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Adaptive Management for Drought on Rangelands

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On the Ground

- Adaptive management can be used to manage complexity, such as how to match forage production variability across years and within portions of a grazing season with animal demand through management flexibility.
- Adaptive management strategies should incorporate flexibility and feedback mechanisms informed by appropriate seasonal weather variables and monitoring metrics to both increase resiliency of rangeland ecosystems and reduce risk for the ranching enterprise associated with drought.
- For management flexibility, we provide four general strategies that ranchers can use to deal with drought: 1) predict it using weather and climate forecasting tools, 2) track it, 3) employ conservative stocking rates, and 4) utilize inherent spatial variability.
- Adaptive grazing management plans that seek to integrate drought prediction tools, conservative but flexible stocking, and existing and predicted spatial heterogeneity in forage quantity and quality can be incorporated into conservation practices where spatial heterogeneity in forage resources within and among allotments/pastures is often not explicitly monitored or considered when planning livestock movements.

Keywords: enterprise flexibility, grassbanking, herd structure, resiliency, risk management, risk reduction.

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Rangelands are characterized by spatial heterogeneity in soils, topography, landscape positions, historical disturbance patterns, weather, and management influences. Furthermore, rangelands often are characterized by dramatic spatiotemporal variation in precipitation[1] and temperature, and are experiencing increases in extreme droughts and deluges at multiple temporal scales under a changing climate. Adaptive management can be used to manage complexity, such as how to match forage production variability across years and within portions of a grazing season with animal demand through management flexibility. Adaptive management strategies should incorporate flexibility and feedback mechanisms informed by appropriate seasonal weather variables[2] and monitoring metrics to both increase resiliency of rangeland ecosystems and reduce risk for the ranching enterprise associated with drought. With drought having soil moisture deficits due to increased evapotranspiration at different temporal scales, reductions in forage production can markedly affect livestock weight gains and, as a result, economics for the ranching operation.[3] The movement of livestock in relation to spatial heterogeneity in forage resources can be a key strategy to mitigate the influence of extreme temporal variability in weather, especially drought.

Drought and Rangelands

Surveys of ranchers consistently showcase that most employ reactive drought management practices where herd size is reduced and feed is purchased, but fewer have well-defined proactive strategies in their drought management plans such as reserve forage supplies and varying herd numbers with forage supply[4] (Fig. 1). Moreover, there is a continued need for ranchers to engage in written drought management plans that can incorporate adaptive management and flexibility for the ranching enterprise as only 60% of surveyed ranchers in Wyoming had a current plan.[4] Droughts often are the catalyst to make ranching enterprise changes as they can be an expensive education to do something different.

Drought management plans for ranchers should encompass two primary strategies: 1) enterprise flexibility – defined as herd structure where the proportion of cow-calf pairs and yearlings (stockers) provides plasticity to match forage availability with forage demand, with advantages to economic returns[5,6] and increased resiliency of plant communities; and 2) management flexibility – defined here as adaptive management where relevant monitoring metrics provide feedback to influence subsequent decision-making processes to promote risk reduction. For management flexibility, we provide four general strategies that ranchers can use to deal with drought: 1) predict it using weather and climate forecasting tools, 2) track it, 3)

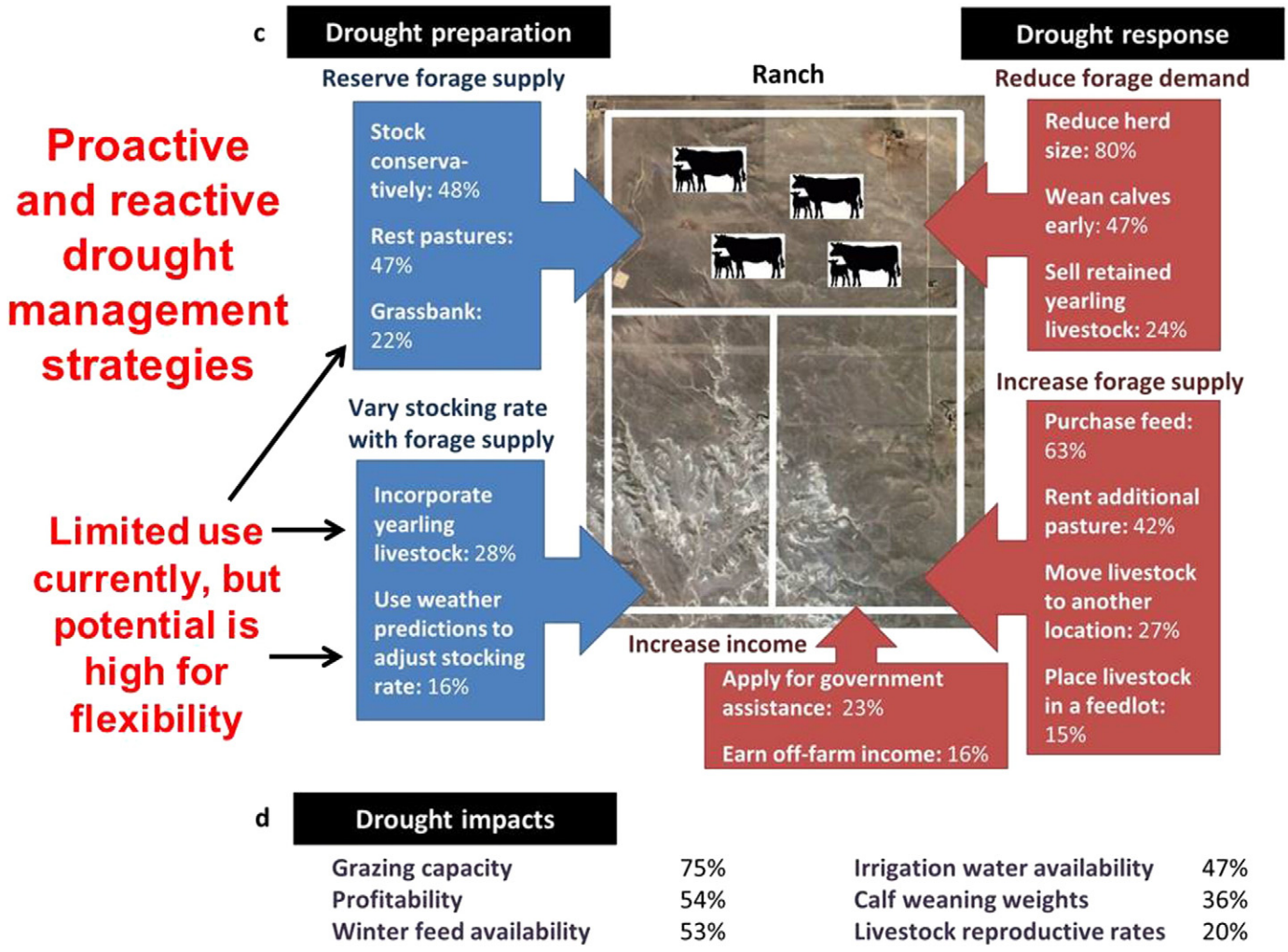

Figure 1. Proactive (drought preparation) and reactive (drought response) drought management strategies employed by Wyoming ranchers (adapted from Kachergis et al. 2014[4]).

employ conservative stocking rates, and 4) utilize inherent spatial variability. Ranchers typically utilize a combination of all these strategies, as each involves inherent limitations or costs.

Predicting Droughts

Increased understanding of the complexity of climatological influences on drought provides a foundation for the spatial and temporal aspects of drought frequency, and illustrates the need for adaptive management to provide flexibility for the ranching enterprise. For example, over half of the spatial and temporal variance in multidecadal drought frequency in the United States is attributed to the influences of the Pacific and Atlantic Ocean oscillations.[7] The combinations of positive (warm) and negative (cool) regimes for the Pacific Decadal Oscillation (PDO) and the Atlantic Multi-decadal Oscillation (AMO) lead to contrasting spatial configurations of drought frequency across the United States (see Fig. 2).[7]

The Dust Bowl years of the 1930s drought occurred when both the PDO and AMO were positive (panel C, Fig. 2).[7] The 1950s drought had a similar positive AMO but a negative PDO (panel D), and this combination has also been prevalent over the 2000s. With the PDO currently entering a warm phase (+PDO), and the AMO beginning to enter a negative phase (-AMO), the historical relationships suggest that drought frequency across most of the rangelands of the United States will be low (panel A, Fig. 2), with the exception of the West Coast, and the northern tier of western states (most of Idaho, Montana, Wyoming, and North Dakota). Our rapidly improving understanding of how these decadal-scale oscillations influence drought risk in North American rangelands provides a context in which to assess the magnitude of drought risk.

While we are currently fortunate to be in an oscillation pattern associated with reduced drought risk in the Great Plains and Great Basin, predictions of weather 3 to 12 months out still involve substantial uncertainty. For example, the seasonal precipitation patterns predicted in mid-May 2012 for summer (June, July, and August) 2012, showcased only below average precipitation for the Pacific Northwest; yet the summer 2012 across the Great Plains rivaled the 1930s Dust Bowl in terms of spatial extent and had devastating economic consequences for ranchers. This uncertainty in predicting precipitation for critical forage growths period for many rangelands is problematic for ranchers in grazing