Stocking rate, steer-days/A (H)


Ecosystem
Management
Economics
Sunlight
Stocking rate
Other things
Rangeland Production
Forage per animal
Cost of management
$ Profit $
Rainfall
Fire
Weight Gain per acre
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

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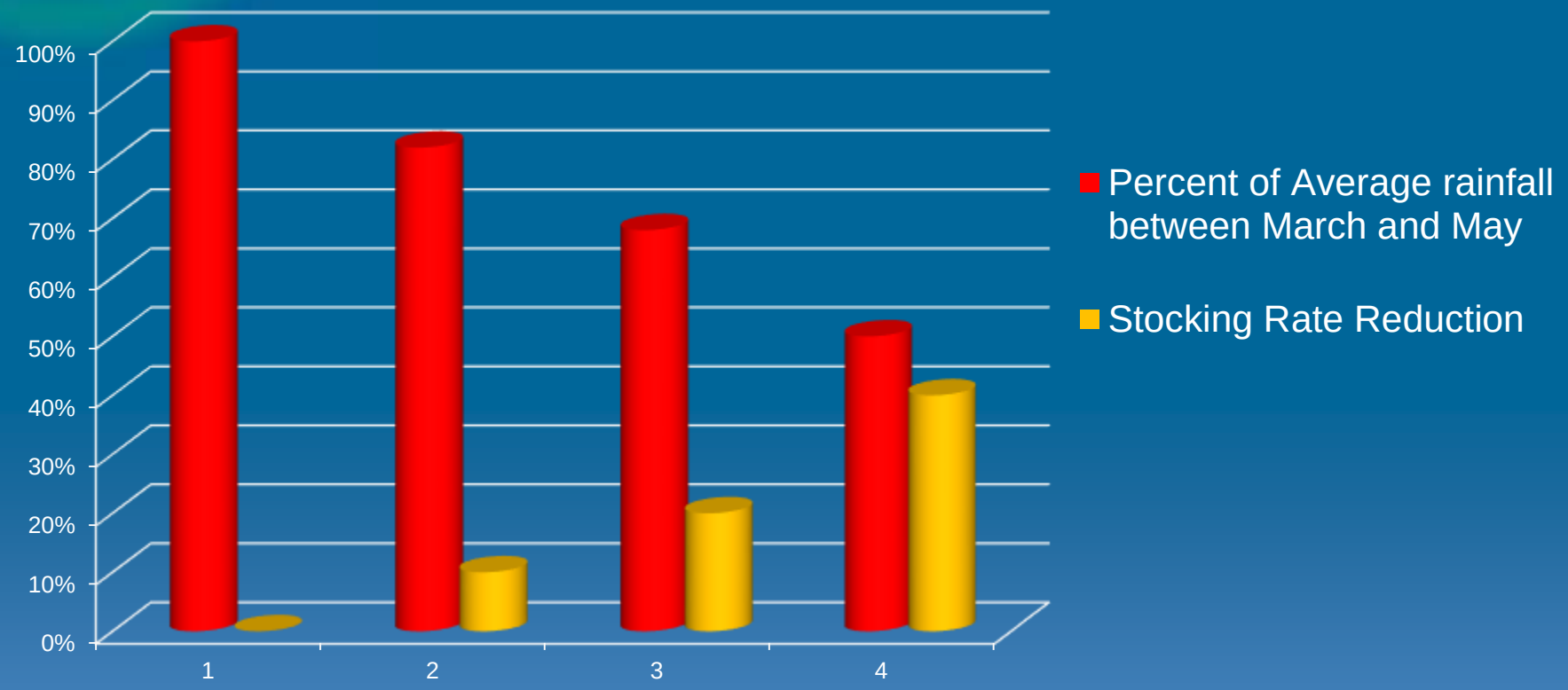
   - Rapid response – but not too rapid?
   - Long term plan with conservative stocking rate

Rapid Response



David J. Kraft
Rangeland Management Specialist
NRCS, Emporia, Kansas

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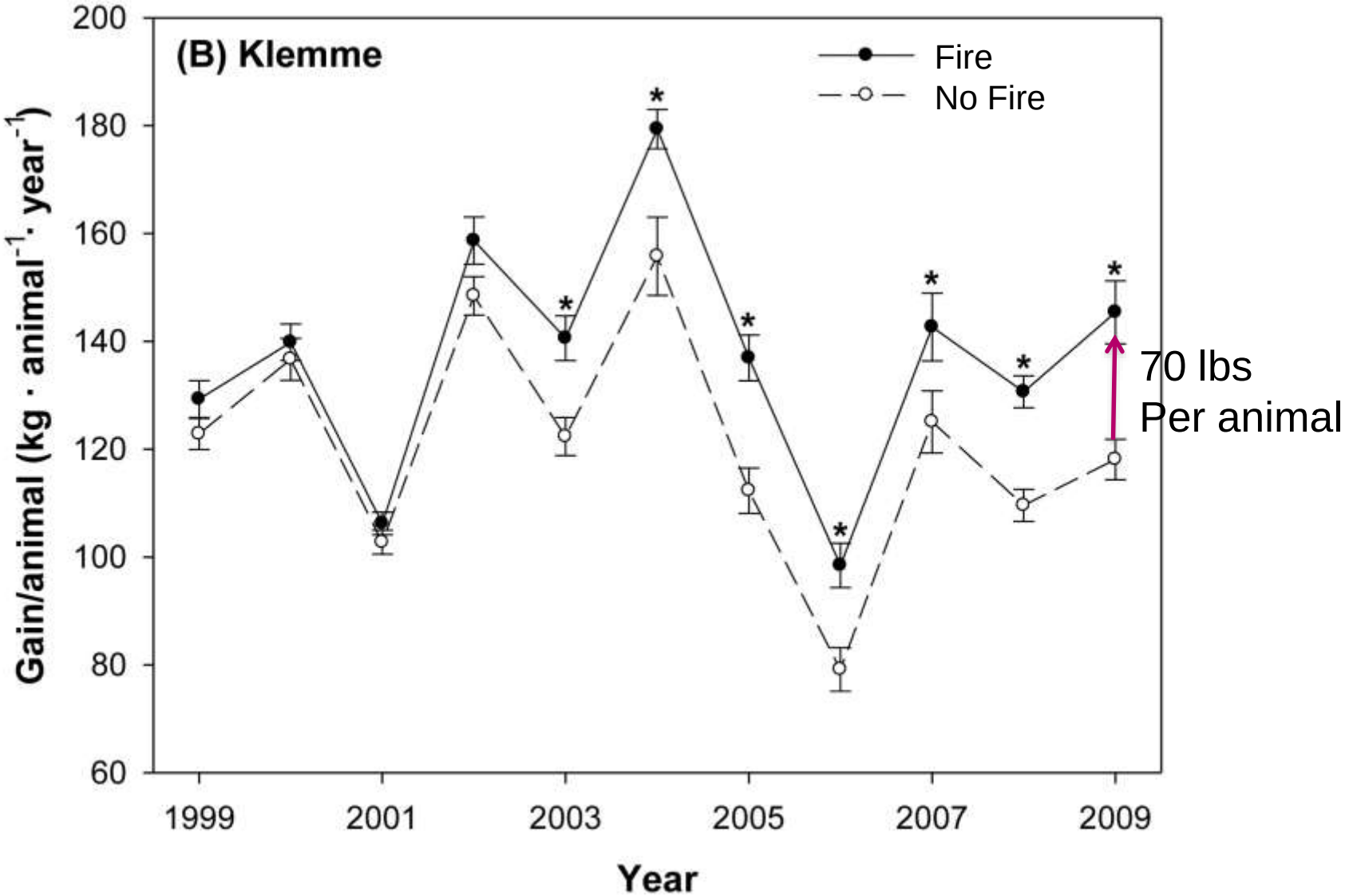
3. Help invasive brush to die

% Change in Total Woody Cover
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1958
2011

Weight Gains by Stocker Cattle on Mixed Prairie

Limb et al. (2011)



Principles for managing pastures and rangelands during drought

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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

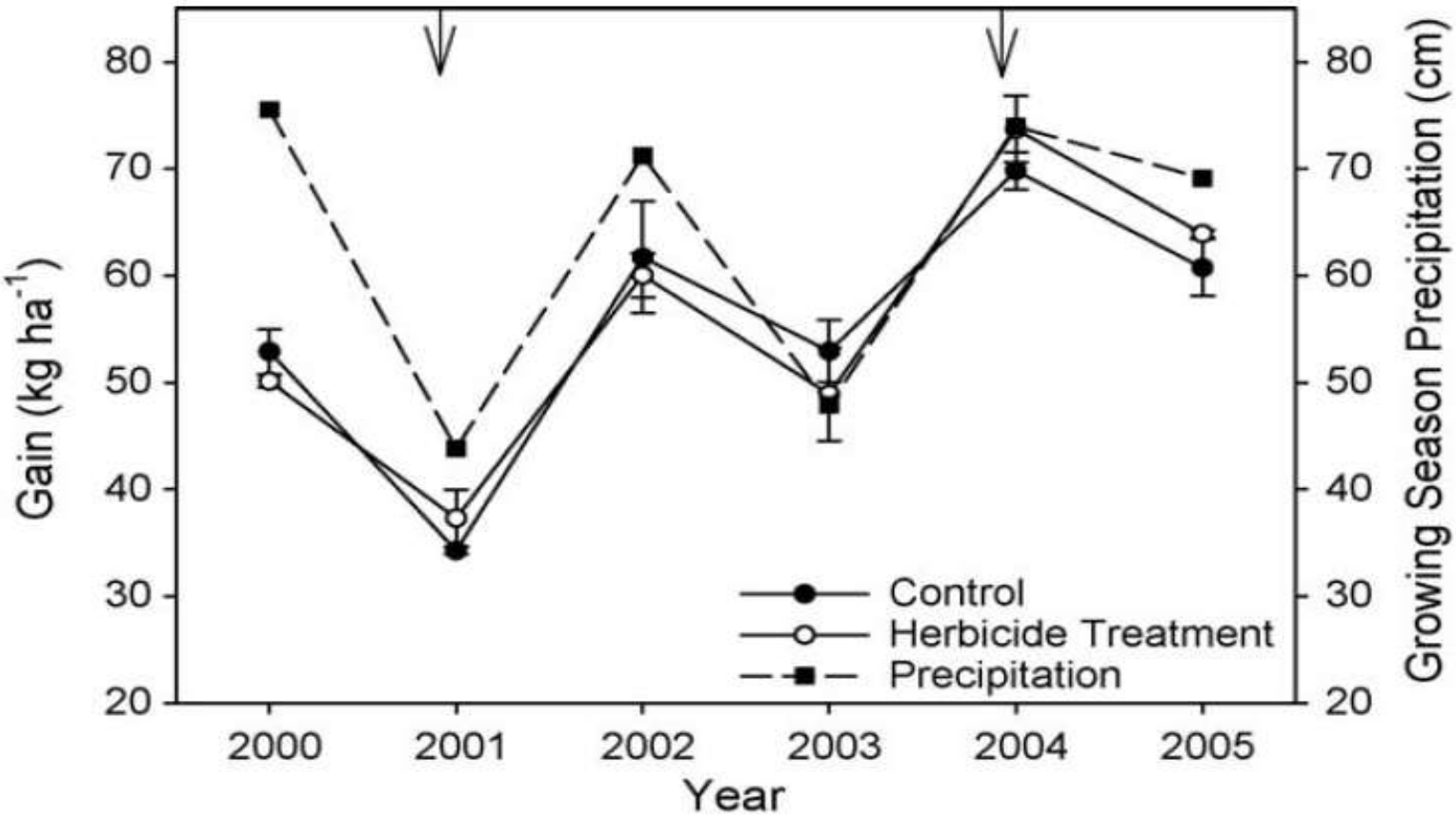

Fig. 5. Gain of stocker cattle (gain per area) and growing-season precipitation (March to October) from 2000 to 2005 on the Marvin Klemme Range Research Station. Herbicide was applied in April 2001 and May 2004 (indicated by vertical arrows) to the herbicide treatment pastures. Error bars are 1 SE. Treatments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

Rangeland Ecol Manage 61:3–17 | January 2008

Synthesis Paper

Rotational Grazing on Rangelands: Reconciliation of Perception and Experimental Evidence

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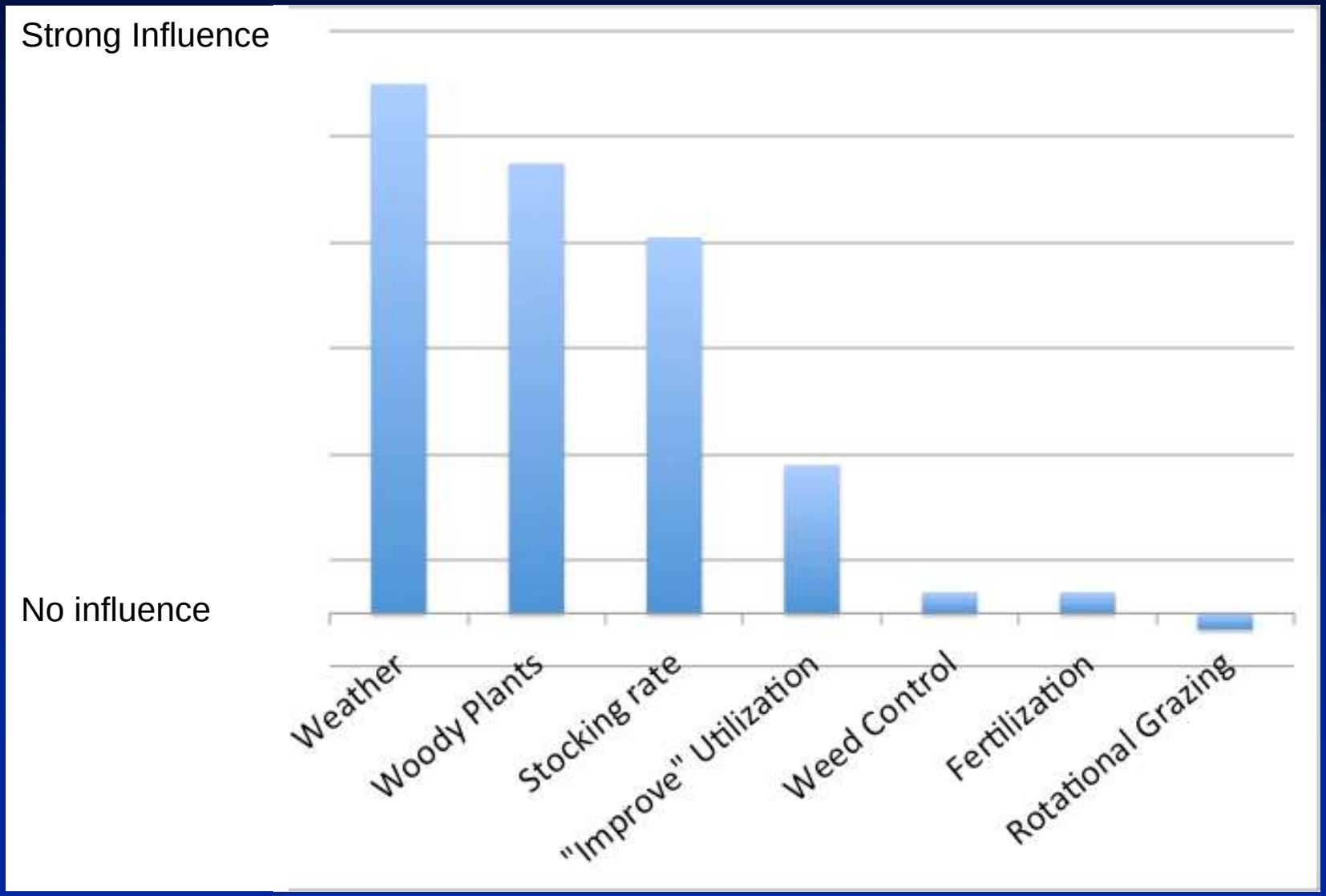
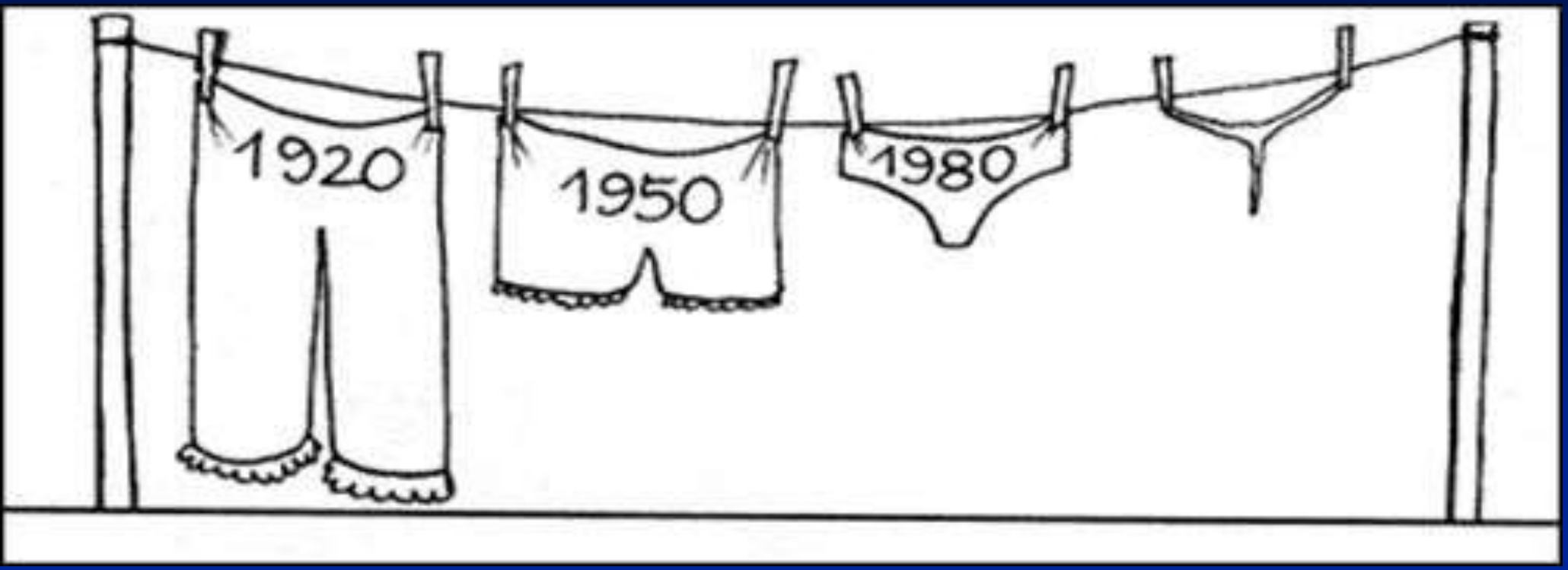
Abstract

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.

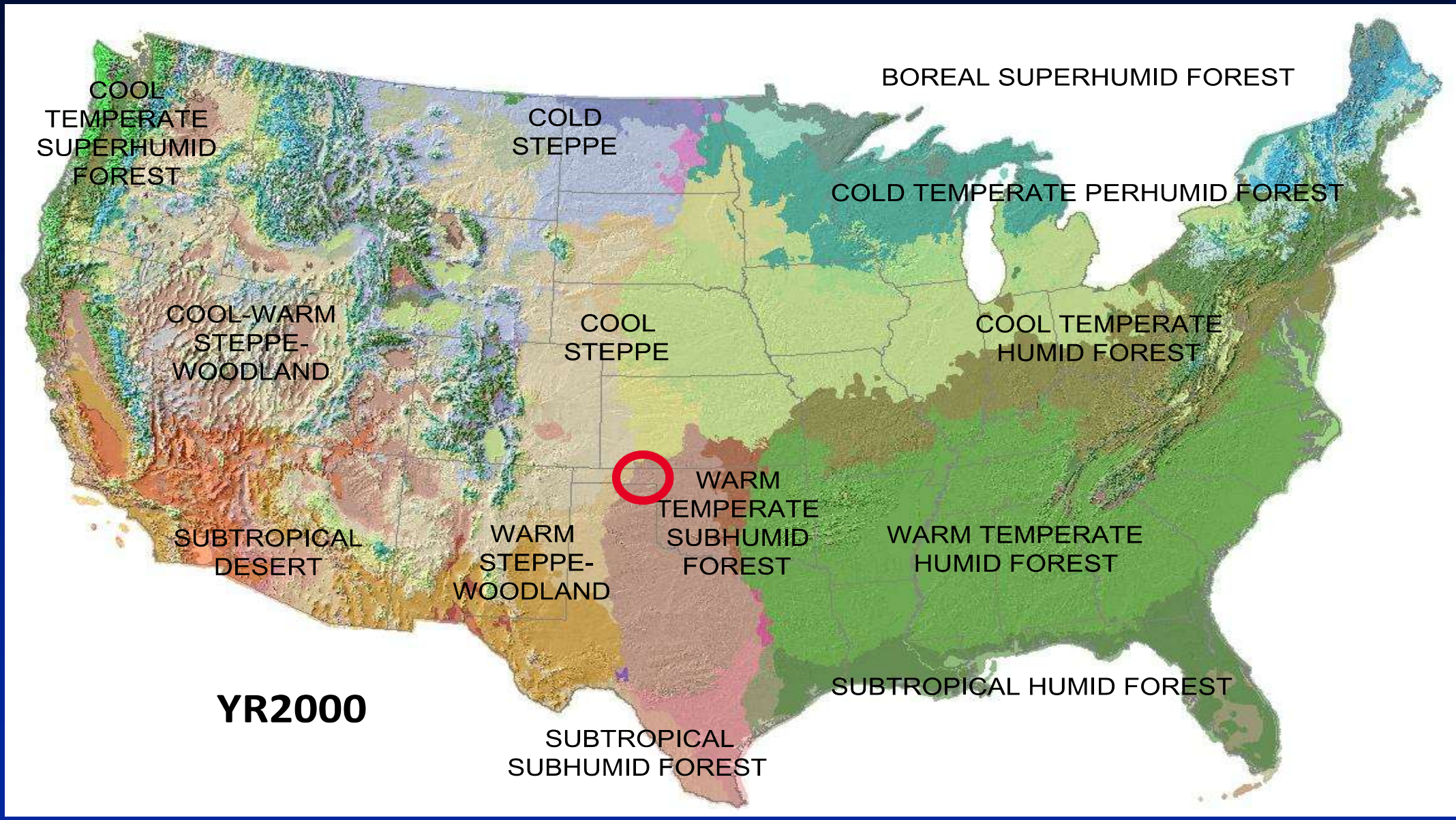
CONCLUSION:
What factors influence production



Evidence for global warming?



Holdridge Life Zones for CONUS



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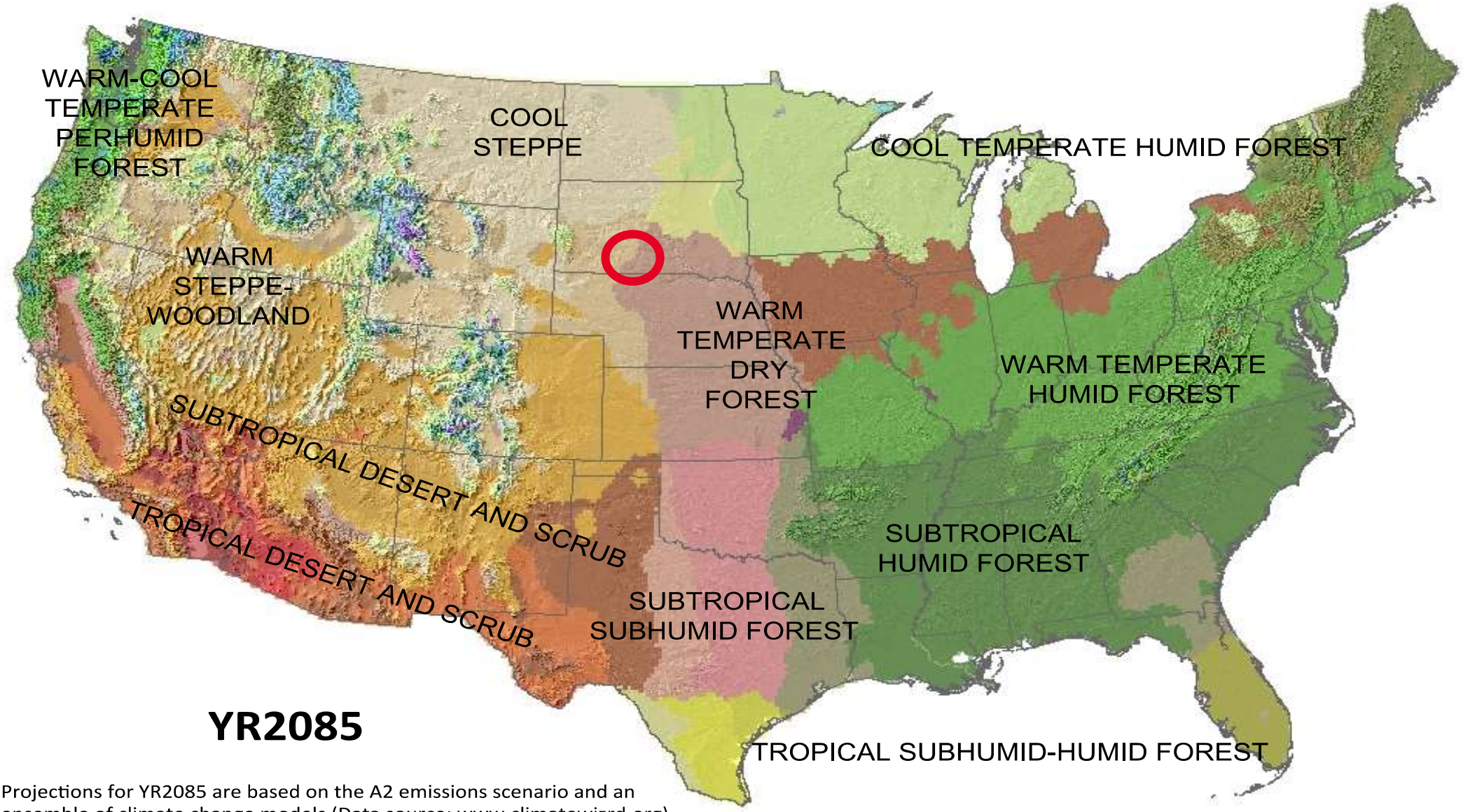


YR2085

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

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

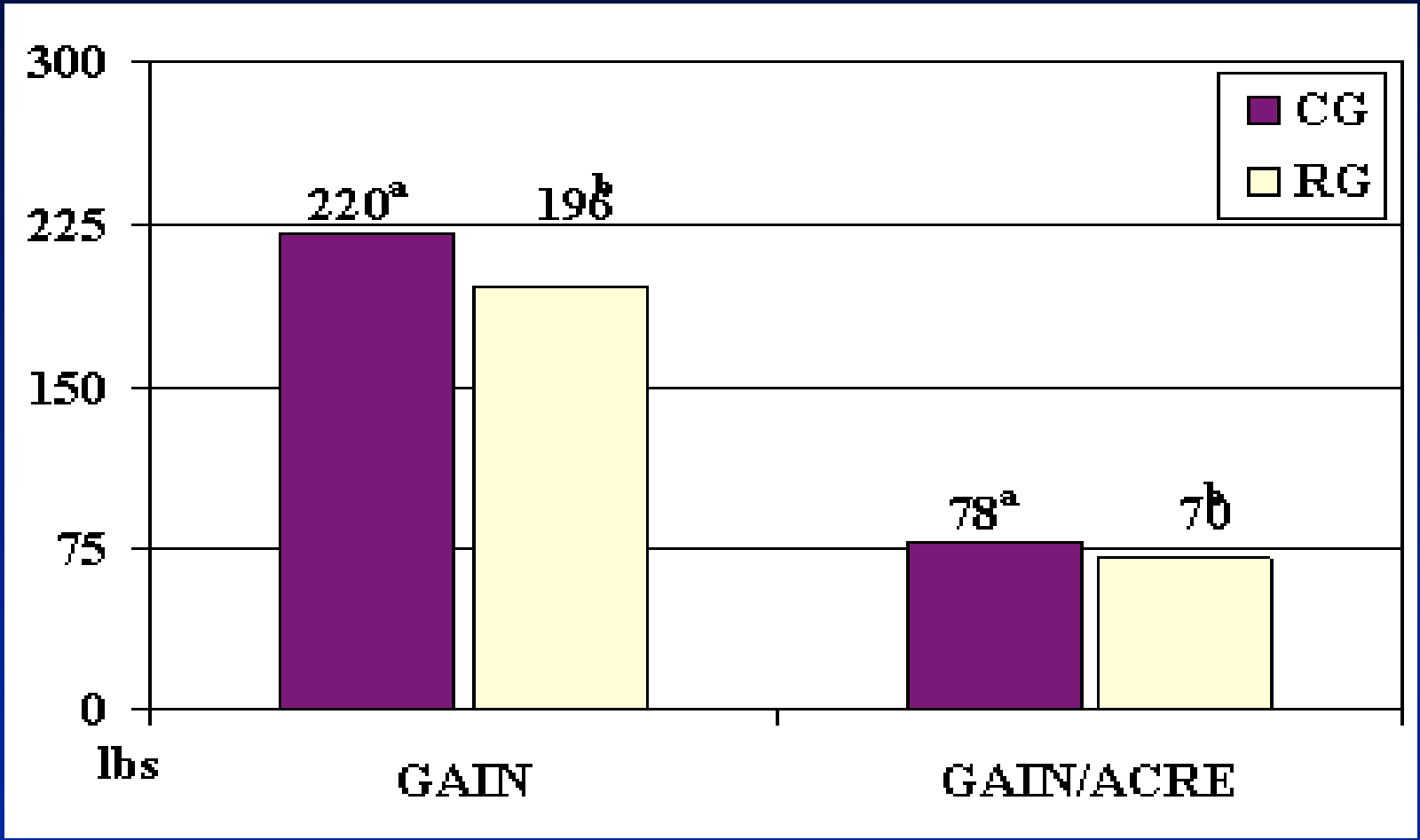
Holechek et al. 1999

629

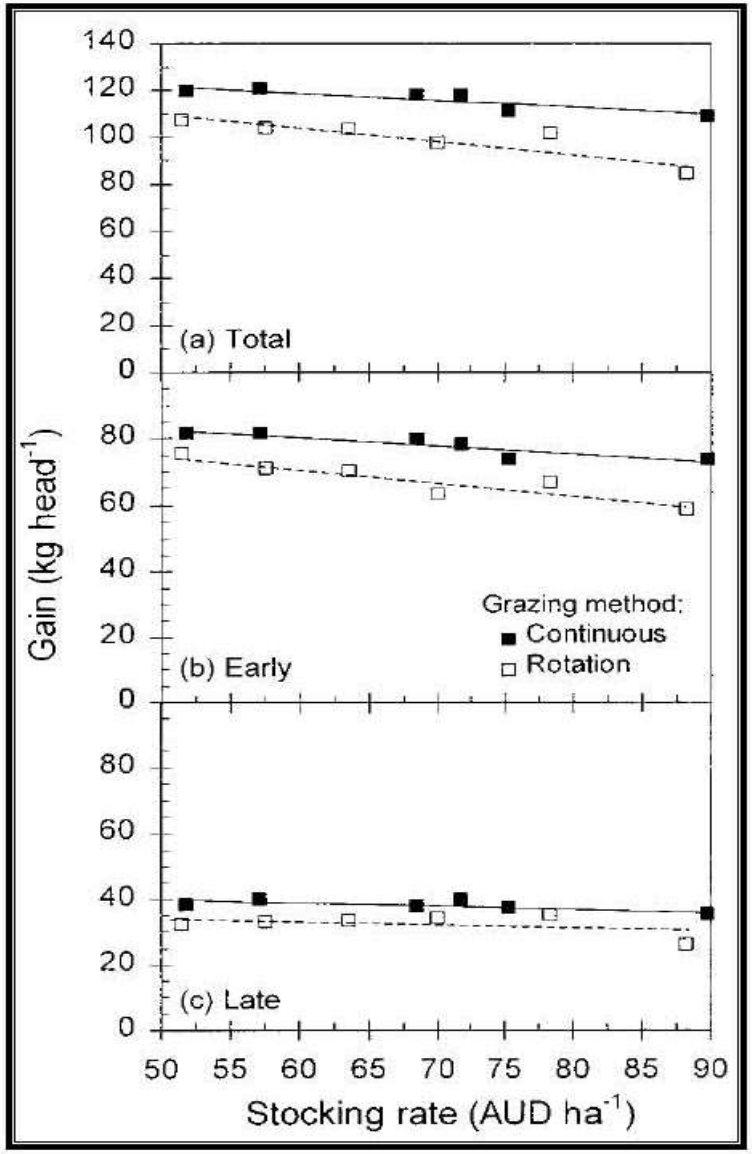
Prior Grazing System Summaries

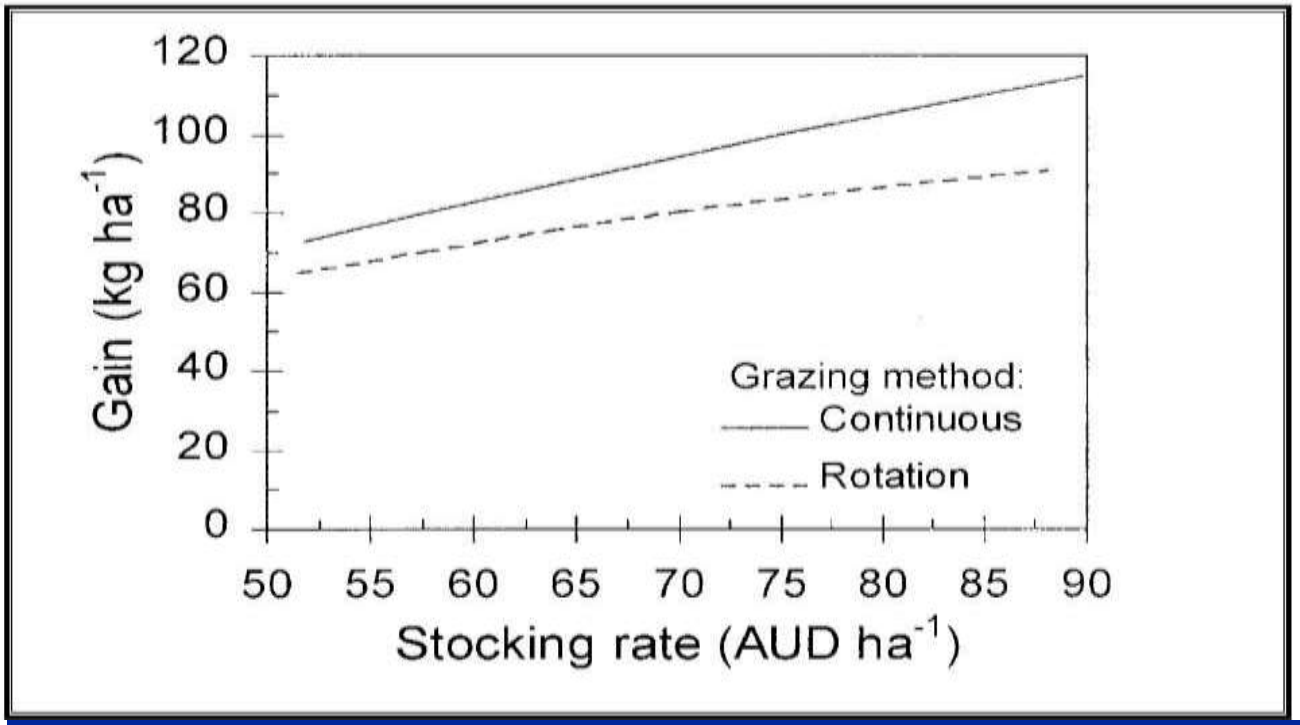
Sampson 1951	"…two fairly distinct viewpoints (conservationists and operators) regarding merits of rotational grazing"
Heady 1961	"…specialized grazing system has no advantage in livestock production over continuous grazing"
Van Poollen and Lacey 1979	"…land managers should place more emphasis on proper stocking intensity, and less on grazing system implementation."
O' Reagain and Turner 1992	"…relative to [stocking rate], the grazing system employed is of minor importance."

Bodine et al. 1998



Experimental Findings: Animals



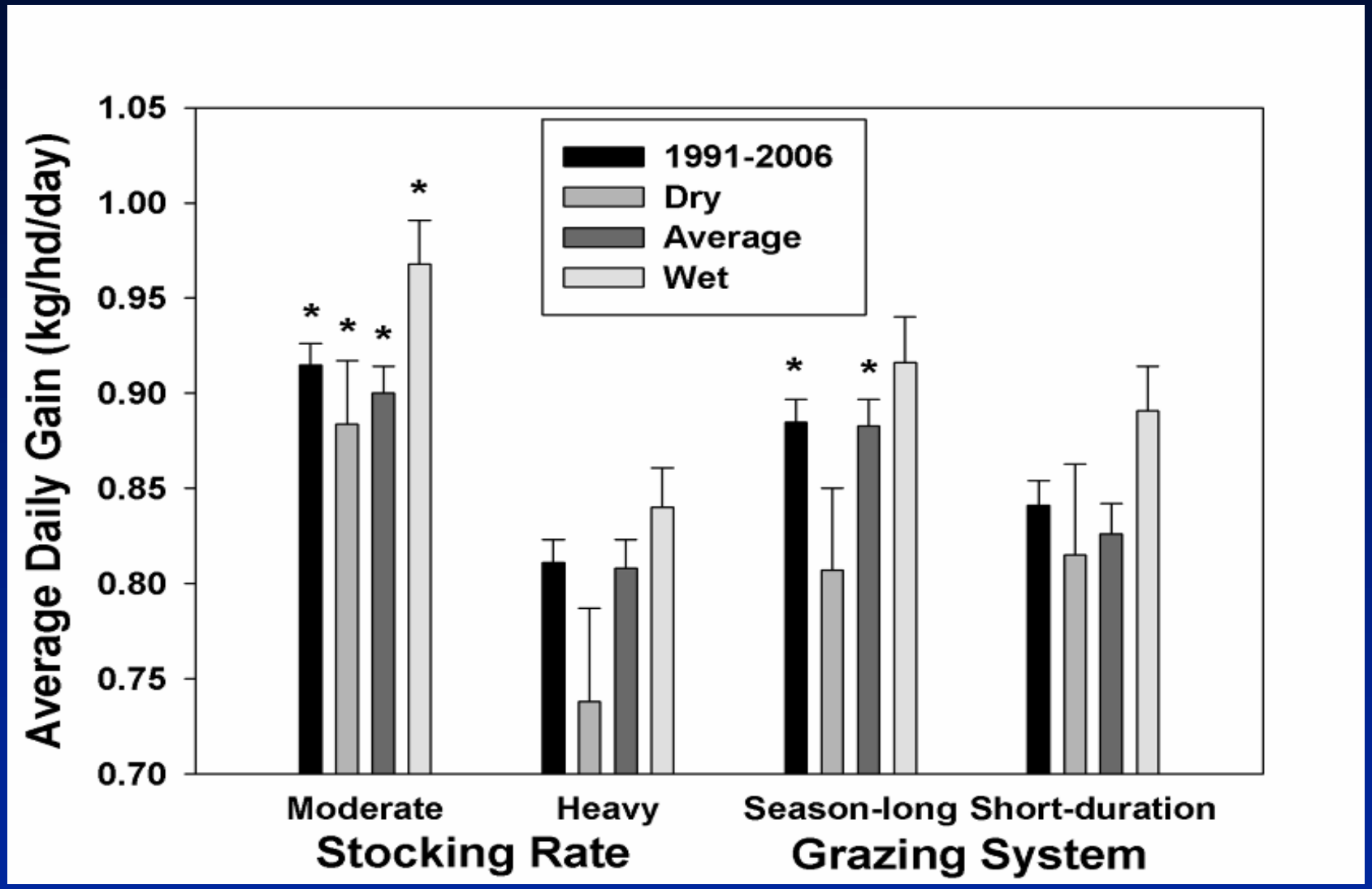


McCollum et al. 1999

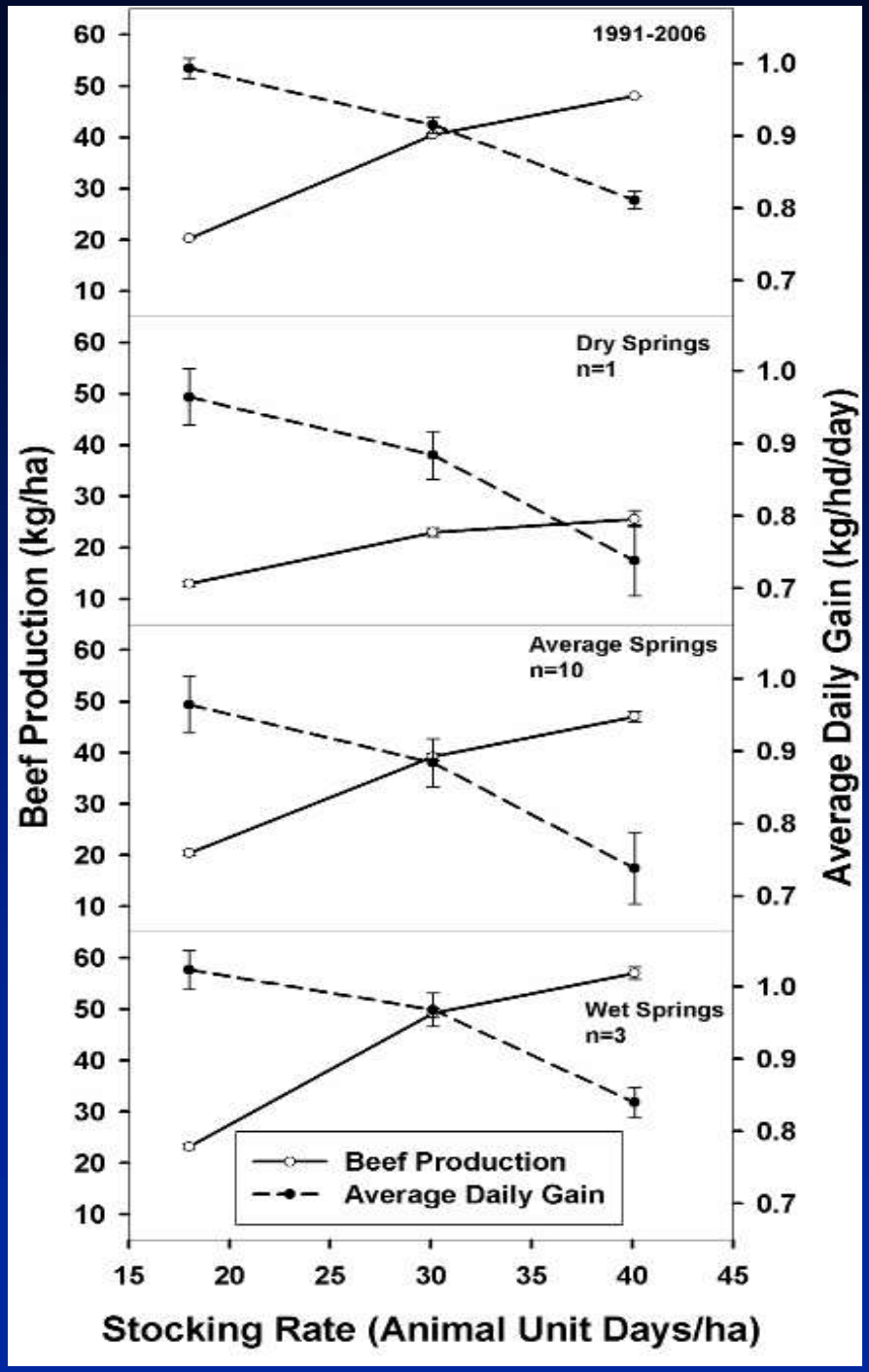
Research from over 30 years on rangelands has concluded that rotational grazing resulted in:

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

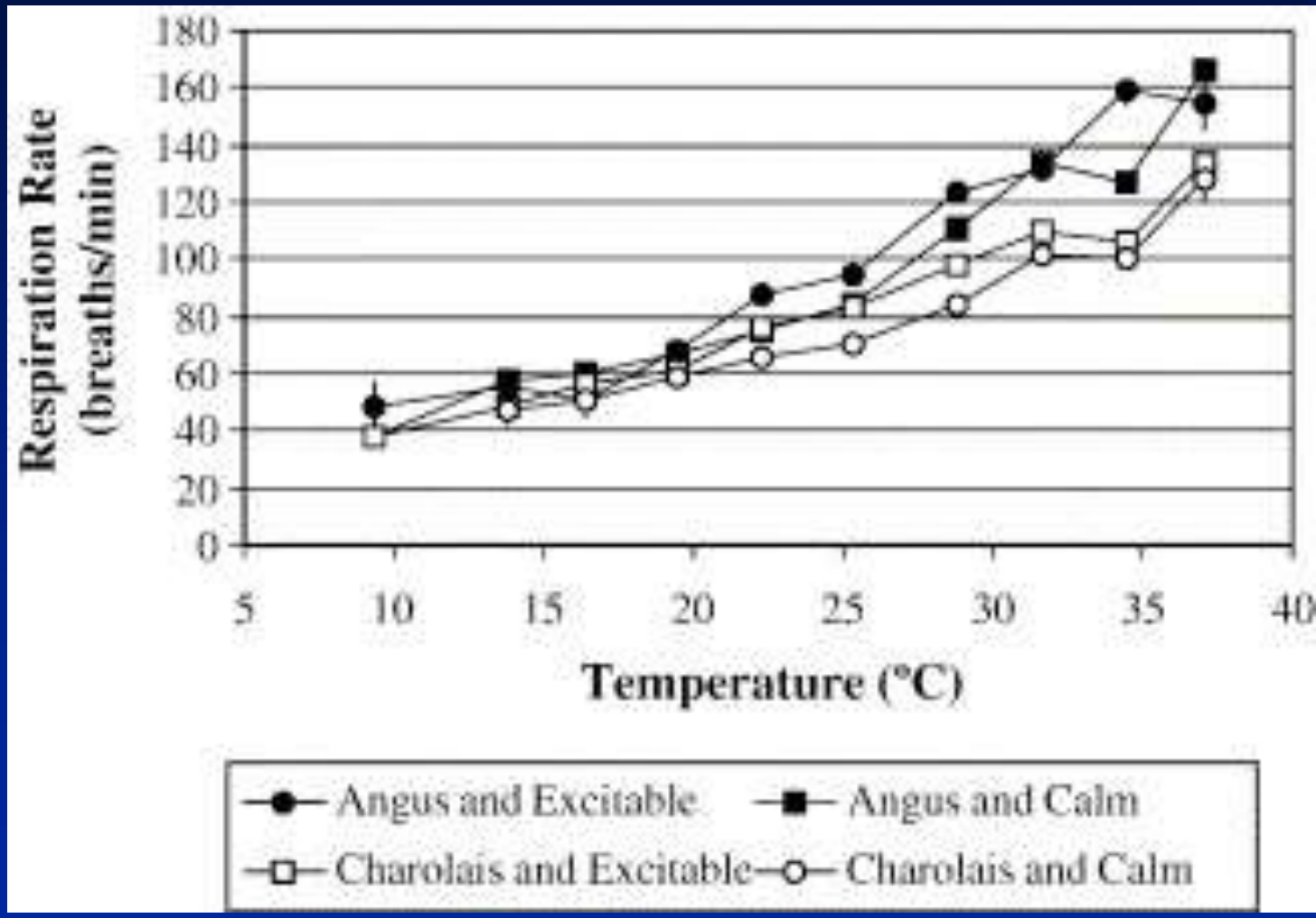
Bryant et al. 1987
Thurow 1991
Briske et al. 2008



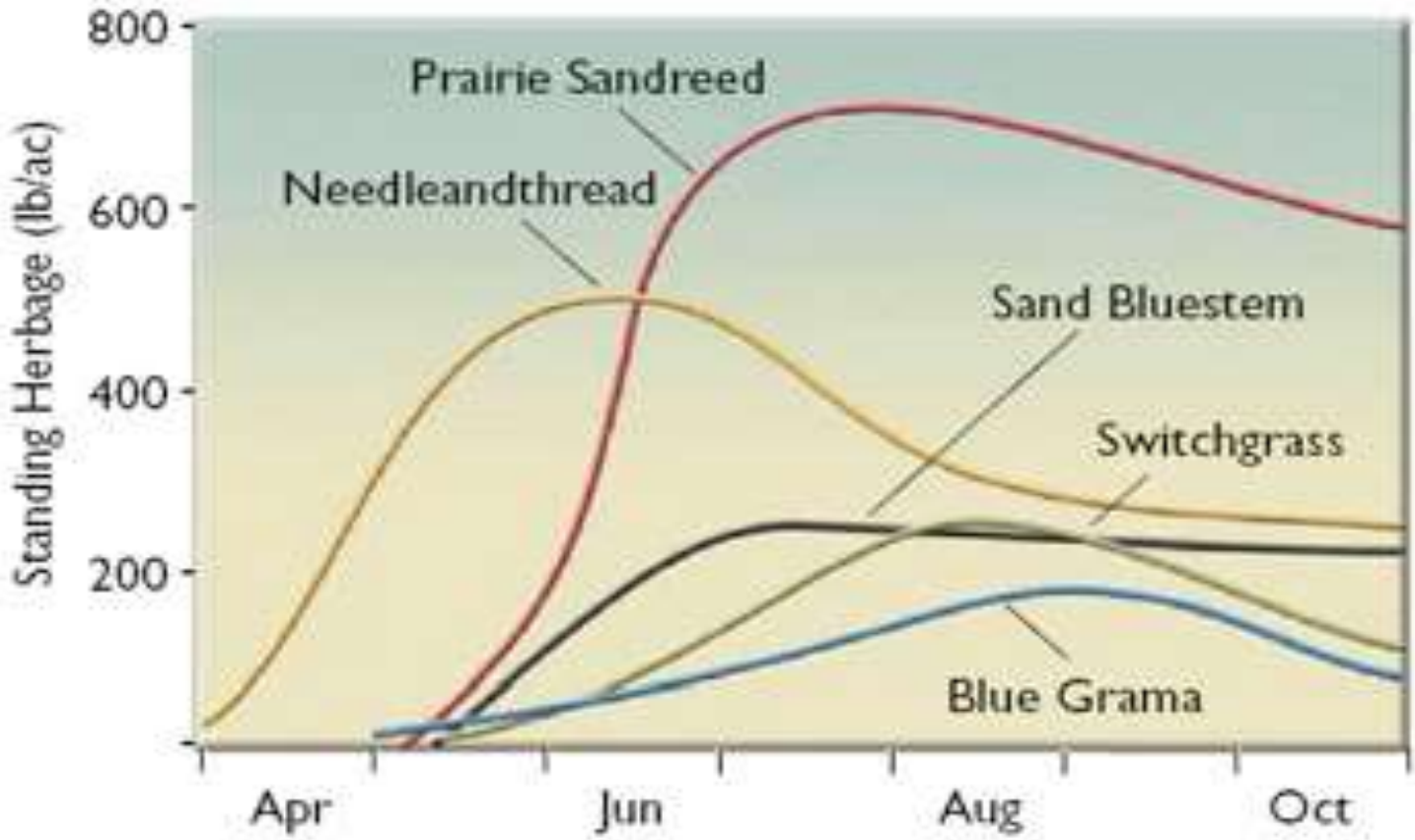
Derner et al., in press



Derner and Hart, in press

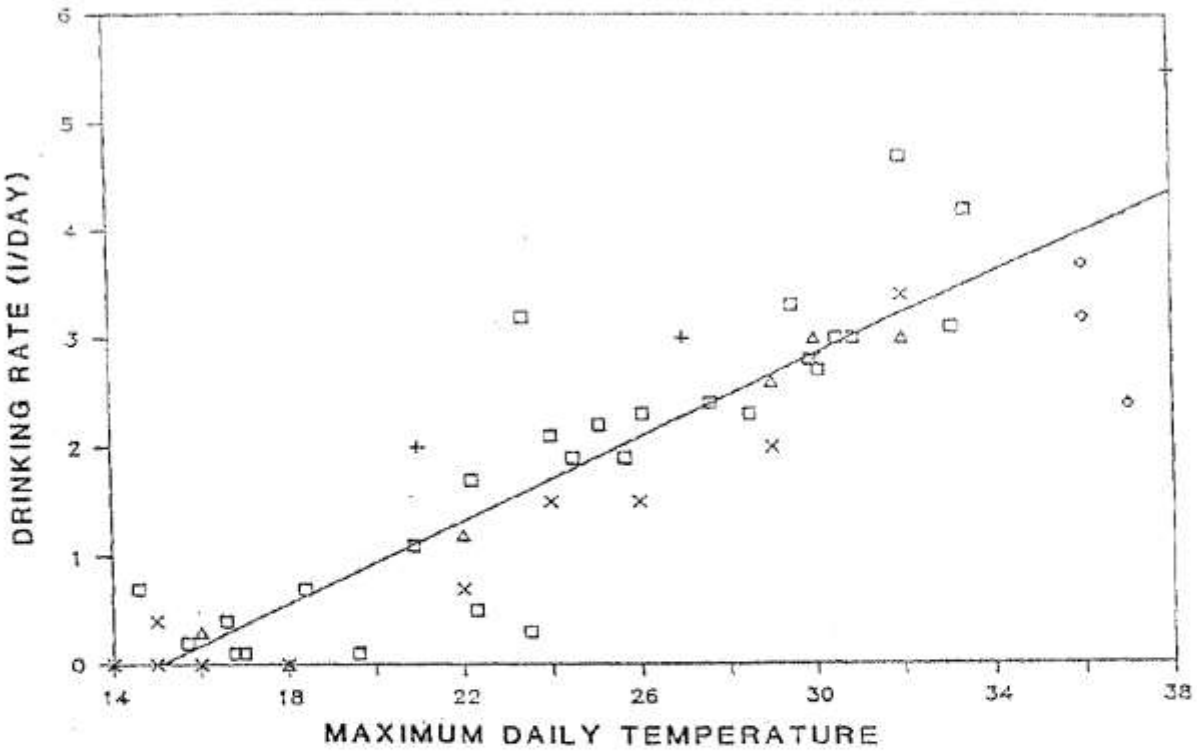


Brown-Brandi et al 2006



Seasonal distribution of current-year herbage by species on sandy range sites in good to excellent range condition with average precipitation. (Nosal 1983)

http://drought.unl.edu/ranchplan/DroughtBasics/GrazingDrought.aspx

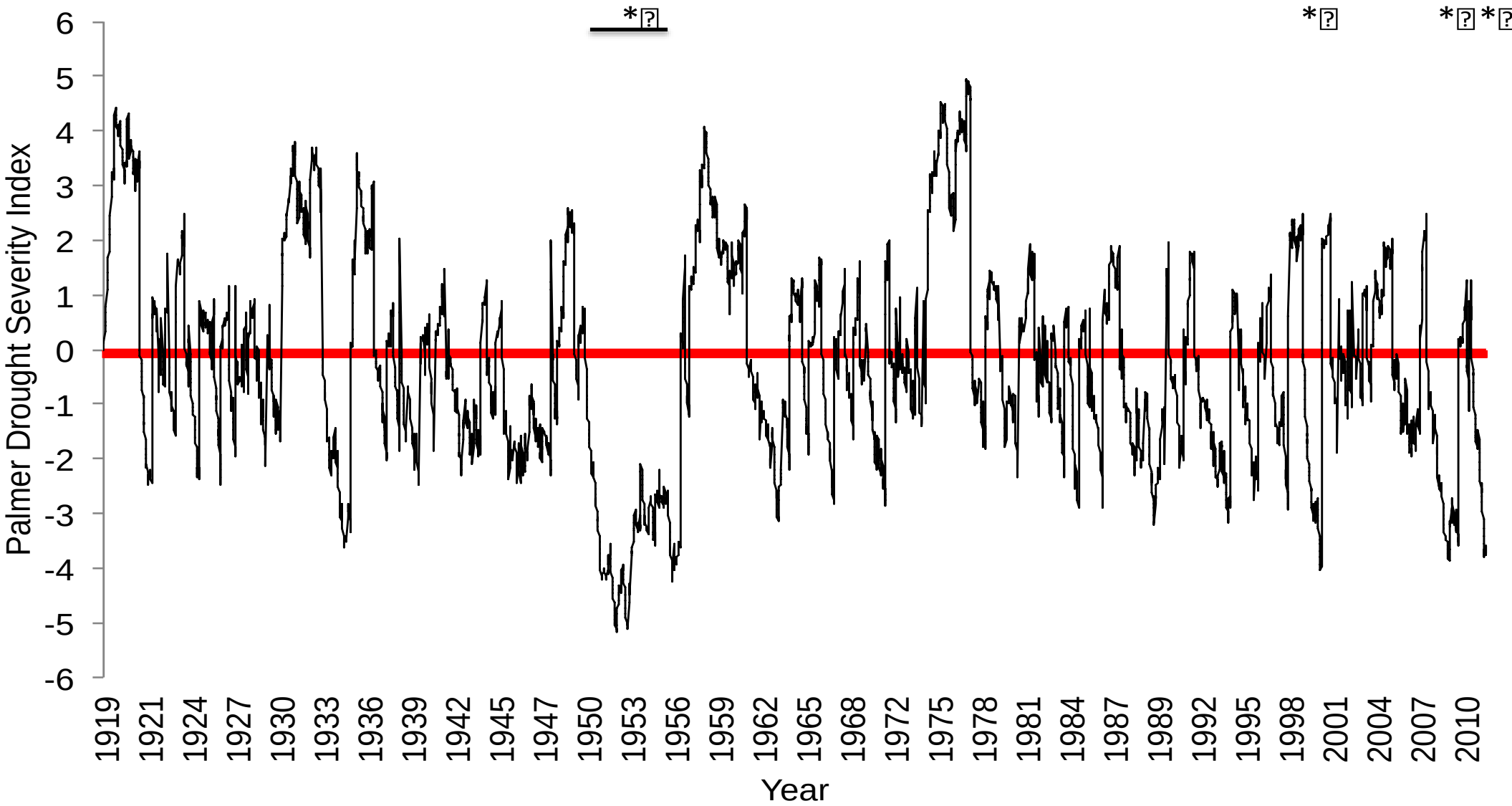


REFERENCES

- □ WRIGHT AND ASHTON (1978)
- + MacFARLANE AND HOWARD (1966)
- ◊ MacFARLANE et al (1966)
- △ WILSON (1975)
- x WILSON (1974)

Figure 1. Relationship between maximum daily temperature and the drinking rate of sheep.

Luke 1987


*?
*?
??
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
Palmer Drought Severity Index
1919
1921
1924
1927
1930
1933
1936
1939
1942
1945
1947
1950
1953
1956
1959
1962
1965
1968
1972
1975
1978
1981
1984
1987
1989
1992
1995
1998
2001
2004
2007
2010
Year

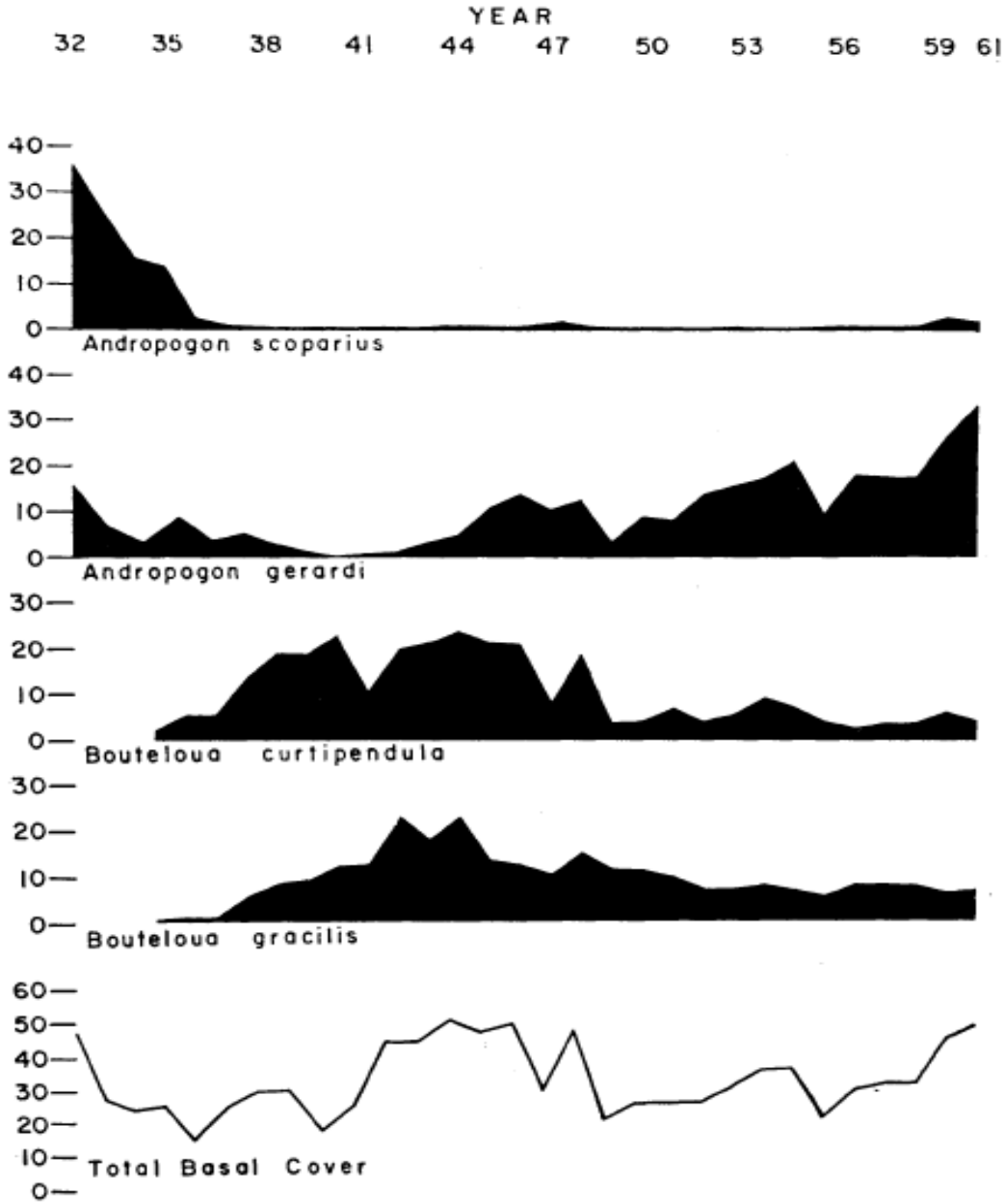
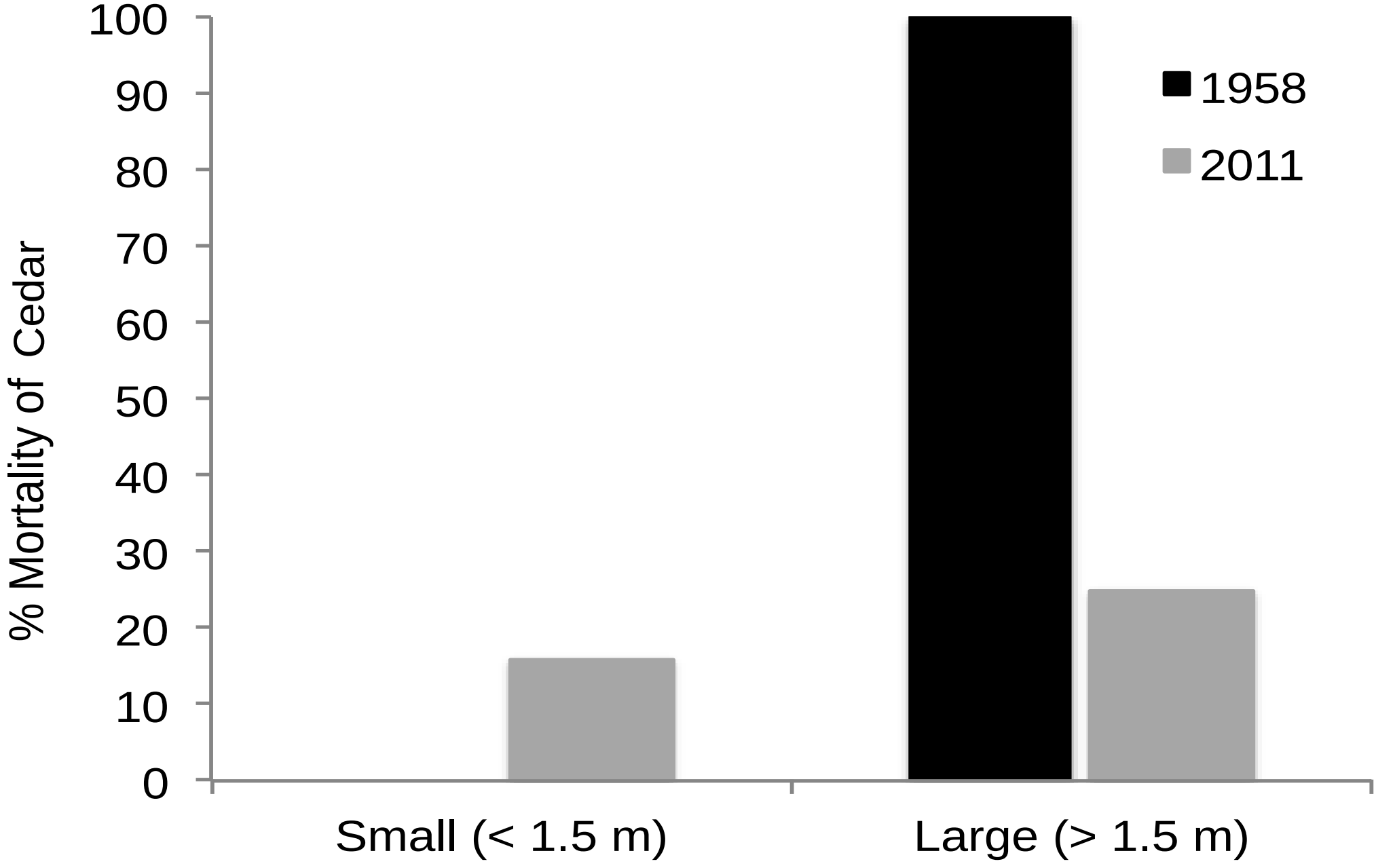
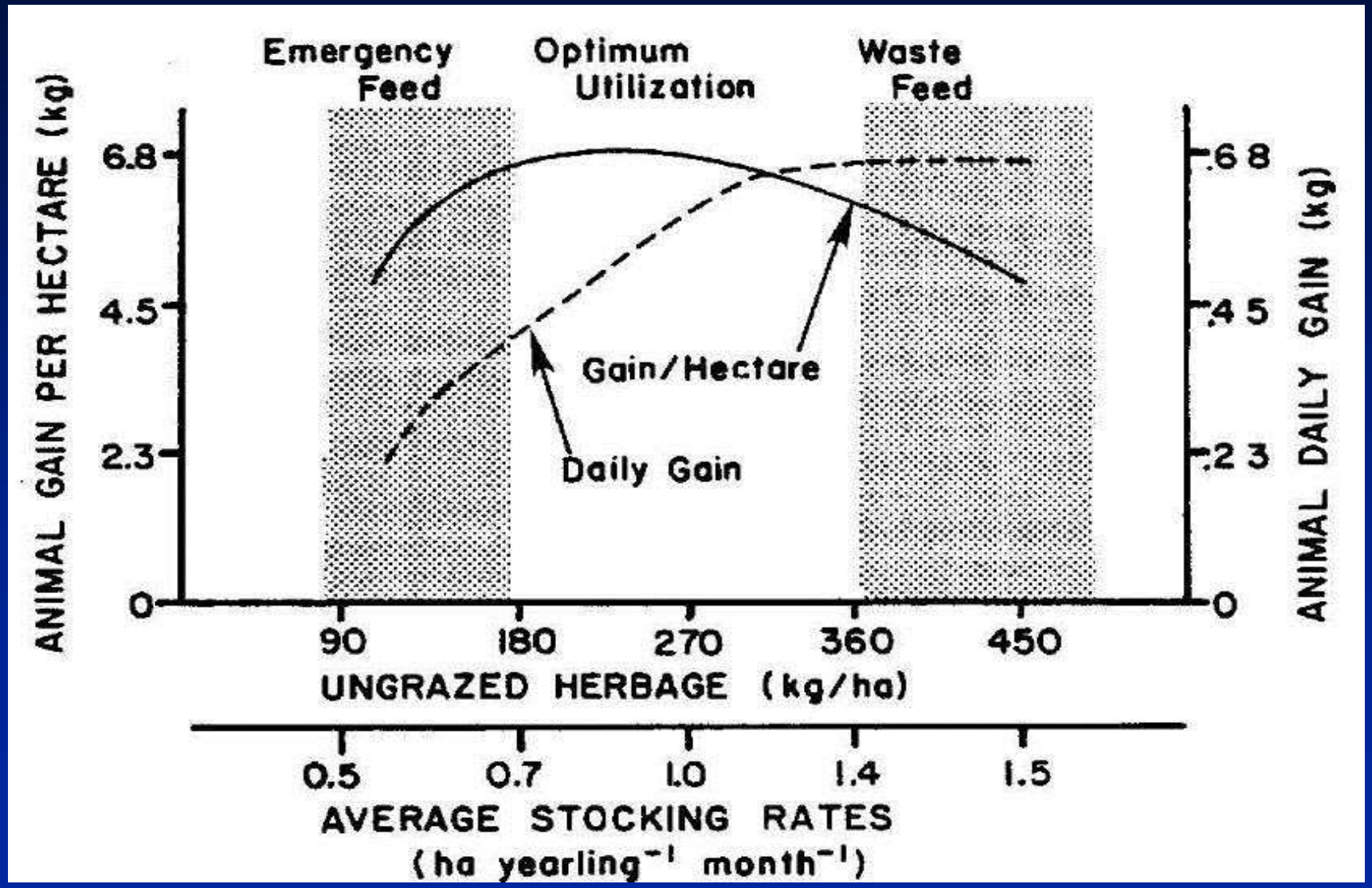


FIG. 4. Changes in basal cover (per cent) and percentage composition of dominant grasses of the little bluestem-big bluestem community from 1932 to 1961, inclusive.

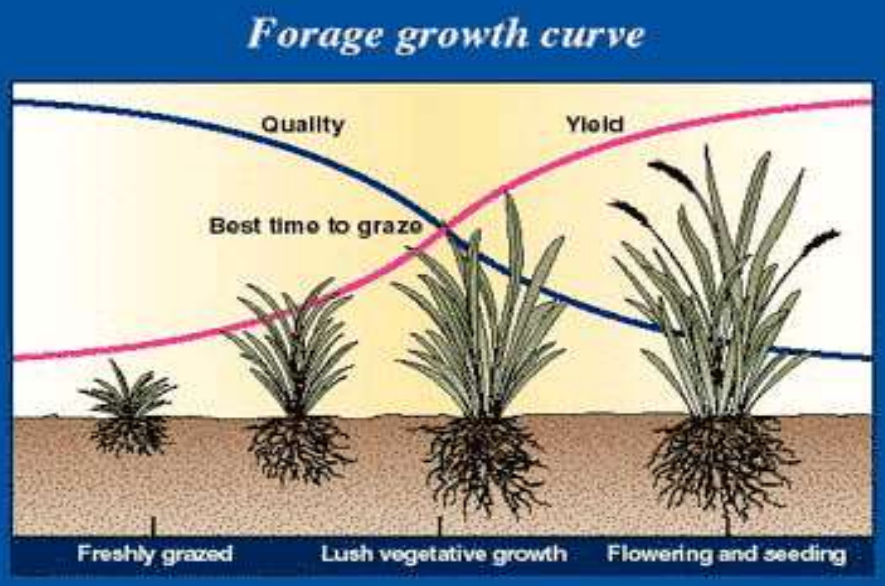
Albertson and Tomanek 1965

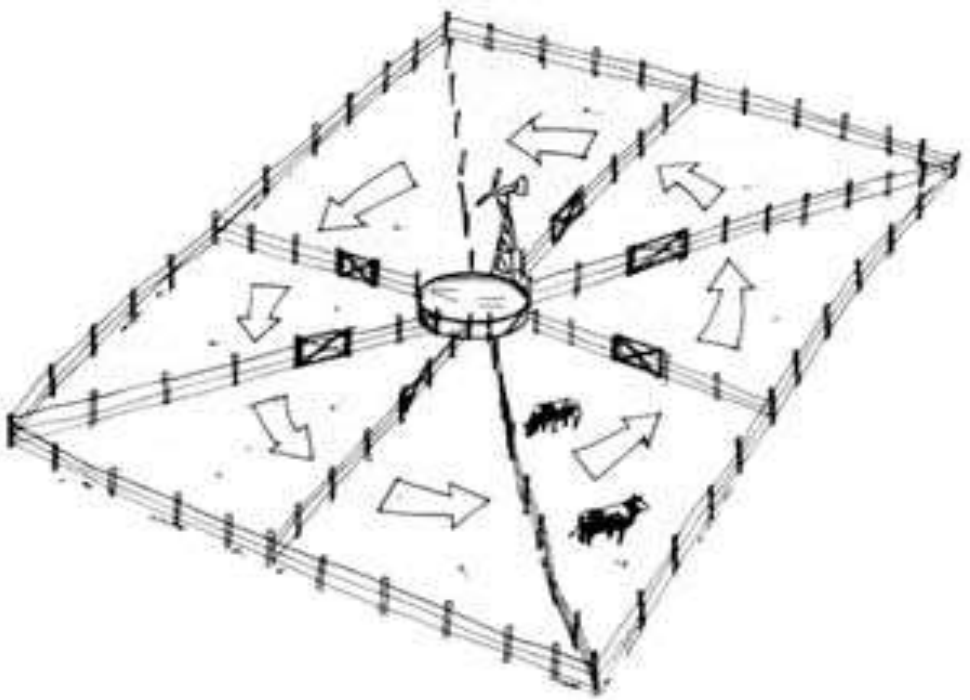

100
90
80
70
60
50
40
30
20
10
0
% Mortality of Cedar
1958
2011
Small (< 1.5 m)
Large (> 1.5 m)

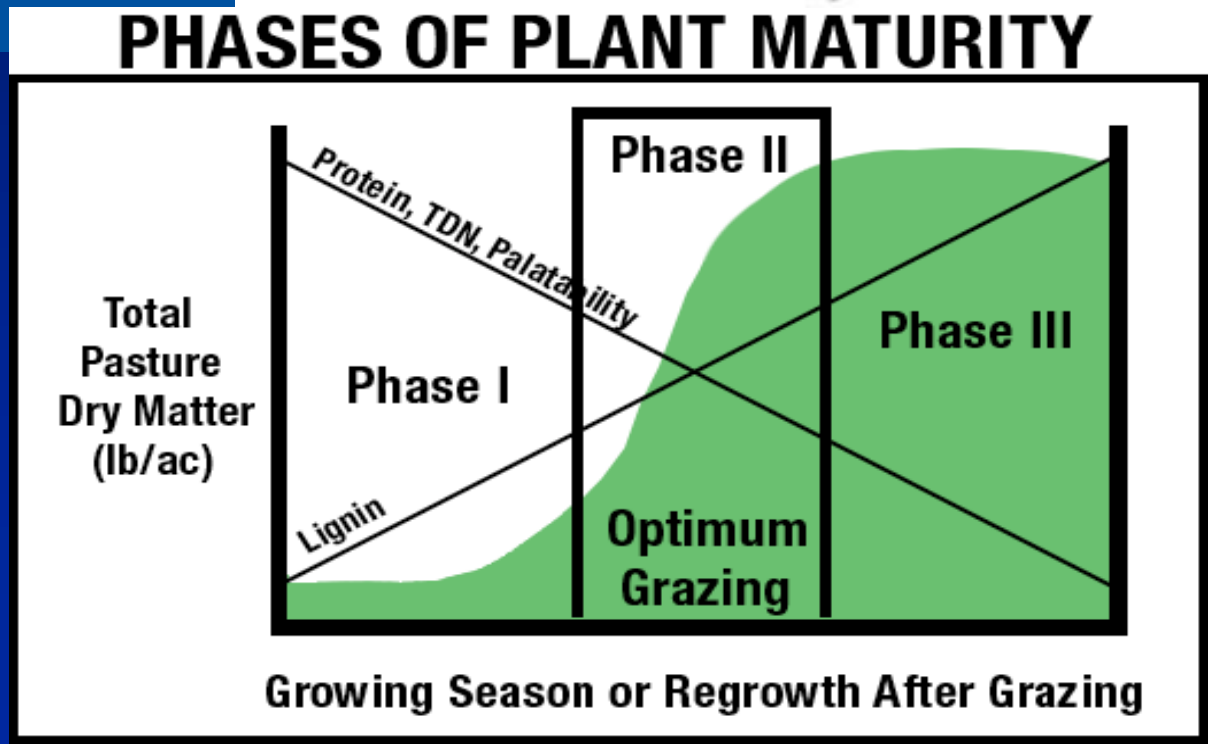
Experimental Findings: Animals



Bement 1969


Forage growth curve
Quality
Yield
Best time to graze
Freshly grazed
Lush vegetative growth
Flowering and seeding




PHASES OF PLANT MATURITY
Total Pasture Dry Matter (lb/ac)
Protein, TDN, Palatability
Lignin
Phase I
Phase II
Phase III
Optimum Grazing
Growing Season or Regrowth After Grazing

Types of Grazing Systems

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

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- 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?

Holechek et al. 1999

Summary of 15 studies of grazing system on native rangeland in North America

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

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 gimicks

What about Grazing Systems?

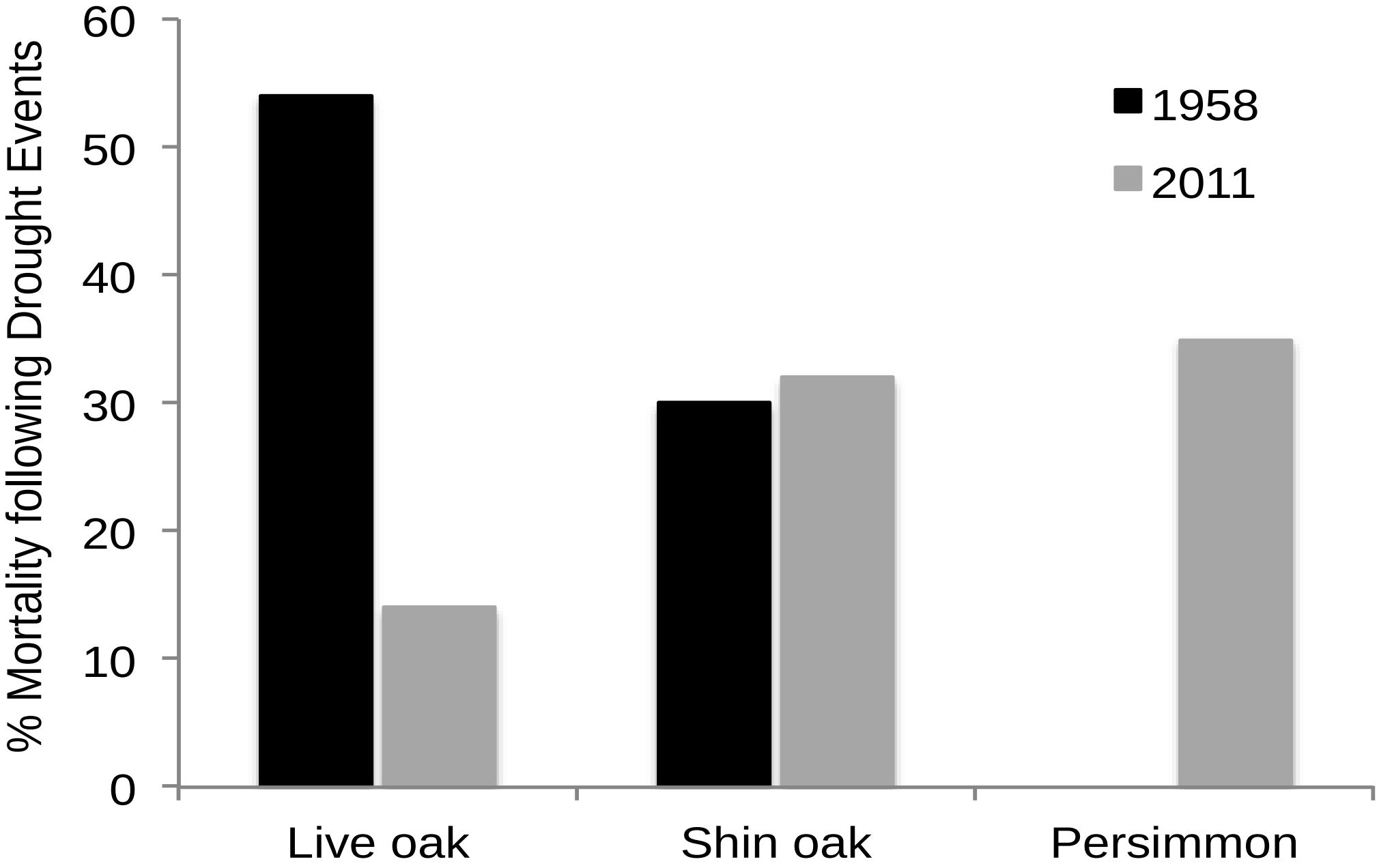
- Specialization of grazing management that defines reoccurring periods of grazing and non-grazing (rest, deferment) for 2 or more pastures
- General goal: increase production by:
  - Improve species composition
  - Reduce animal selectivity
  - Promote uniform animal distribution
  - Manage forage quality and quantity

Synthesis Key Points on Grazing Systems

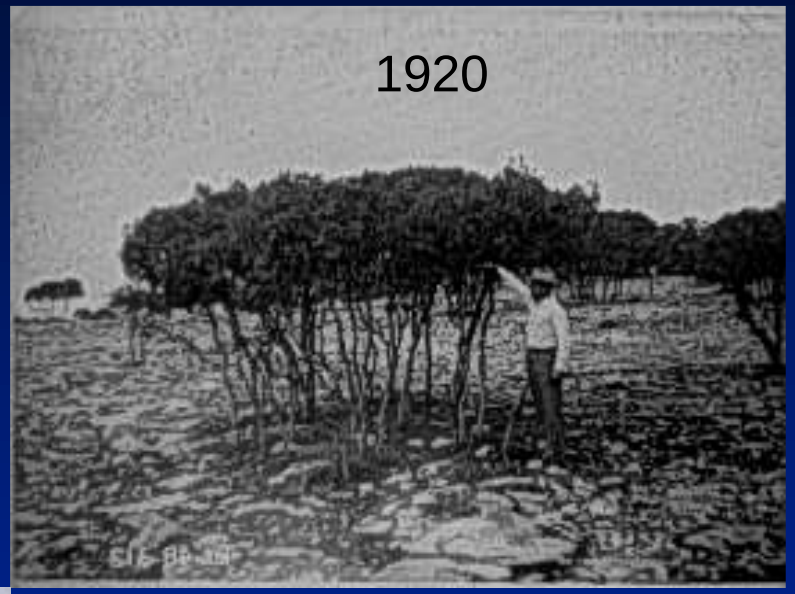
Briske et al. 2008

- 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

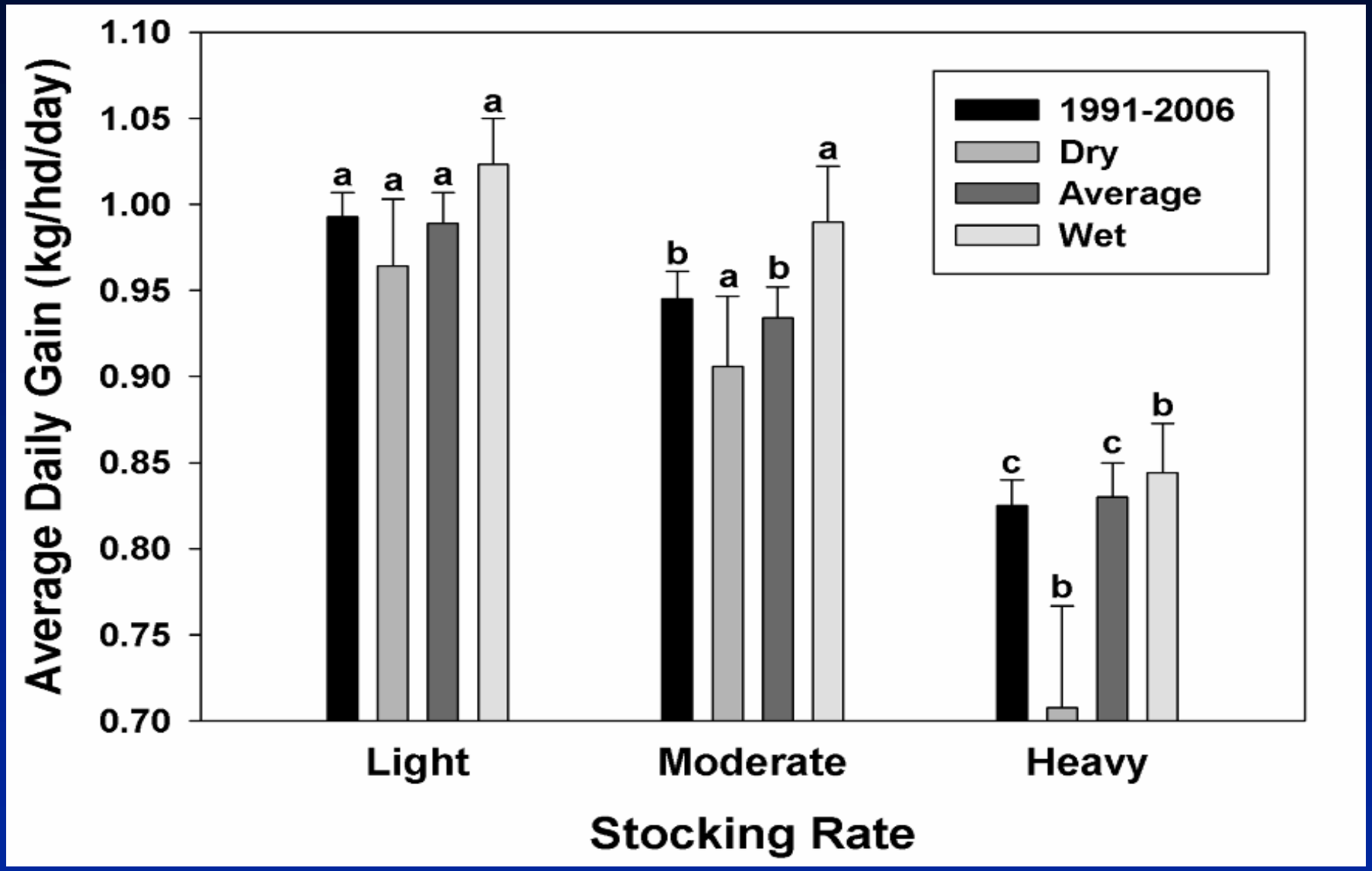

% Mortality following Drought Events
60
50
40
30
20
10
0
1958
2011
Live oak
Shin oak
Persimmon

What is good Range Management?



Poor Grazing Management (no fire)

Proper Grazing Management (frequent fire)



Derner and Hart, in press

A Model of Thermal Acclimation in Cattle

R. L. Senft and L. R. Rittenhouse

J ANIM SCI 1985, 61:297-306.

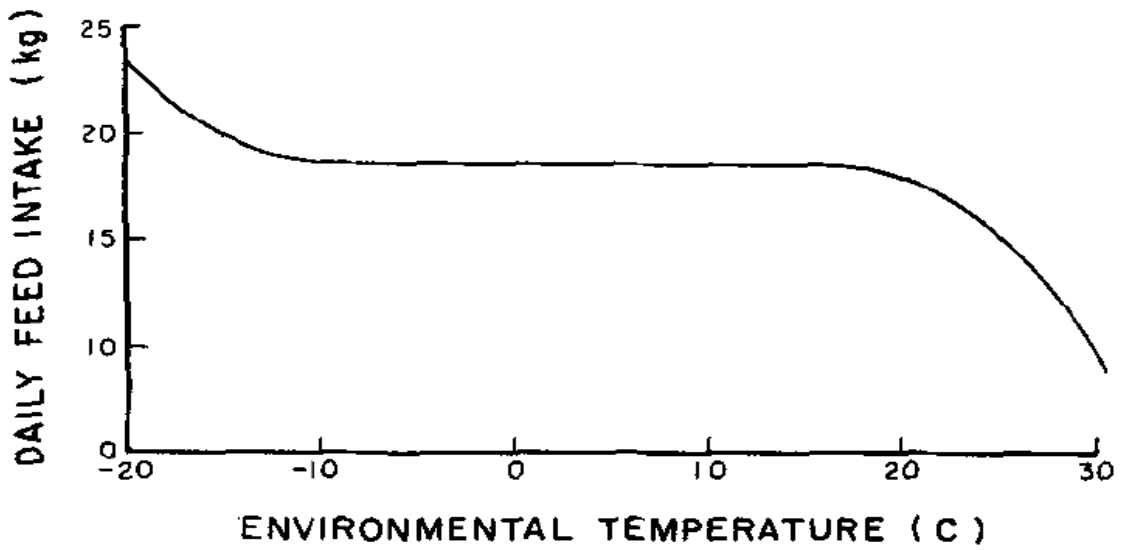


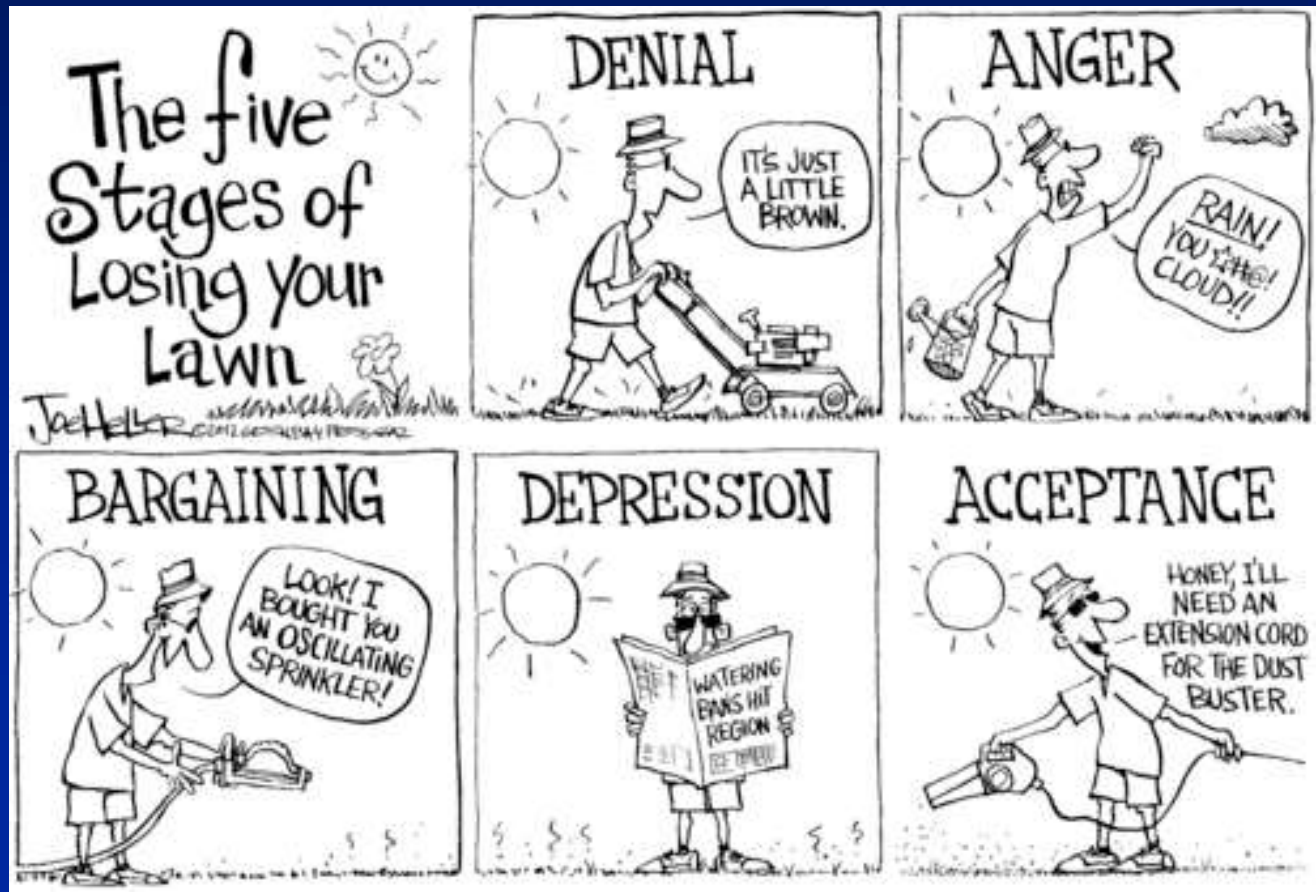
Figure 1. Classical model of cattle feed intake as a function of environmental temperature.

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

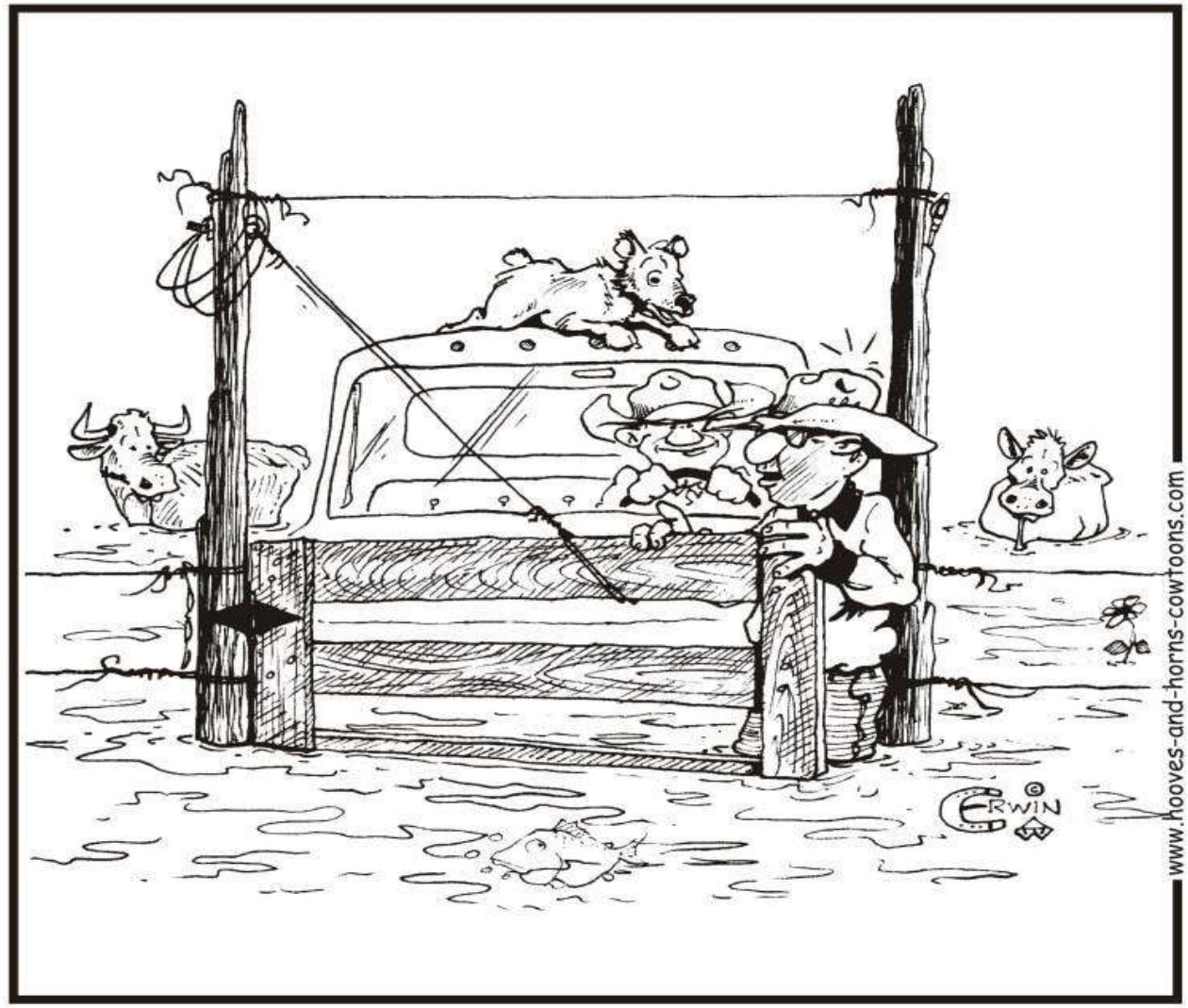
Complexities of Drought

- 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?"

HOOVES & HORNS BY A.W. ERWIN



"I ain't gunna say a word,.... Th'last time I complained 'bout th'weather we had a 5 year drought!"