2010

Cattle Temporal and Spatial Distribution in Midwestern Pastures Using Global Positioning (Three-year Progress Report)

Douglas A. Bear
Iowa State University

James R. Russell
Iowa State University, jrussell@iastate.edu

Daniel G. Morrical
Iowa State University, morrical@iastate.edu

Cattle Temporal and Spatial Distribution in Midwestern Pastures Using Global Positioning (Three-year Progress Report)

Abstract
Previous research has shown that grazing cattle tend to congregate in streamside zones of pastures to obtain water and shade for thermoregulation. However, problems associated with thermoregulation may be increased because of the presence of endophyte-infected tall fescue in pastures. Defining relationships between cattle distribution, such pasture characteristics as size, shape, shade distribution, botanical composition, and climatic factors related to heat stress, will provide the basis for the development and implementation of management practices that minimize nonpoint source pollution possibly associated with grazing cattle.

Keywords
RFR A9131, Animal Science

Disciplines
Agricultural Science | Agriculture | Animal Sciences

Cattle Temporal and Spatial Distribution in Midwestern Pastures Using Global Positioning (Three-year Progress Report)

RFR-A9131

Douglas Bear, research assistant
Jim Russell, professor
Dan Morrical, professor
Department of Animal Science

Introduction

Previous research has shown that grazing cattle tend to congregate in streamside zones of pastures to obtain water and shade for thermoregulation. However, problems associated with thermoregulation may be increased because of the presence of endophyte-infected tall fescue in pastures. Defining relationships between cattle distribution, such pasture characteristics as size, shape, shade distribution, botanical composition, and climatic factors related to heat stress, will provide the basis for the development and implementation of management practices that minimize nonpoint source pollution possibly associated with grazing cattle.

Therefore, the objectives were to evaluate the effects of pasture characteristics and botanical composition and climate on the temporal and spatial distribution of grazing cattle within and outside the streamside zones of pastures.

Materials and Methods

Pastures ranging from 19 to 309 acres on five cooperating beef cow-calf farms were used. During spring, summer, and fall of 2007, 2008, and 2009, 2 to 3 cows per pasture were fitted with Global Positioning System (GPS) collars to record position at 10-minute intervals for periods of 5 to 14 days. One hundred thirty-nine data sets, all farms combined over three years, were obtained throughout the grazing seasons to determine cattle locations.

Streams and/or ponds and fence lines were referenced in all pastures using a handheld GPS receiver. Upon referencing, points were used to establish zones in the pastures. Zones were in the stream or pond (water source), within 100 ft (100 ft zone), or greater than 100 ft (uplands) from a natural water source. Streamside zone was identified as the area of the water source plus the 100 ft zone.

Microclimate data including ambient temperature, black globe temperature, dew point, wind speed and direction, relative humidity, and rainfall were recorded at 10-minute intervals. For each unit increment of each microclimate variable, the number of observations that a cow was in or within 100 ft of the water source was divided by the total number of observations at that temperature or heat index unit to determine the probability of a cow being in either of these zones at that microclimatic variable increment.

Results and Discussion

Water source. Seasonal differences were observed for the proportion of time cattle spent in a water source on the larger pastures, but not on the smaller pastures of the study. In spite of some farm differences, cows across all farms spent, on average, less than 3% of observations in the water source; which is lower than percentages reported by others in the literature.

Streamside zone. The proportion of observations of cows located in the streamside zones of pastures (Table 1) did not differ between seasons, but did differ between farms. Because of the differences in the percentage of time that cattle were in the streamside zones between farms, the influence of pasture characteristics and microclimate on cattle temporal/spatial distribution was evaluated. Microclimatic changes and abnormal rainfall amounts that caused flooding in summer 2008 and 2009, may have contributed to differences of cattle distribution within the streamside zones between years.

Botanical composition. Cattle locations were regressed against botanical composition of the pastures, but no relationship existed.

Microclimate variables. Cattle locations and microclimatic factors were paired to evaluate the temporal/spatial distributions within the streamside zone of a pasture. Of the climatic variables, ambient temperature most accurately predicted the probability of cow presence in the streamside zone. Each farm was modeled for predicting the probability of cattle presence in the streamside zone of a pasture. Probabilities of cattle located within the streamside zone ranged from 2 to 26% at 41^{o}F and from 4 to 46% at 86^{o}F. Differences imply that there may be individual pasture characteristics affecting cow distribution.

Shade distribution. Using Geographical Information Systems (GIS) software, image analysis of aerial photos showed that pasture shade across all farms ranged from 19 to 73% of the pasture area. Streamside shade ranged from 37 to 90% of the streamside zone and accounted for 3 to 73% of the total pasture shade. In spite of this variation in pasture shade, proportion of cow distribution was weakly related to the proportion of total pasture shade within the streamside zone on different-sized pastures, particularly in the summer and fall when the effects of shade should have been the greatest. However, the total proportion of pasture shade within the streamside zone accounted for 79, 15, and 95% of the variation on approximately the same-sized pastures at the McNay Research Farm during spring, summer, and fall grazing seasons (Figure 1).

Cattle observations in streamside zone area was related to proportion of streamside zone in the total pasture and accounted for 34, 93, and 5% of the variation in the observations of cows within the streamside zones of the pastures during the spring, summer, and fall grazing seasons, respectively (Figure 2).

Total pasture area was regressed against cattle location in the streamside zones (Figure 3). Total pasture size accounted for 40, 55, and 59% of the variation in cow observations within the streamside zones of the pastures in the spring, summer, and fall grazing seasons.

Results imply that the presence of cattle in streamside zones of pastures increased with increasing ambient temperature, increasing the proportion of streamside zone within a pasture, increasing the proportion of total pasture shade within the streamside zone, and decreasing pasture size. Surprisingly, cattle presence in streamside zones was not highly related to proportions of tall fescue in pastures that contained 10 to 51% tall fescue. Pasture size and/or shape may supersede botanical composition effects of Midwestern pastures on the temporal/spatial distribution of cattle.

Acknowledgements

The authors would like to thank the cooperating producers, the USDA-NRCS, Soil and Water Conservation District, and extension personnel for their assistance with this project. The material in this report is based on the work supported, in part, by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under Award No. 2006-51130-03700. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the U. S. Department of Agriculture. Additional funding was provided by the Leopold Center for Sustainable Agriculture.

Table 1. Mean percentage of observations of cattle within the water source and streamside zone of pastures in spring, summer, and fall grazing seasons on eight farms in 2007, 2008, and 2009.

	2007, 2008, and 2009 grazing seasons, percent of observations					
Name	Water source			Streamside zone		
	Spring	Summer	Fall	Spring	Summer	Fall
Farm A	1.06^{c}	0.73^{d}	0.90^{cd}	15.76^{d}	10.48^{d}	13.20^{c}
Farm B	0.21$^{d, y}$	2.46$^{ab, x}$	0.64$^{d, y}$	2.43^{f}	6.86^{d}	3.33^{d}
Farm C	0.82$^{cd, y}$	2.09$^{abc, x}$	1.08$^{cd, y}$	10.65^{e}	11.40^{d}	8.93^{c}
Farm D	1.80^{bc}	1.43^{bcd}	1.06^{cd}	26.92$^{ab, x}$	23.45$^{bc, xy}$	20.51$^{b, y}$
Farm E	1.37^{c}	2.18^{abc}	1.49^{bc}	20.71$^{c, y}$	28.40$^{b, x}$	27.31$^{a, x}$
Pasture N	2.67$^{ab, x}$	1.13$^{cd, y}$	3.27$^{a, x}$	21.23$^{bcd, x}$	12.03$^{d, y}$	29.03$^{a, x}$
Pasture NE	1.00^{cd}	1.20^{cd}	2.23^{abc}	10.07^{e}	20.50^{c}	13.03^{c}
Pasture S	3.43^{a}	2.90^{a}	2.30^{ab}	33.80$^{a, y}$	47.57$^{a, x}$	32.57$^{a, y}$
Average	1.62	1.55	1.76	17.70	20.09	18.49

^{a,b,c,d,e,f}Within a column, least squares means without a common subscript differ ($P < 0.05$) within season.
^{v,w,x,y,z}Within a row location, least squares means without a common subscript differ ($P < 0.05$) within farm.

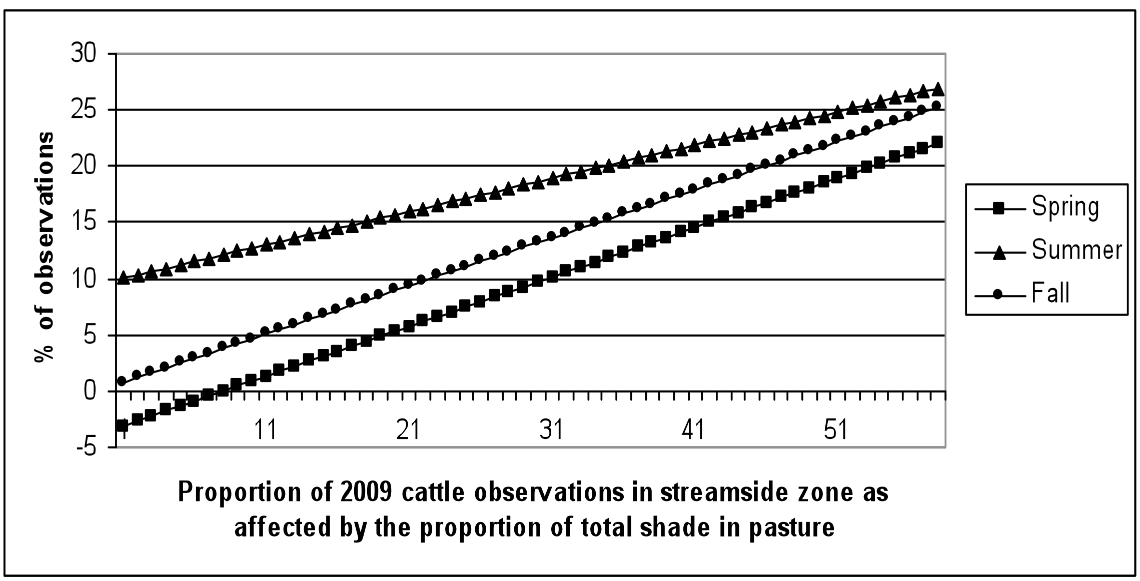

Figure 1. Proportion of new 2009 pasture cattle observations at the McNay Research Farm in streamside zone as affected by the proportion of the total pasture shade within the streamside zone.

Spring: $Y=-3.07+0.44x$; ($r^2=0.79$)
Summer: $Y=10.04+0.30x$; ($r^2=0.15$)
Fall: $Y=0.77+0.42x$; ($r^2=0.95$)

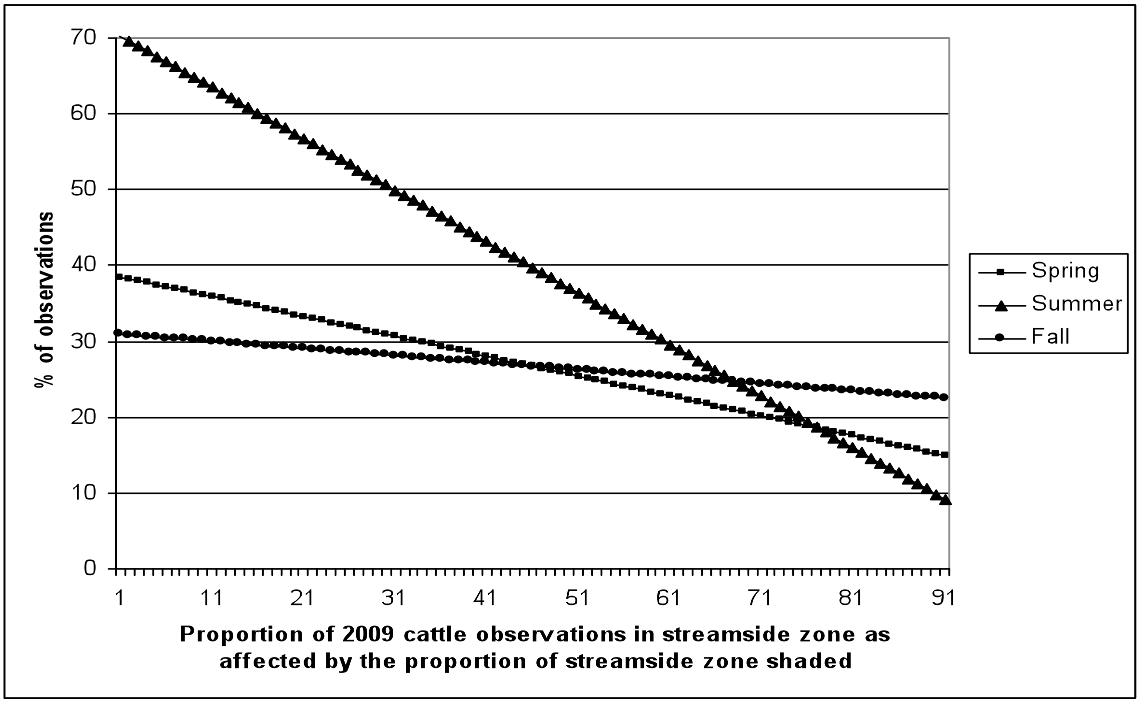

Figure 2. Proportion of new 2009 pasture cattle observations at McNay in streamside zone as affected by the proportion of streamside zone shaded.

Spring: $Y=38.52-0.26x$; ($r^2=0.34$)
Summer: $Y=70.29-0.68x$; ($r^2=0.93$)
Fall: $Y=30.88-0.09x$; ($r^2=0.05$)

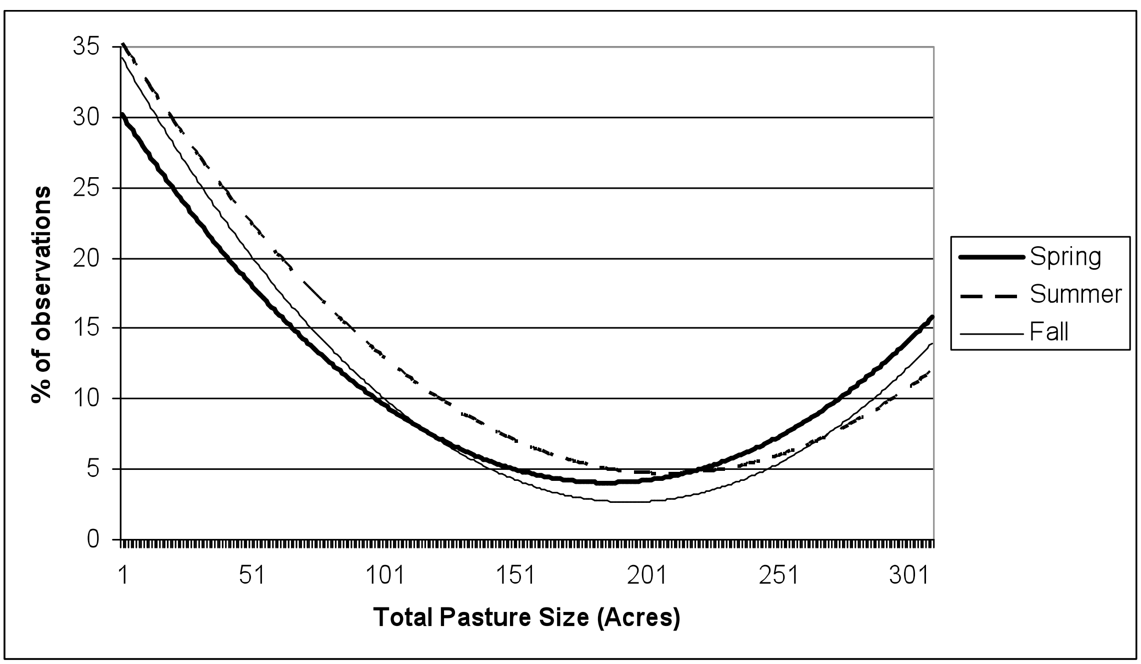

Figure 3. Proportion of all cattle observations in streamside zone in 2007, 2008, and 2009 as affected by the total pasture size.

Spring: $Y=30.15-0.28x+0.00076x^2$; ($r^2=0.40$)
Summer: $Y=35.24-0.29x+0.00071x^2$; ($r^2=0.55$)
Fall: $Y=34.16-0.33x+0.00084x^2$; ($r^2=0.59$)