An ecological and economic risk avoidance drought management decision support system

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Introduction Ecologists have long recognized the fundamental impacts of drought on rangeland structure and function. Simulation models have been developed to increase our understanding of these impacts as they relate to forage production, particularly for predictive purposes. Although the capacity of these models to accurately predict quantity and quality of forage produced under varying climatic conditions is often quite good, their ability to serve as an effective and proactive drought management decision support system is often limited. This is in large part because their complexity impedes their use by on-the-ground managers. The objective of this research was to develop a very simple and user-friendly drought management decision support system for rangeland managers in the Northern Great Plains of North America.

Materials and methods The proportion of herbage produced on a monthly basis was estimated using aboveground net primary production (ANPP) estimates from 14 native rangeland data sets (Heitschmidt *et al.* 1995; 1999; 2004) collected over 11 years at the Fort Keogh Livestock and Range Research Laboratory located near Miles City, MT. Correlations coefficients were calculated between monthly precipitation and annual ANPP estimates. Published (http://hprcc.unl.edu/index.html) site-specific, monthly, rainfall probabilities were also incorporated into the system to enhance predictive capacity.

Results Both total and perennial grass production were significantly ($P<0.10$) correlated with precipitation in January and April whereas cool-season perennial grass production, the over-whelming dominant functional group in this herbage complex, was significantly correlated with precipitation in January and May. In these analyses, the correlation in January is viewed with suspicion (i.e., a spurious correlation) as precipitation is snow and only averages 12 mm which is < 4% of the 338 mm of the annual total. The correlation with spring precipitation is biologically sound in that the sum total of precipitation in April and May averages 84 mm. In a similar study at this location, Kruse (2004) also found significant relationships between total herbage production and precipitation in April and May.

Analyses of the proportion of ANPP of perennial grasses produced on a monthly basis showed 35%, 69% and 91% was produced by 1 May, 1 June, and 1 July, respectively. The 95% confidence limit for the estimate on 1 July was 24% which indicates that at least 67% of annual production of perennial grasses would be completed by 1 July in 19 out of 20 years. Thus, in this region grazing managers can estimate appropriate end-of-growing season stocking rates by early July with a relatively high level of confidence. Moreover, confidence in these decisions can be further bolstered by examining long-term, post-1 July probabilities of rainfall. For example, the probability of receiving 25.4 mm of precipitation in July and August at Miles City, MT is 59% and 42%, respectively, whereas probability estimates for receiving 50.8 mm in July and August are 22% and 17%, respectively.

Conclusions The results provide insight into temporal dynamics of forage production in the Northern Great Plains of USA. Results demonstrate that forage production is largely a function of precipitation received prior to 1 July. Thus, proactive stocking rate adjustments can be made by early July, with considerable certainty, thereby reducing ecological and economic risks that arise from late-season forage demand/availability imbalances.

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