REPORT OF THE

SCIENTIFIC REVIEW TEAM

Dakota Prairie Grasslands

May 2005

Table of Contents

Definitions of Acronyms 4

Introduction 7

History 7

Charge and Charter 7

The Process 8

Content 9

Issues and Recommendations 9

Section I – Baseline Data 9

Section II – Visual Obstruction Reading 12

Section III – Management Indicator Species 14

Section IV – Monitoring 16

Section V – Grazing Management Issues 18

Section VI – Woody and Riparian Communities 21

Section VII – Prairie Dog Management 25

Section VIII – Drought Management Strategies 25

Section IX – Sheyenne National Grassland 25

Conclusion 32

Acknowledgements 34

Literature Citations and Suggested Readings 35

Appendix A- Prescribed Burning Suggestions 42
B- Importance of Diverse Management for Native Grassland Flora and Fauna 47
C- Prairie Dog Control 51
D- Drought Management Strategies For National Grasslands 53

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DEFINITIONS OF ACRONYMS USED IN THIS REPORT

AMP: Allotment Management Plan

AUM: Animal Unit per Month

CRNG: Cedar River National Grassland

DPG: Dakota Prairie Grasslands

FEIS: Final Environmental Impact Statement

FS: United States Forest Service

FQI: Floristic Quality Index

GRNG: Grand River National Grassland

LMNG: Little Missouri National Grassland

LRMP: Land and Resource Management Plan

MIS: Management Indicator Species

NRCS: Natural Resources Conservation Service

PFC: Proper Functioning Condition

SNG: Sheyenne National Grassland

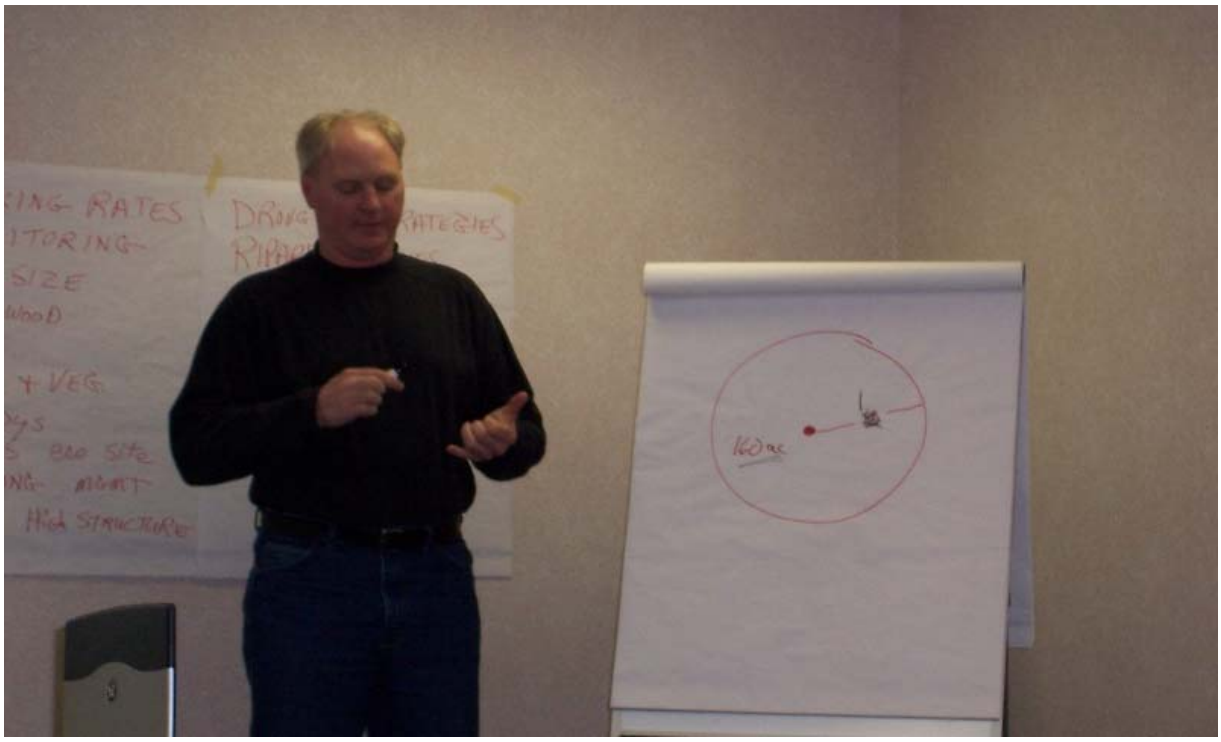
SRT: Scientific Review Team

USGS: United States Geological Survey

WPFO: Western Prairie Fringed Orchid

VOR: Visual Obstruction Reading

Riparian Areas


RATES
SIZE
+ VEG
HIGH STRUCTURE

INTRODUCTION

HISTORY

The United States Department of Agriculture's Forest Service (FS) is required to update its Land and Resource Management Plans (LRMP) every 10-15 years. These plans provide "management sideboards" within which the FS can evaluate, approve, and implement management projects. Land and Resource Management Plans are subject to all applicable federal laws and regulations, and are developed through an extensive public involvement process.

In 1996, the FS initiated revision of the LRMP for the Dakota Prairie Grasslands (DPGs). The LRMP revision has been a lengthy process with considerable interest from the public. At the time of the Record of Decision (ROD), more than 74,000 written comments had been received. The LRMP was released in draft form in July 1999 and in final form in July 2001. Regional Forester Brad Powell signed the ROD on July 31, 2002. That ROD established the need for, and role of, a Scientific Review Team (SRT).

The ROD is the official adoption of the revised LRMP. In the ROD, Mr. Powell made an exception relating to livestock grazing. He recognized that the LRMP includes estimates of the effects it will have. Specifically he noted, "With regard to livestock grazing the FS has estimated a nine percent reduction in grazing levels. Other entities have estimated reductions of 43 to 69 percent, and these estimates have fueled controversy stemming from projections of major adverse economic effects on local communities and a perceived uncertainty of effects to individuals. To remedy this situation, I have decided to 'phase in' this decision with regard to livestock grazing."

Mr. Powell continued, "The first phase of the decision will include development of sample AMPs that will be reviewed by a 'Scientific Review Team' …Completion of these sample allotments will be like taking the new plan out for a 'test drive.' The intent … is to determine if the grazing portion of the LRMP can be implemented and to verify that grazing levels are similar to those projected in the Revised Grasslands Plan FEIS."

CHARGE AND CHARTER

Public comments received on both the Draft and Final Environmental Impact Statements questioned the FS's projected livestock stocking levels. Some comments stated that good science was not used to determine the existing conditions or predicted outcomes. Other comments said the LRMP, as written, could not be implemented because the land was incapable of achieving the stated goals and objectives.

The primary purpose for creation of the SRT was the stated concern by some that the Final Environmental Impact Statement (FEIS) lacked good scientific analysis, specifically in regard to the livestock and wildlife issues. The SRT is to address that concern by providing outside, independent review of the assumptions in the FEIS, the sample Allotment Management Plan's (AMP) baseline data, analysis procedures and predicted outcomes. The SRT's role is limited to these items unless the SRT itself identifies and agrees upon grazing issues that warrant review.

In order to provide assurances to grazing permittees and local communities regarding the scientific approach and predicted outcomes, the Regional Forester postponed decisions on AMP revisions until 64 sample AMPs could be developed and reviewed by a team of experts. This expert review would address two key questions posed by the FS:

1. Can the grazing portion of the LRMP be implemented?
2. Are grazing levels in the sample AMPs similar to those projected in the FEIS?

After completing the review process, the Regional Forester will make a final decision to either adopt or revise the grazing portion of the LRMP.

In summary, the role of the SRT includes:

1. Review of the scientific assumptions in the FEIS, specifically in regard to the livestock and wildlife issues.
2. Review the 64 randomly selected AMPs on the DPGs.
3. Review the processes and scientific methods used by the FS in developing the sample AMPs.
4. Verify or reject estimated grazing levels based on the results of the sample AMPs.
5. Recommend changes, if needed.

THE PROCESS

In the fall of 2002, the FS randomly chose 8 groups of 8 allotments each, for a total of 64 allotments for review. Because the LRMP based its effects analysis at the landscape level, sample allotments were chosen in groups of eight to geographically spread the sample AMPs. Efforts were then begun to collect the site-specific information that would be needed in order to complete each sample AMP. However, for this process it was acknowledged that the FS may not have all the requisite site-specific information needed for the development of the sample AMPs. In addition to available site-specific and landscape scale information, development of sample plans included information from field observations as well as professional judgment and grazing permittee input.

The SRT conducted 13 meetings between February of 2003 and March of 2005. At the SRT meetings the FS provided data relating to the methods they used in developing the LRMP and responded to questions of the SRT. A typical meeting consisted of the SRT discussing and commenting on the AMP group they had received and reviewed at the prior meeting. They then reviewed the briefing packet for the next group of AMPs. Many of the meetings were conducted over a two-day period, one day for presentations and one day for tours to allow the SRT to conduct field site visits. The meetings continued under this format until the process had been completed on all eight groups of AMPs. Between meetings, each SRT member reviewed the information packet and prepared written comments. Contact and collaboration among SRT members occurred regularly between meetings. Prior to each subsequent meeting all SRT members emailed their comments to the facilitator, who in turn emailed a compilation of the comments to each SRT member and to the FS. These comments remain a part of the official record.

CONTENT

The SRT report focuses on specific issues that arose during the process. It addresses nine categories and each category has one or more issues related to it. The body of the report is found below under "Issues and Recommendations." The format breaks information into the nine sections. Within each section, each issue is identified, the science of the issue is discussed, and final recommendations are made for dealing with the issue.

The conclusion provides an overall summary of the SRT report and responds to questions submitted by the FS in the SRT Charter.

ISSUES AND RECOMMENDATIONS

SECTION I - BASELINE DATA

Issue I - 1: Data utilized to estimate livestock carrying capacities, varying wildlife habitat traits, etc. (i.e., Little Missouri National Grasslands rangeland assessment, also referred to as, Dragon data) lacks the required level of resolution needed to develop, implement, and monitor individual pasture AMPs.

The SRT believes that the Dragon data set, at best, adequately reflects broad-based, landscape-level vegetation community composition and structure. However, the SRT has serious reservations about its effectiveness as a management tool at the allotment or pasture level. This is because the Dragon data "habitat types" are based on high-altitude imagery that does not appropriately consider or accurately reflect the detailed impacts that different soils, slopes, and aspects have on both current and potential vegetation and plant species composition at the individual pasture or allotment level. This is in contrast to mapped Natural Resources Conservation Service (NRCS) ecological sites, wherein soil series are the principal mapping units that define each site. Moreover, because the NRCS has a wealth of information on most ecological sites relative to actual and potential plant species composition, herbage production, ecological condition, successional pathways, etc., instances where mapped NRCS soil series/ecological sites are available greatly enhances management's ability to accurately estimate and predict the effects of various land management strategies and tactics at the individual ecological site level.

Recommendation I - 1: The NRCS has completed Order 2 (five acre accuracy for dissimilar soils) soil surveys for all portions of the DPGs. Therefore, the SRT recommends using these maps and associated ecological site information in the development, implementation, monitoring, and refinement of pasture or allotment-level management plans.

Issue I - 2: Disregarding potential contribution of "uncapable" sites (i.e., those lands producing < 300 lbs/ac of herbage annually) inappropriately reduces per unit land area herbage production estimates particularly when large proportions of the landscape are deemed uncapable.

Definitions of suitable vs. unsuitable acres are logical because they are defined based upon the ability of an animal to physically graze a site. However, classifying all uncapable acres (those

that produce < 300 lbs/ac) as unsuitable is inappropriate because: 1) many meet the definition of suitable; and 2) they can seriously affect carrying capacity estimates and subsequent stocking rate recommendations.

Example - 8,000-acre allotment:

With 5 percent of land classified as uncapable but suitable producing an average of 200 lbs/ac and utilized at 30 percent (15 percent trampling and desiccated, 15 percent consumed by the animal) or 30 lbs. grazed, the livestock would harvest 12,000 lbs. of forage or 13 Animal Unit Month (AUM).

With 10 percent of land classified as uncapable but suitable producing an average of 200 lbs/ac and utilized at 30 percent (15 percent trampling and desiccated, 15 percent consumed by the animal) or 30 lbs. grazed, the livestock would harvest 24,000 lbs. of forage or 26 AUM.

With 20 percent of land classified as uncapable but suitable producing an average of 200 lbs/ac and utilized at 30 percent (15 percent trampling and desiccated, 15 percent consumed by the animal) or 30 lbs. grazed, the livestock would harvest 48,000 lbs of forage or 52 AUM.

Lands classified as uncapable but suitable should be included in carrying capacity and stocking rate calculations as they can significantly affect estimates.

Recommendation I - 2: AMP's herbage production estimates should be estimates for all sites. If adjustments in livestock carrying capacities are necessary because of unsuitable terrain (i.e., unsuitable sites), adjustments should be made directly (i.e., no allowable forage) rather than indirectly (i.e., no herbage produced).

Issue I - 3: There is, at present, a lack of information to define "Biologically Capable" acres to meet structure goals.

Presently the FS defines "Biologically Capable" as "herbaceously-dominated soils capable of producing at least 800 lbs/ac"(Gary Foli and Arden Warm's presentation to the SRT on March 10, 2004). Based upon best available information from the area (Vader 2000), the SRT believes this level of annual production will be unlikely to produce an herbaceous structure resulting in a transect Visual Obstruction Reading (VOR) of at least 3.5 inches.

For example, Vader (2000) reported that an ungrazed Shallow Ecological Site had a mean herbaceous production of nearly 1100 lbs/ac, while VORs for the site averaged 2.4 inches. A Silty Ecological Site produced over 1400 lbs/ac of herbage and yielded a mean VOR of 2.8 inches. Finally, an Overflow Ecological Site, dominated by western snowberry, yielded approximately 3500 lbs/ac standing crop with an average VOR of 10.5 inches.

Recommendation I - 3: The SRT recommends studying and revising the definition of "Biologically Capable" to accurately reflect the capability of the soils and plant communities to meet structure goals for the gallinaceous Management Indicator Species.

Issue I - 4: The Floristic Quality Index (FQI) is not the proper tool for determining seral stage of rangeland/grassland plant communities.

The FEIS for the Land and Resource Management Plan for the Dakota Prairies Grassland outline seral stage goals for various plant communities. The FS proposes using the FQI to determine the seral stage of these plant communities and provided the SRT with examples throughout the sample AMP process. However, how the seral stages within the example AMPs were determined or the actual FQI protocol was never explained to the SRT during this review process. When asked if the FQI protocol being used was the same as that outlined in "Coefficients for Conservationism for the Vascular Flora of the Dakotas and Adjacent Grasslands" (United States Geological Survey technical report USGS/BRD/ITR – 2001-0001 dated 2001), the FS response was "no" without benefit of explanation.

A review of the FQI protocol as outlined in "Coefficients for Conservationism for the Vascular Flora of the Dakotas and Adjacent Grasslands" revealed that this protocol was not specifically intended to be used in the manner proposed by the FS. The reference does indicate the protocol may provide some useful information regarding ecosystem integrity, but other measurements should be included. In addition to the proper application question, the FQI only addresses whether a plant is present or absent in a plant community rather than the frequency at which it occurs or the amount it contributes to biomass production. It also has a precautionary statement regarding the influence of sampling area. Selection of sampling area is critical for proper application of the protocol since a sampling area that contains multiple habitat or ecological sites would probably yield a higher FQI score than a sampling area containing a single ecological site.

In the FEIS, seral state is defined as, "The sequence of a plant community's successional stages to potential natural vegetation." Under this definition, a site's potential natural vegetation should result in a high FQI score. Has the FS verified this? In the case of woody draws for example, the FS has indicated that potential natural vegetation consists of a plant community dominated by trees and shrubs and would be classified as "high seral" under their system. However, a brief review of the coefficients of conservatism assigned to plant species in the "Coefficients for Conservationism for the Vascular Flora of the Dakotas and Adjacent Grasslands" would seem to indicate that a higher seral stage for this site would be an herbaceous plant community dominated by tall warm season grasses and mid-stature warm and cool season grasses. The herbaceous plant community would more closely resemble the plant community expected if the site was exposed to naturally occurring disturbances such as periodic fire and grazing versus a plant community that develops in the absence of fire and is, therefore, dominated by woody species.

By definition, seral stage and range condition class are practically interchangeable terms. Both are based upon subjective ecologically based measurements of how closely the present plant community resembles the climax or potential plant community. NRCS has used range condition and range condition classes for a number of decades to rate grassland/rangeland plant communities. With the issuance in 1996 of the NRCS National Range and Pasture Handbook, the term range condition was dropped and replaced with similarity index.

Recommendation I - 4: The SRT recommends the FS discard the FQI for determining seral stages and adopt a system such as the NRCS similarity index for seral state determinations.

SECTION II - VISUAL OBSTRUCTION READING (VOR)

Visual obstruction readings, as recorded by using a Robel pole, play a prominent role in assessing the condition of the DPGs, particularly as it relates to high-, moderate-, and low-structure vegetation. Because of the importance placed on this methodology in the management of the national grasslands, details of its application and applicability should be clearly understood.

Robel et al. (1970) originally developed what came to be known as the Robel pole, a method for obtaining an easily measured index of height and density of grassland vegetation. Height and density were thought to be more important aspects of grassland habitat for sharp-tailed grouse *(Tympanuchus phasianellus jamesi)* and greater prairie-chickens *(Tympanuchus cupido pinnatus)* than was the plant species composition. In addition, Robel et al. (1970) suggested that the method might prove useful for determining standing crop, or above-ground biomass of vegetation.

The Robel et al. (1970) method entails placing a 1.5-m long, 3-cm diameter pole in the ground where a measurement is desired. The pole is painted with brown and white bands alternating each decimeter. Midpoints of decimeters are marked with black stripes. An observer kneels 4 meters away from the central pole, observes the pole from 1 meter high and records the lowest 0.5-dm marking that is visible. Robel et al. examined various distances and heights and found the above values provided the highest correlation with standing crop.

Issue II - 1: Field methodology is neither well defined nor standardized.

Because of the ease of using the Robel pole, especially in comparison to more detailed but time-consuming methods such as the Wiens rod (Wiens 1969), and studies that showed that its readings reflected habitat preference for a number of wildlife species, it became a common tool used by wildlife investigators and managers (common, but not standardized). As the use of the Robel pole spread, adherence to protocols established by Robel et al. (1970) did not. Variants on the pole itself and on how readings were taken blossomed. For example, Kirsch et al. (1978) in an early application to waterfowl nesting habitat indicated that they used a “slightly modified version” of the Robel method, without indicating what those modifications were.

Changes in pole shape (from round to square) or diameter (3 cm to 2-inch) occurred. Some poles were marked in decimeters, others were in fractions of decimeters or even in inches. Readings also varied. Some observers recorded the lowest number visible, others recorded the highest number not visible, and some interpolated.

Some of these variants likely represented changes thought to be improvements, at least in the situations to which they were applied. Others may have resulted simply from expediency -- perhaps square poles were easier to obtain than round poles. Many changes simply resulted from inattention or indifference to the established protocols.

Regardless of their etiology, variations in the methodology pose problems when applying the Robel method, especially at a broad scale, for multiple objectives or in contentious situations. If management for a particular species is a goal, for example, evaluation of management practices might be based on published research that describes appropriate habitat for that species. If appropriate habitat has been described through research using Robel readings, the evaluation of management practices based on Robel readings should be obtained by the same protocol. (There

is another issue involving how habitat needs of species might vary geographically, or temporally, but that is not relevant to this discussion.) If multiple objectives are being evaluated by Robel readings, problems may arise if studies that addressed those multiple objectives used different variants of the Robel methodology. Clearly, a systematic assessment of the consistency of Robel methodology would be worthwhile.

Recommendation II - 1: Standardized protocols should be adopted and training provided for consistency among years and observers using the Robel pole method.

Issue II - 2: Current summarization of the Robel pole data is incomplete and to a large extent, inappropriate.

A concern raised repeatedly by the SRT was the FS use of means of Robel readings from all stations along individual transects to characterize the condition of the grassland. While means certainly reflect something of the general height and density at the sites evaluated, they do not convey specific information about percentiles, which often are the management goal of the FS. For example, the FS may desire that a certain fraction of an allotment have a Robel reading exceeding 6 inches, a value that may have been derived from studies of a species of interest. Instead of specifying that objective, however, the FS might pose a management goal of having the mean Robel reading from a transect average, say, 3 inches. The idea supporting this practice is that, if a transect averages 3 inches, there will be a sufficient number of stations at which the Robel value exceeds 6 inches. While somewhat defensible, no general relationship between mean values and percentiles has been demonstrated.

For instance, when summarizing the VORs collected from Allotment 2 on the Little Missouri National Grassland (LMNG), 34.9 percent of the mean VOR readings on transects (n = 43) were low structure (<1.5 in), 60.5 percent moderate structure (1.5 – 3.49 in), and 4.7 percent high structure (>3.5 in) (US Forest Service unpublished data). When reviewing all VOR stations (n = 860), 50.6 percent were low, 34.7 percent mid, and 14.8 percent high structure. The individual stations allow for a more detailed interpretation of the landscape. In this data set, one would conclude that low VORs (<1.5 in) compose 50% of the area; however, inclusions of taller swards (>3.5 inches) are common, composing almost 15% of the landscape.

In another scenario, if you had a desired vegetation height at nest sites (e.g., 5.5 inches) a logical questions would be, “How many stations were 5.5 inches or greater?” In this data set, 40 stations, or 4.7 percent were greater than 5.5 inches. Vegetation swards (stations) with VOR heights equal to or greater than 4 inches compose 10.2 percent of the landscape. The question then is, “How much of the land area needs to compose ‘true’ high structure to maintain and improve gallinaceous Management Indicator Species populations, and how patchy should this be?” If the literature shows transect VORs need to achieve say, 15 percent of some level of high structure, one should develop a protocol and procedure to monitor that target value (Kohn et al. 1982, Prose 1987, Sedivec et al. 1990, Kirby and Grosz 1995, Reece et al. 2001). If the patchiness of a desired height is used to monitor the cover, such as by using stations, then a protocol and procedure must be developed to monitor that value (Prose 2002, Reece et al. 2001). A major concern is that only the Kohn et al. (1982) study was conducted in western North Dakota. So interpreting other findings from more mesic sites or sites with green vegetation could skew the habitat requirements higher than the hen actually needs. Many studies collected VOR readings of the habitat and nest sites when green vegetation was present, and thus do not provide a true comparison with VORs in fall, when senescence has occurred and green vegetation is not present.

Recommendation II - 2: Robel pole data should be summarized by frequencies of readings rather than by averaging readings.

Issue II - 3: The impacts of pre- and post-management activities and season of year on the presumed relationship between Robel pole readings and desired vegetation structure at a future point of time appear to be discounted.

The concern is that the relationship between fall, spring, and summer Robel pole readings will vary widely depending upon pre- and post-grazing management activities (e.g., grazing) and abiotic condition (e.g., precipitation, temperature). These factors can substantially alter vegetation structure, thereby rendering pre-treatment estimates rather useless for estimating post-treatment structure.

Recommendation II - 3: Associations between fall measurements and subsequent spring measurements should be determined in relation to vegetation type (e.g., Kentucky bluegrass (*Poa pratensis*) vs. green needlegrass (*Stipa viridula*)) (reference for plant scientific names is Flora of the Great Plains. 1986), winter precipitation, grazing after fall measurements, and other factors.

Issue II - 4: The potential influences of various ecological sites on vegetation composition and subsequent structure are inadequately considered in Robel pole data interpretation.

It is well known that plant species composition is a key determinant of vegetation structure. Similarly, actual versus potential plant species composition can vary greatly among ecological sites. Thus, it is critical that Robel pole data be collected, summarized, and interpreted in light of actual and potential differences in plant species composition and structure among ecological sites.

Finally, it is important that the Robel readings, as well as other vegetation measurements, be collected by properly stratifying the DPG(s) by habitat or ecological sites. Transects should then be randomly or systematically selected with an adequate number of transects and points collected to properly represent the area. Fall transects appear to be conducted to represent structure remaining following the grazing season. These transects, and subsequent points, should be collected in pastures where grazing has been terminated for the current year, thus minimizing false high structure readings that can occur if domestic cattle continue to graze following the collection period.

Recommendation II - 4: All Robel pole data should be collected, summarized, and interpreted with full consideration given to potential influences of ecological sites on plant species composition, and current and potential vegetation structure.

SECTION III - MANAGEMENT INDICATOR SPECIES (MIS)

Issue III - 1: Monitoring sharp-tailed grouse and greater sage-grouse (*Centrocercus urophasianus*) only on “reference areas” of the LMNG, Cedar River National Grassland (CRNG), and Grand River National Grassland (GRNG) will be inadequate to guide management for each allotment and the interplay of all allotments towards a functioning grassland ecosystem.

The FS is directed to select, evaluate and monitor specific MISs. They are to use these species' population status as indicators of management effect to guide land management activities. There are five MIS selected for the four DPGs of which three of the MIS's nesting habitats are linked to high-structure vegetation. Specifically, these three MIS species are: plains sharp-tailed grouse, which is an indicator species throughout the DPGs; greater prairie-chicken, which is an indicator species for the western and southern portions of the Sheyenne National Grassland (SNG); and greater sage-grouse, which is an indicator species for the western and southern portions of the LMNG. These are likely the most suitable MISs for the DPGs, but there are still shortcomings in using any MIS for evaluating management accomplishments or failures. Hereafter, these are collectively referred to as gallinaceous MIS.

Densities of lekking arenas provide an index to populations and indirectly reflect changes in habitat quality in just three or four years given favorable weather conditions. But to begin detecting population changes with certainty requires extensive and intensive monitoring of the number of lekking arenas and number of males on each arena. For sharp-tailed grouse, if habitats remain constant, dancing-ground locations remain fairly constant. If habitats decline, hens will eventually leave the area and males will gradually abandon dancing grounds not visited by hens. If habitats improve, the number of males will exceed the capacity of existing grounds and new grounds are formed. The fine tuning of population responses to favorable management are detected when these new grounds, initially with few males, increase in number of males. Thus, to detect habitat quality change using dancing-ground monitoring, all grounds should be located and the number of males on each ground counted. Because of the size of the Grasslands, such intensive monitoring likely cannot be completed each year. It might be reasonable to survey, say, 20 percent of a Grassland each year, so that the entire Grassland gets surveyed within a 5-year period. There are other factors, e.g., weather, that affect populations fluctuations from year to year, but long-term trends will be detected with long-term monitoring.

For the SNG, the FS plan is to locate and count lekking males on all dancing and booming grounds and use this information to ensure that 30 percent of the area within 1 mile of each ground has sufficient high structure, expressed as 20-30 percent of VOR transects in capable soil types. If this appropriate monitoring is accomplished, it will detect population changes that reflect habitat qualities for gallinaceous MISs and can guide land-management activities.

The current FS plan for LMNG, CRNG, and GRNG is to locate and count all lekking arenas on "reference areas" within these grasslands. To complement arena monitoring, VOR transects are to be completed on the entire DPGs to ensure 20-30 percent of transect stations in capable soil types meet high structure standards. Monitoring lekking arenas within reference areas will guide management activities within corresponding allotments, but allotments outside these areas will have no information. Also, monitoring only reference areas will be inadequate to provide information regarding whether the grassland ecosystem is functioning as a whole.

Recommendation III - 1: Monitoring of habitat features considered key to the success of gallinaceous MIS populations should be intensified. Intensification should include both an increase in the sampling intensity using current methodology as well as using additional techniques as necessary (e.g., June infrared photograph showed well-established dancing grounds in northwestern North Dakota). Realizing that intensive monitoring each year is difficult on 1 million acres, monitoring 20 percent, as an example, of non-referenced areas each year over a five-year period will locate many lekking arenas on the entire DPGs. Over several years this should help detect any change in lekking arena numbers; thus management adjustments could be made accordingly, if necessary. Methodology for monitoring lekking

arenas should be stringent, standardized across years and sites, and detailed in annual training workshops. In addition, a Geographic Information System driven data base system should be developed for permanent record-keeping of display grounds to evaluate changes in conditions affecting populations (e.g., number and location of arenas, and number of males on each display ground).

Issue III - 2: Annual monitoring of gallinaceous MIS's lekking arenas will not detect woody habitat changes soon enough to prevent population crashes.

Although sharp-tailed grouse are fairly tolerant of expanding woody plant communities, there is a limit to what they will tolerate. For example, during a 21-year study on a 20-km^2 area in Manitoba, researchers found expanding quaking aspen (*Populus tremuloides*) groves adversely affected sharp-tailed grouse populations. Unfortunately, the population crash occurred after the woody threshold was reached, thus even with extensive and intensive monitoring of annual dancing grounds, this kind of habitat alteration over time was not detected soon enough (Berger and Baydack 1992). The greater sage-grouse has similar intolerance to non-sagebrush woody expansion, while the greater prairie-chicken has little tolerance of any woody community. (See Woody Communities Issues for more details).

Even though the gallinaceous MIS are likely the most suitable MIS for the DPGs, woody expansion is an example of the inadequacies of using any MIS by themselves for detecting management accomplishments or failures.

Recommendation III - 2: Monitoring protocols must include assessment of rate and extent of change of woody plant communities.

Issue III - 3: Considering structural attributes of western snowberry (*Symphoricarpos occidentalis*) as the equivalent to those of herbaceous vegetation is inappropriate.

Recommendation III - 3: VOR field sampling and subsequent summarization and interpretation of data should be appropriately stratified in accordance with vegetation type (i.e., herbaceous vs. half-shrubs vs. shrubs, etc.). A maximum number of high-structure readings obtained from snowberry should be established.

SECTION IV - MONITORING

Issue IV - 1: The absence of historical pasture-specific grazing records limits evaluation of the past effects of grazing strategies.

Determining what effect any treatment has, in this case grazing, without knowing what treatment was applied is impossible. Accordingly, one cannot judge the effectiveness of past, present, or future grazing plans unless the details of the grazing regime are known. The SRT understands that certain parties have what they perceive as valid reasons for not sharing that information. However, the FS is charged with managing public lands, and FS managers must know what is happening on those lands if they are to fulfill their duties. Very often the SRT was unable to judge the efficacy of past grazing programs because critical information was not available.

Recommendation IV - 1: All parties should agree to share detailed (i.e., number and size of grazers, on and off dates, etc.) pasture-specific records on an annual basis.

Issue IV - 2: Inadequate data is available to determine the capacity of both past or present management strategies and tactics to meet stated goals and objectives.

In the LRMP, the FS (USDA Forest Service Dakota Prairie Grasslands Monitoring and Evaluation Report: Fiscal Year 2003) recognizes that monitoring and evaluation are needed "to determine how well objectives have been met and how closely management standards and guideline have been applied." FS also noted that, "Monitoring provides the information necessary to determine whether the LRMP is sufficient to guide management of the national grasslands for subsequent years or whether modification of the plan is needed."

The SRT concurs with the FS about the importance of information collected and analyzed to assess progress toward desired objectives. The lack of information on how vegetation responds to changes in grazing practices has hampered the SRT in its evaluation, and no doubt hampers the FS in carrying out its mission. The SRT recognizes that resources for monitoring are limited, but proposes that carefully designed protocols can be implemented without major additional costs.

Some monitoring activities will be grassland-wide; others will be specific to individual allotments or pastures. Monitoring protocols will need to address the specific objectives for the allotment or pasture. The SRT believes the success of the LRMP rests on sufficient AMP monitoring that addresses the following questions:

1) What was the original status (at the beginning of the period covered by the AMP)?
2) What are the goals?
3) What management tactics are planned?
4) What are the actual outcomes?
5) What progress is being made toward the goals?
6) How do actual AUMs compare with projected values?

It is especially important that vegetation be monitored before and after changes to grazing regimes to determine effectiveness of changes. Also, managers must account for variations in growing conditions when assessing the response to grazing and other treatments.

Recommendation IV - 2: The FS should collect, on a periodic basis, information that will permit them to determine the effectiveness of management actions (see specific recommendations related to monitoring below).

Information Related to Monitoring:

The SRT offers some general recommendations regarding monitoring. First, the objectives of monitoring need to be clearly stated. They should be transparent and understood by all involved parties. The protocols selected need to be objective, repeatable, and, wherever possible, quantitative. Procedures should be carefully described so that they can be followed consistently in subsequent years. Also, they should be easily learned, so that a minimal amount of training would be needed for new staff. The exact protocols used should demonstrate, most clearly, progress towards meeting the objectives. For example, if a particular allotment has no objective that involves high-structure vegetation, then obtaining VORs in that allotment is probably unnecessary.

The following specific monitoring activities should be considered:

Photo stations: This is a very simple and easy method to obtain qualitative and very graphic information on a long-term basis. Simply, a photograph is taken from a fixed point in a specified direction on (approximately) the same date and time of day each year. The SRT recommends that this be done annually on each allotment at a location that provides a representative view of a selected management site within the allotment.

Visual Obstruction Readings: Measurements taken with a Robel pole provide a convenient index to standing biomass, which often is a useful proxy for the height and density of vegetation (see section elsewhere on the Robel pole). Readings should be taken in a standardized manner.

Species Composition: For many management objectives, it is necessary to know the species composition of vegetation in an allotment and how it might be changing. Belt transects are one useful method.

Some additional considerations when monitoring are to assess overall patterns, not focus on anomalies unless those anomalies themselves are of management interest. Also, monitoring near roads might provide a biased perspective that would not offer a valid impression of the overall condition of an allotment. This issue needs to be considered specifically in relation to each type of monitoring that is proposed.

SECTION V - GRAZING MANAGEMENT ISSUES

Issue V - 1: The absence of historical pasture-specific grazing records creates serious challenges for managers to assess past, present, and future consequences of specific grazing tactics or strategies such as kind and number of animals and time and length of each grazing event. This information is critical for assessing the consequences of any grazing strategy or tactic. The allotment-level animal data provided were of limited value in a historic assessment of stocking rates and grazing intensities, because the information did not include estimates of the size or weight of the grazing animals, accurate herd size estimates, or the timing and length of grazing events.

Recommendation V - 1: Maintain and share detailed, pasture-specific grazing records by Grazing Association and FS personnel.

Issue V - 2: The current management plan fails to adequately account for changes in animal unit forage demands with changes in cow/calf size.

Cattle size has increased since the grasslands were established. Original “preference” numbers were based on a 1,000 lb. cow, with or without her calf up to six months of age (FEIS 3-84). The actual increase in cow size is debatable; however, the FEIS refers to data indicating cow weight has increased almost 50 percent since mid-century. The same reference indicates calf-weaning weight has also increased in about the same proportion in this time period. Federally inspected cow slaughter weights increased at least 200 lbs. in the period from 1960 to 2002 (Tim Petry, Agribusiness, NDSU, personal communication) and could be as much as 350 lbs. per cow. Larger cows require more feed to support both body weight and increased productivity than do smaller cows. Incremental increases in body size require a corresponding increase in nutritional demand of about seven percent for each additional 100 lbs. of body weight. Therefore, a 1,100

lb. cow requires at least seven percent more feed that a 1,000 lb. cow, a 1,200 lb. cow 14 percent, etc., just for body maintenance. Increased livestock production will require additional nutritional support.

The bottom line is obvious. There are more "Animal Units" on the DPGs than "preference" numbers originally indicated was an appropriate stocking rate. All future management plans must acknowledge the increase in cow and calf size and the subsequent forage demands of larger, higher-producing cows and older, larger calves. Regardless of the techniques used to evaluate the grasslands or the data reported by all sides on the issue, the fact remains that somewhere between 14 and 20 percent more cattle AUs graze the grasslands than did 40 years ago simply because of increased body size. Whether management strategies have kept pace remains to be seen.

Recommendation V - 2: Redefine the Animal Unit to reflect current cow size along with older, larger calves and recalculate the corresponding authorized livestock numbers on allotments.

Issue V - 3: Redistributing animals over time and space in contrast to reducing animal numbers has been inadequately considered.

Proper grazing distribution directly affects healthy vegetative structure by aiding in maintenance of species richness, species composition, plant density, root structure and maintenance, ground and basal cover, wildlife habitat, and in repelling the invasion of introduced plant species. Healthy vegetation structure and heterogeneity tend to increase the biodiversity of managed habitats. Tools used to aid livestock distribution are fencing, herding, water development, salting, fertilization, prescribed burning, weed control, etc. Fencing and water development are most applicable to LMNG, CRNG, and SNG, although the remaining tools can be used to supplement these.

Fencing is a direct distribution tool. Fencing can be permanent, post and barbed wire, or temporary such as one-strand electric. Traditionally, post and barbed-wire fences have been used for boundary and internal fencing on the LMNG, CRNG, and SNG. With new electric fencing products, fencing can be more affordable and have greater utility managing livestock for grazing distribution. Temporary electric fences could be used to facilitate cottonwood regeneration, encourage riparian-woody draw improvement, construct smaller grazing units, maintain sensitive areas and/or plants, control traditional livestock trailing concerns, build fuel for prescribed burning, weed control, restoration, etc. Use of electric fencing would provide land managers the flexibility required to meet multiple-use goals while maintaining a diverse, healthy vegetative structure. This important grazing management distribution tool, fencing, is currently not being effectively used for range improvement or ecological restoration efforts on AMPs in the LMNG, CRNG, and SNG. The SRT urges greater use of temporary electric fencing in the LMNG, CRNG, and SNG for specific ecological improvement and for achieving restoration goals.

Water developments are indirect aids in livestock distribution. Livestock choose whether or not to use a development especially when multiple watering sites are available in a single pasture. Water developments can be made more effective by shutting off the water, where possible, or limiting access to the development (fencing off). Water can be shipped from a well via pipeline to additional tanks, further aiding in livestock grazing distribution. New water developments appear to be undesirable to the DPG management team. The SRT recommends that water development be positively considered as a tool to aid livestock grazing distribution in the

LMNG, CRNG, and SNG, not for the purpose of increasing livestock numbers, but to modify livestock grazing distribution and reduce the frequency and intensity of use of individual plants and plant communities.

Recommendation V - 3: Increase the use of management tools such as temporary electric fencing, herding, combining allotments, prescribed fire and water developments (wells, pipelines and tanks) in order to achieve specific ecological improvement and restoration goals.

Issue V - 4: Early-season grazing of crested wheatgrass/native range mix as a strategy to manage crested wheatgrass (*Agropyron cristatum*) is inappropriate.

Pastures containing crested wheatgrass should, if at all possible, have the crested wheatgrass fenced separately from native grassland. This would allow early season use of the crested wheatgrass. Where this is not possible, deleterious effects to native grasses may occur if the unit is grazed before native grasses reaching the 3.5 leaf stage or June 1. The SRT does not recommend early-season grazing of predominantly native grassland units in an effort to fully utilize crested wheatgrass.

Recommendation V - 4: Where possible, crested wheatgrass in native grasslands should be fenced separately, prescribed burned, or fertilized. Where this is not possible, grazing primarily native grassland should not occur before the 3.5 leaf stage of the management plant species or June 1.

Issue V - 5: Erroneous assumptions are made in estimating livestock carrying capacities by equating grazing/harvest efficiency to high, medium, and low structure without considering the production potential of the ecological site.

Appendix B of the Final Environmental Impact Statement details how forage production will be allocated using three levels of grazing/harvest efficiencies (referred to as “allocated use”) to attain desired vegetation structure goals. This methodology was used in each of the sample plans reviewed by the SRT to adjust stocking rates to achieve desired structure goals.

In the sample plans, structure goals were established as a percentage of the allotment based upon the biologically capable definition. Production figures from the Dragon data were assigned to these acres and a total forage production figure calculated for each structure class (Low, Moderate and High). These total production figures were multiplied by the forage allocation factor (Table B-19) to determine the total usable production. The total usable production was then divided by 790 lbs to determine projected AUMs. The projected AUM figure may have been further reduced to account for the rest objective. The resulting “Total AUM Projected” figure represented the proposed stocking rate for the sample allotment and was the figure the SRT was asked to evaluate in relation to the FEIS stocking rates.

Concerns related to this proposed methodology include the definition of biologically capable (see Issue I-3), suitable vs. capable acres (see Issue I-2), the proposed relationship between percent utilization (a percent by weight measurement) and structure (a height/density measurement), the impact of grazing management (continuous season-long versus rotations) on grazing/harvest efficiencies, air dry versus oven dry weights for forage production and livestock intake figures, and how utilization and structure goals are monitored (Section II - Visual Obstruction Reading (VOR) and Section IV – Monitoring)

Recommendation V - 5: Efforts should be expanded to define relationships among production, grazing/harvest efficiency, and post-grazing structure within ecological sites.

SECTION VI - WOODY AND RIPARIAN COMMUNITIES

Issue VI - 1: Inadequate records are used to document historical trends in woody communities.

Historical records reveal only minor presence of woody plants on the northern Great Plains prior to settlement by Europeans. However, many woody community types are now prevalent and increasing. Some of this expansion is degrading and fragmenting grasslands into habitats unattractive to endemic grassland-sensitive species such as plains sharp-tailed grouse, greater sage-grouse, greater prairie-chicken, Baird's sparrow (*Ammodramus bairdii*) and Sprague's pipit (*Anthus spragueii*) (see Appendix B for details). Gradual expansion of some woody communities affects grassland-sensitive wildlife species over time. For example, sharp-tailed grouse literature indicates this species' population will crash once a woody threshold is reached, but the population decline may be detected only after woody dominance of the native grasslands has occurred (see Section III Management Indicator Species). Some increases in specific woody communities are desired, e.g., in riparian areas where cottonwoods are decreasing due to current management practices (see Issue VI - 5 of Woody and Riparian Community section).

Woody expansion also affects livestock carrying capacity. If grazing is the only defoliation tool used, some woody communities gradually increase, often resulting in decreased herbaceous vegetation that reduces livestock carrying capacity.

One step to properly manage a native grassland community is to determine the degree to which existing prairie has changed. Literature concludes that a manager must determine past and present distributions of prairie and the rate of habitat change before management can succeed.

With woody habitat trends documented, resource managers, livestock operators, and the public will have a better opportunity to understand the past conditions of the woody-dominated communities, their rate of change over time, and their status today. This will clarify what and why specific management tools are being proposed and conducted for managing woody communities, not only for themselves but also to maintain or increase MIS and associated species, and maintain or improve livestock carrying capacity.

Recommendation VI - 1: Use historical black-and-white aerial photographs and current Dragon data to document trends. Document historical woody trends using specific woody community types such as:

- green ash (*Fraxinus pennsylvanica*) draws
- quaking aspen groves
- creeping juniper (*Juniperus horizontalis*)
- ponderosa pine (*Pinus ponderosa*) savanna
- bur oak (*Quercus macrocarpa*) savanna
- tall-shrub
- willow (*Salix* spp.)
- cottonwood (*Populus* spp.)
- juniper (*Juniperus* spp.)
- sagebrush (*Artemisia* spp.)
- low-shrub

Issue VI - 2: The LRMP has a lack of stated quantitative objectives for woody community types.

Without quantitative objectives for specific woody community types, increases or decreases will go undetected for many years. What can happen without quantitative objectives is best illustrated by the ability of western snowberry to expand. This species is an aggressive native low-shrub that increases in northern mixed-grass prairies managed with either or both prolonged idle and grazing treatments. It is a species that is so successful that it shades out native herbaceous species, increases in patch size and frequency, and facilitates the invasion of trees. One of the last herbaceous species to survive under snowberry is Kentucky bluegrass, a non-native invader, but it too succumbs to snowberry competition over time. These dense snowberry stands age and drop off in production, becoming decadent. The decadent habitat is conducive to invasion by smooth brome (*Bromus inermis*) on sites where there is little grazing influence. Snowberry habitats described above have been seen on the DPGs and are increasing. Fragmentation of native grasslands by woody and exotic species decreases the ecological health of native grasslands.

The LRMP and other related documents include quantitative objectives for specific herbaceous community seral stages. These plans also reference "desired conditions" for woody communities and "desired" understory of multi-layer and multi-age class of shrubs and trees. However, no measurable, quantitative information is given for woody community types.

Prescribed fire is mentioned in the LRMP as a tool for managing forested stands to maintain long-term integrity of stands, and prevent encroachment into other habitats (prescribed burning suggestions in Appendix A). Quantitative information is needed for the desired types of woody communities, age class, patch size, distribution, understory composition, and frequencies across the DPGs. Resource managers will find it difficult to manage woody communities with fire without having the historical woody community trend and specific quantitative objectives for these communities. Quantitative information is needed for effective, efficient, and successful management that will attain goals and objectives connected with sensitive grassland species, stabilizing or increasing MIS, determining livestock carrying capacity, and maintaining or enhancing grassland ecological health.

The LRMP describes the role of gallinaceous MIS populations to be used to monitor grassland conditions by monitoring lekking arenas. However, this will be inadequate for detecting woody plant expansion soon enough (see Section III, MIS Issues), thus it is more appropriate to develop quantitative guidelines for woody communities before they have expanded too far. Scientific literature is available to guide these decisions (see Appendix B).

Recommendation VI - 2: Develop quantitative objectives for each woody community type, and identify a range of patch sizes and distribution across the landscape for each type (see Recommendation VI - 1 of Woody and Riparian Communities for possible types).

Issue VI - 3: The Proper Functioning Condition (PFC) assessment of riparian areas is potentially inadequate.

Assessing riparian habitat health and functioning is imperative for properly prescribing grazing management strategies on the LMNG, CRNG, and SNG. The DPG has adopted the process developed in 1993 by the U.S. Department of the Interior (Technical Reference 1737-9) for assessing riparian habitats. Copies of the Technical Reference were given to members of the

SRT for their information and evaluation. The process appears to be straight forward, user-friendly, and repeatable. However, some cautions need to be exercised whenever a new assessment technique is adopted by a land management agency.

The assessment tool must be developed or adapted to the region of use. The 1993 Technical Reference process and attributes were developed for the Great Basin region west of the Rocky Mountains. It was not made clear to the SRT members that attributes used in assessment on the DPG have been adapted to the Great Plains riparian habitats. The functional checklist used by the DPG to assess riparian habitat functioning should be evaluated by a team of biologists, ecologists, hydrologists, and soil scientists as to its applicability to Great Plains habitats. The DPG should also review the website www.cowsandfish.org for a riparian health and functioning assessment process developed in Alberta, Canada, for riparian habitats having similar attributes to those in the northern Great Plains of the U.S.

The 1993 Technical Reference states, "Since natural riparian-wetland areas are characterized by the interactions of vegetation, soils, and hydrology, the process of assessing whether a riparian-wetland area is functioning properly requires an interdisciplinary team." It is not apparent to the SRT members that an interdisciplinary team was being used to assess riparian habitats in the LMNG, CRNG, and SNG. If a team approach was used, continue this practice. If not, the SRT questions whether one observer can serve the functions of a team of experts, and strongly suggests following the 1993 Technical Reference process.

The process used for assessing PFC, as stated before, appears to be straight forward, user-friendly, and repeatable. Having said this, training on the process becomes even more critical to avoid assessor mistakes. Assessors should be trained at the start of each season and retrained throughout the season as needed. The assessment relies heavily on judgment and experience. Therefore, extensive training in the field is necessary to get reliable and repeatable results. Developing a training manual as well as a rigorous training process would be valuable to future assessment teams and the DPG and is strongly suggested by the SRT.

Recommendation VI - 3: Determine if PFC rating is applicable to North Dakota, use multi-disciplinary team to conduct PFC ratings, and develop a training manual and process.

Issue VI - 4: The grazing tactics in riparian areas are inappropriate.

Grazing management strategies for riparian habitats should be developed to improve livestock distribution. No single approach will work for every situation but good livestock distribution is the key to maintaining or improving riparian habitat health. Three major strategies can be used: 1) attractants and herding, 2) fencing, and 3) rotation grazing systems that utilize proper timing, duration and intensity.

Attractants and herding are designed to lure or move livestock to uplands and away from riparian habitats. The most commonly used attractants are water developments, salt, minerals, feeders, oilers, and rubbing posts. Livestock attractants are most effective where there are small variations in topography, habitat types and elevation, and where grazing periods are short in targeted pastures.

Off-stream watering sites, tanks or reservoirs, can draw livestock grazing away from riparian habitats and improve livestock distribution to upland habitats. Research in Canada indicates that an off-stream water source decreased the amount of time livestock spent in the stream by up to

90 percent (McIver 2004). In many cases, water can be drawn from the stream to the watering tank in a continuous flow with an overflow returned back to the stream by underground pipe. This secures a steady supply of clean, cool water that is preferred by grazing livestock. Using multiple watering tanks or reservoirs in a pasture can be an effective way to move livestock when forage becomes short or when livestock begin to overutilize an adjacent riparian habitat. Attractants, such as water development or herding, should be used alone only where fencing is not practical or possible.

Electric fencing could be placed to exclude livestock grazing from riparian habitats, but this is not recommended except in initial improvement efforts. A short-term fencing program only treats the symptom of a problem, overuse of a riparian habitat, which instead needs to be addressed by proper livestock management.

For most allotments, undesirable effects of livestock grazing can be minimized or eliminated with proper planning and controlling of livestock use of these habitats. Riparian habitats should be fenced into smaller units to more easily control stocking rate and season of use of livestock. Smaller units would require shorter grazing periods, given a set herd size, which allows better management of the intensity and frequency of use of the riparian habitat. Additionally, fencing riparian habitats into smaller units allows managers to graze livestock at times or in seasons when the soils are dry, resulting in minimum bank damage and soil erosion.

Recommendation VI - 4: Tailor grazing tactics to meet site-specific goals and objectives of riparian habitats.

Issue VI - 5: The LRMP does not include provisions to address timely responses for short-term circumstances that could lead to cottonwood regeneration.

The plains cottonwoods (*Populus deltoides*) and associated riparian communities are identified as a rare plant community in the LMRP. Cottonwood establishment, growth, and survival are affected by seedling survival (dispersal, germination, and establishment), water cycle (fluvial processes, flooding, scouring, drought), regulated stream flows (dams, irrigation intake), wildlife (deer (*Odocoileus* spp.), elk (*Cervus elaphus*), beaver (*Castor canadensis*)), exotic competitors (Russian olive (*Elaeagnus angustifolia*), saltcedar (*Tamarix parviflora*), and livestock grazing.

Conditions conducive to cottonwood establishment do not occur every year but may be separated by several years. Once seedlings are established, the FS and permittees will have a very narrow window to identify the situation, make management decisions, and take actions to promote seedling survival. Areas with developing seedlings will need to be excluded from grazing by fencing or the pasture deferred until cottonwood plants are firmly established and can withstand grazing.

Recommendation VI - 5: Develop specific guidelines for quick response by the Grazing Association members and FS to exclude livestock when suitable flooding event(s) occur.

(See Appendix A for prescribed burning suggestions and Appendix B regarding the importance of diverse management for native grassland flora and fauna.)

SECTION VII – BLACK-TAILED PRAIRIE DOG MANAGEMENT

Issue VII - 1: The ability to use rodenticides as an effective tool for limiting black-tailed prairie dog (*Cynomys ludovicianus*) colonies to desired area(s) is uncertain.

Although the LRMP stipulates the restricted use of rodenticides to control unwanted expansions of prairie dog colonies, the SRT is concerned that obtaining official authorization in a timely manner may prove difficult. Certainly, topographic features, soil texture and depth, and vegetation structure can hinder expansion, but their effectiveness has not proven satisfactory in all situations. Thus, expanding prairie dog colonies need to be closely monitored and effective containment plans need to be readily implemented when desired colony size is attained.

Recommendation VII - 1: Aggressively monitor colony expansion and proactively develop rapid response control procedures that limit expansion to desired area(s) in a timely manner (see Appendix C for greater detail on prairie dog control).

SECTION VIII - DROUGHT MANAGEMENT STRATEGIES

Issue VIII - 1: There is no clear, proactive, destocking or grazing management plan for dealing with the detrimental effects of drought on livestock and wildlife carrying capacities.

Drought is an inherent property of grassland ecosystems. If it were not, most grassland would be forest. Because grassland managers are typically optimistic when it comes to rain, they seldom consider the fact that drought looms around every corner. Regardless of our desires to ignore the realities of drought, having a proactive drought management plan is critical for sustaining healthy grasslands.

Key to an effective drought management plan is to be proactive rather than reactive. Too often, drought management strategies don't kick in until available forage is essentially gone. This strategy results in increased economic risks as well as resource-based ecological risks. Granted, no drought management plan will ever prove to be 100 percent effective or universally applicable to every region and every operation, but that is an inherent characteristic of most grassland management plans. Grassland managers must understand that drought is "normal" in grassland ecosystems, and that failing to develop and follow effective drought management strategies and tactics is abnormal.

Recommendation VIII - 1: Develop viable, proactive drought management strategies and tactics that, when followed, reduce economic risks, minimize ecological risks, and enhance the long-term sustainability of both the responsible management enterprise and the grassland resource (see Appendix D for details regarding Drought Strategies).

SECTION IX - SHEYENNE NATIONAL GRASSLAND (SNG)

The SRT decided to discuss the SNG separately from the LMNG and CRNG due to its unique characteristics and management challenges. The SNG is a northern tall-grass prairie remnant in southeastern North Dakota. It is approximately 70,000 acres in size, fragmented, and generally isolated by a predominance of cropland surrounding it. Its soils are sandy, topography is hummocky, and the area is generally subirrigated due to impervious layers beneath the soil

surface. Over decades, the plant communities of the SNG have been altered because of lack of fire, improper livestock grazing practices, and possibly its isolation from other remnant tall-grass prairie tracts. This has resulted in significant woody plant expansion (e.g., willows and aspen) into the grasslands and invasion by introduced plant species (e.g., Kentucky bluegrass and leafy spurge (*Euphorbia esula*)). A well-planned, long-term management strategy that is adhered to, will be necessary to restore the ecological health of the SNG plant communities.

Issue IX - 1: Historical, pasture-specific grazing records were not used in developing the LRMP.

This is as large an issue at the SNG as at the other DPGs. Again, a fundamental component of beginning to restore native plant communities on the SNG is pasture-specific grazing records. Under proper management, livestock grazing can be a tool for maintenance or improvement of grassland ecosystems. These records should include the kind, number, and size of livestock, as well as the timing and length of grazing periods by pasture. Not accounting for size of livestock could lead to over-stocking.

Recommendation IX - 1: Maintain and share detailed, pasture-specific grazing records between the FS and the Grazing Association.

Issue IX - 2: The frequency and intensity of livestock grazing over time and space was inadequately distributed.

Again, this is an issue faced on the other DPGs. Quite simply, proper grazing distribution relates directly to a healthy vegetation structure by helping maintain the species richness, diversity, species composition, plant density, root structure and maintenance, ground and basal cover, and wildlife habitat. Proper grazing also helps repel the invasion of introduced plant species. Healthy vegetation structure and heterogeneity tend to increase the biodiversity of managed habitats. Tools used to aid livestock distribution that are most applicable to the SNG are fencing and water development, although many other tools can be used to supplement these.

Fencing is a direct distribution tool. Fencing can be permanent, post and barbed wire, or temporary, such as one-strand electric. Traditionally, post and barbed wire fences have been used for boundary and internal fencing on the SNG. With new electric fencing products, fencing can be more affordable and have greater utility for managing livestock for grazing distribution. Temporary electric fences could be used to establish smaller grazing units, to maintain sensitive areas or plants, to control traditional livestock trailing concerns, to build fuel for prescribed burning, weed control, restoration, etc. Use of electric fencing would provide land managers the flexibility required to meet multiple-use goals and to maintain a diverse, healthy vegetation structure.

Water developments are indirect tools to aid in livestock distribution. Livestock choose whether or not to use a water development especially when multiple watering sites are available in a single pasture. DPG's management team seems to view the creation of new water developments as undesirable.

Grazing systems for livestock have been designed to maintain, improve, or renovate grasslands by controlling the frequency and intensity of plant communities and even individual plant species use within plant communities. Subdividing a grazing unit into multiple pastures and rotating livestock through these pastures are the most effective ways to control the frequency and

intensity of use. Rotations are planned for specific purposes (e.g., seed production, tillering response). Given sufficient pasture numbers, rotations can be planned to provide wildlife cover, build fuels for a prescribed fire, and other purposes.

Rotational grazing systems utilize numerous pastures and one livestock herd. Pastures are generally grazed two or more times in a growing season. Rotations are designed to keep grazing periods short in order to preclude the grazing of regrowth. Deferment periods are long enough to encourage regrowth and storage of plant root carbohydrates. Pasture numbers can be as few as two but 10-12 are recommended for optimal management flexibility. For example, if 12 pastures are available, each pasture is only approximately eight percent of the total grazed area, which allows a manager to rest an individual pasture for range improvement or renovation treatment while having little effect on stocking rate.

Grazing systems for livestock are not magical but are simply an organized means to deal with grazing distribution, season and length of use, and stocking rate and density. When grazing systems are used, the generally noted characteristics are:

1) They are stocking-rate sensitive regarding livestock performance and grassland health.
2) Changes in structural plant community attributes may appear rapidly (in a single season) but change in ecological health is most often slow to very slow.
3) Any rotational grazing system is better than season-long grazing and the best approach is a rotational system designed to maximize a land manager's flexibility and opportunities to meet vegetation and multiple-use goals and objectives.
4) There is no scientific evidence that suggests one type of rotational grazing system is superior to another in terms of enhancing the ecological health of grazed plant communities or animal performance and production.

Recommendation IX - 2a: The SRT urges greater use of temporary electric fencing in the SNG to address specific ecological improvement and restoration goals.

Recommendation IX - 2b: The SRT recommends that water development be positively considered as a tool to aid livestock grazing distribution in the SNG. The SRT does not recommend that additional water sources be constructed for the purpose of increasing livestock numbers. Rather, they should be used to modify livestock grazing distribution and reduce the frequency and intensity of use of individual plants and plant communities.

Recommendation IX - 2c: The SRT recommends combining grazing allotments and rotating two or more herds together through the combined pastures (preferably 10-12), or using temporary electric fencing to subdivide current pastures to obtain more grazing units. Given the need for ecological restoration in the SNG, adoption of rotation grazing systems by combining allotments, as well as stocking rate adjustments, are highly recommended strategies to achieve the stated goals of improving the ecological health in plant communities.

Issue IX - 3: Uncertainty exists regarding the "proper" rates of stocking to achieve desired ecological restoration in the SNG.

Although "proper" stocking rates are an issue on the LMNG and CRNG, the SRT believes this issue is of even greater concern in the SNG for several reasons:

1) Planned stocking rate reductions for the SNG are substantially greater than those outlined for the LMNG and CRNG.

2) Current miscalculations in stocking rates (i.e., forage demand) because of increases in cow-calf size over time may be even greater for the SNG than the LMNG and CRNG.
3) The SNG climate is considerably more mesic than LMNG and CRNG. Therefore, the potential to positively affect livestock carrying capacities by implementing sophisticated grazing systems, strategic cross-fencing, mineral and salt placement, water development, etc., may be greater for the SNG than the LMNG and CRNG.
4) To meet resource management goals and objectives for the SNG (i.e., ecological restoration) will require greater inputs in terms of labor, fossil fuel, etc., than those required to meet LMNG and CRNG goals and objectives (i.e., enhanced "maintenance"). As such, anticipating optimal stocking rates for the SNG with great confidence is difficult. Regardless, the SRT believes stocking rate reductions will be required to implement successful ecological restoration strategies in the SNG.

Recommendation IX - 3: Proposed stocking rates should be implemented as necessary to achieve the desired resource management goals and objectives. However, clearly documenting the effects that changes in stocking rates have toward meeting resource management goals and objectives must be done in concert with reducing the stocking rates. It is also imperative that future increases or decreases in stocking rates be made based on documented changes in the resource.

Issue IX - 4: Insufficient research information is available to develop sound management plans to sustain and enhance the western prairie fringed orchid (*Platanthera praeclara*) (WPFO).

The WPFO was classified as a threatened plant species in 1989 (USFWS 1989) under the Endangered Species Act (1973), as amended. As such, a WPFO Recovery Plan was published (USFWS 1996) that "delineates reasonable actions which are believed to be required to recover and/or protect listed species." Approved plans can be modified as new findings arise or species recovery takes place.

According to the WPFO Recovery Plan (1996) the WPFO preferred habitat is unplowed, calcareous prairies and sedge (*Carex* spp.) meadows, although WPFO have been observed on highly disturbed sites such as borrow pits, old fields, and roadside ditches. The WPFO has a patchy distribution generally restricted to wetland swale landscapes on the SNG (Hof et al. 1999). Approximately 2,000 to 3,000 acres (about three percent) of the SNG are considered suitable habitat for the WPFO (P. Sjursen, personal communication).

The WPFO Recovery Plan states, "The major historical cause of the species' decline was conversion of habitat to cropland." This is not applicable to the SNG as it is protected from conversion. It goes on to say, "Hydrologic changes that draw down or contaminate the water table may also adversely affect the species." On the SNG, WPFO numbers and flowering has been positively correlated with above-normal precipitation and surface soil moisture (Sieg and King 1995). No activities on the SNG significantly influence water table levels. The recovery plan also states that, "Other land management practices such as burning, grazing, and mowing may affect the species depending on their timing, frequency and intensity. However, some disturbance may be important for establishment." This last statement is where the controversy and concerns surface in relation to the management of the WPFO on the SNG.

No documented evidence was presented in the WPFO Recovery Plan, nor was any more recent evidence provided, to recommend prescribed fire or grazing strategies for maintaining or enhancing orchid populations. Of the 71 censussed sites in North Dakota having WPFO

(USFWS 1996), the predominant land use was grazing or haying, with an occasional periodic burning treatment. Bowles (1983) and Bowles and Duxbury (1986) have suggested that orchid flowering may be suppressed by litter accumulation but stimulated by fire, seasonal mowing, and grazing. Sieg and King (1995) reported that Kentucky bluegrass cover was negatively associated with WPFO populations. This is presumably due to Kentucky bluegrass being a sod-forming species that may inhibit the germination and establishment of WPFO seeds. The WPFO is a short-lived, perennial species dependent upon seed production and suitable germination sites for its survival. Finally, over five years, Sieg and King (1995) reported no differences in WPFO density between grazed (season-long or rotational), ungrazed, grazed and burned, or ungrazed and burned treatments. They concluded that the WPFO has erratic growing and flowering habits and these habits appear to be influenced primarily by precipitation.

Recommendation IX – 4a: Core WPFO should be actively managed by rotational grazing and prescribed burning to prevent litter buildup, decrease competition, and increase suitable germination sites.

Recommendation IX - 4b: Core WPFO populations should be managed to minimize potential grazing disturbance to flowering orchids. The SRT suggests adopting improved rotational grazing systems that allow deferment of core WPFO populations during flowering. (See Section IX - SNGs, grazing management issues one, two and three.)

Issue IX - 5: Switchgrass (*Panicum virgatum*) is an inappropriate MIS for the WPFO.

Switchgrass is a rather ubiquitous plant occurring across the tall- and mixed-grass prairies. It associates with the WPFO at the upper level of the WPFO habitat. However, the WPFO is associated with many native and introduced species but it most often occurs in swales dominated by sedges and rushes (*Juncus* spp.) (Sieg and Bjugstad 1994). Sieg and King (1995) determined through regression analyses that slimstem reedgrass (*Calamagrostis stricta*), is the best indicator of WPFO habitat on the SNG.

Recommendation IX - 5: If a MIS is necessary to the recovery of the WPFO, slimstem reedgrass would serve as the best indicator of the orchid habitat.

Issue IX - 6: Increases in invasive and native woody species threaten the integrity of plant communities.

Invasive species (Kentucky bluegrass, leafy spurge, Canada thistle (*Cirsium canadensis*), smooth brome, buckthorn (*Rhamnus cathartica*), and redtop (*Agrostis stolonifera*)) as well as increases in the population of some native invasive species (western snowberry, willow spp., quaking aspen) represent a real threat to the integrity of the SNG plant communities. On some ecological sites, thresholds may have already been crossed. This means extensive and expensive restoration work will be required to meet the LRMP's goals. In the case of some sites, more intensive management may be capable of returning the plant communities to a state that more closely resembles the potential natural vegetation or historic climax plant community. In all cases, the level or intensity of well-planned, ecologically sound management will need to be increased. A "hands off" approach will only result in a further deterioration of the plant community resource.

Generally speaking, plant communities respond to the management that is applied within the limitations of existing climatic conditions. Those plant species with the competitive advantage for moisture, nutrients, and sunlight generally increase and eventually may dominate the plant community. If Kentucky bluegrass is increasing, then the management tools being applied are probably giving it a competitive advantage. Weather conditions often compound this problem. For example, some of the proposed actions (e.g., reduced stocking rates, more deferment whether it be for orchids, grouse, butterflies, or whatever) will result in more decadent plant material (aka structure) covering the crowns of the warm season grasses. More cover results in less sunlight reaching the crowns of the warm season grass plants and cooler temperatures at the soil surface. The optimum temperature for cool season grass photosynthesis is 50° F to 70° F. Cool season grasses light saturation point is about 50 percent of full sunlight. Optimum temperature for warm season photosynthesis is 86° F to 104° F. Warm season grasses achieve maximum photosynthetic rates at full light saturation (Bedunah and Sosebee 1995). Consequently, excessive amounts of residual cover will give the competitive advantage to Kentucky bluegrass when present in a tall grass prairie.

Therefore, managers must develop a sound ecological understanding of plant community dynamics and how various management "tools" may shift the competitive advantage away from the invasive species and toward the desired species before any restoration actions are taken. This is especially true in those instances where thresholds have been crossed and drastic actions (e.g., chemical, mechanical) are required to restore a plant community. Without this understanding, improper management following the restoration will once again give the competitive advantage to the invasive species, resulting in the reoccurrence of the problem.

Consistent application of certain management tools is also of concern. Prescribed fire needs to be applied in the most effective and consistent manner possible in order for the desired outcomes to be realized. It may be necessary to apply the tool of fire annually for a period of several years to the same area in order to reduce some fire-adapted woody species.

Recommendation IX - 6a: Determine which plant communities and sites have crossed ecological thresholds. Identify ecological strengths and weaknesses of "undesirable" (invasive and undesirable natives) and "desirable" (e.g., big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), porcupine grass (*Stipa spartea*)) species and develop ecologically sound, integrated management strategies for each species.

Recommendation IX - 6b: Develop and implement simple but effective monitoring protocols to be able to evaluate whether applied management is achieving the desired results.

Recommendation IX - 6c: Apply management tools (prescribed fire, prescribed grazing, rest, herbicides, etc.) in a manner that is responsive to changing environmental conditions yet consistent in application. For example, if prescribed fire is to be applied to reduce Kentucky bluegrass or a woody plant component, ensure proper timing of burns and continued annual application across the same location(s) to ensure desired outcome. See Appendix A for further recommendations on the application of prescribed fire.

Issue IX - 7: The effectiveness of proposed ecological restoration on the SNG is questionable.

The SRT agrees with the need to address ecological restoration on the SNG. However, based upon our collective experiences, we encourage the FS to proceed with caution and to completely think through the process before committing resources (staff time and funding) toward this effort. Without a proper understanding of the ecological processes involved, restoration efforts generally fail initially, or are unsuccessful long term due to a failure to address underlying problems.

Before commencing restoration efforts, determine existing baseline conditions to include site-specific inventory data on plant community composition and health, hydrology and soils. From this information, identify with the best existing knowledge those plant communities that have crossed thresholds and which communities may still be restored through intensive management activities only. Those that have crossed thresholds will require more drastic measures, much beyond what management changes alone can address.

Recommendation IX - 7a: Initiate ecological restoration projects on a small scale (few acres) and monitor to refine techniques before applying the techniques at larger scales.

Recommendation IX - 7b: Seek expertise in other agencies and private industry that have experience in ecological restoration. If funding permits, contract out restoration efforts.

CONCLUSION

The SRT has completed the process of reviewing the sample AMPs. From that review the above issues have arisen and the Team has provided recommendations on each issue. The SRT was also charged to address three specific questions that were stated in the Charter:

1. Can the grazing portion (standards, guidelines, objectives, and desired conditions) of the Grasslands Plan be implemented?

This apparently simple question is anything but that. Analogous to this question might be the question, "Can we fly to Seattle?" The answer is yes if we have a plane, fuel, an experienced pilot, and directions or a plan to get to our destination. On the other hand, the answer is no if you or I are expected to fly the plane and somehow find our destination, Seattle. That is what the SRT members faced in attempting to answer the above question. The answer is not a simple yes or no. In general, the SRT members' comments on the sample AMP reports stated that, "Yes, the LRMP can be implemented." However, the general qualifier to that statement was, "But the outcome is uncertain." The rationale for this nearly universal SRT member conclusion is detailed in the final SRT Report. Specific references to refer to are:

SECTION I - BASELINE DATA:

Issue I-1: The SRT recommends using the NRCS ecological site information for designing pasture/allotment-level management plans.

Issue I-2: Uncapable lands should be included in stocking rate calculations.

Issue I-3: The definition of "Biologically Capable" land in reference to meeting structure goals needs study and revision.

Issue I-4: The FQI should not be used for determining plant community seral stage. The SRT recommends adopting the NRCS similarity index.

SECTION IV - MONITORING:

Issue IV-1: The lack of annual pasture-specific grazing records prevented the SRT from assessing the efficacy of past grazing management strategies on the DPG.

Issue IV-2: The SRT members concur with the FS that monitoring data is important to achieve the goals stated in the LRMP. However, the SRT was provided inadequate data to judge whether the past or present management strategies may achieve the stated goals and objectives in the LRMP.

SECTION VI - WOODY AND RIPARIAN COMMUNITIES:

Issue VI-1: There are inadequate records of woodland plant community expansion and its effect of grazing capacity and wildlife species and populations.

Issue VI-3: The present PFC technique for assessing riparian areas may not be appropriate for the region, or be repeatable, and needs study.

Issue VI-4: Riparian habitats will need increased livestock management strategies to meet specific ecological health goals and objectives.

Issue VI-5: At present, the LRMP does not include provisions to address timely responses for short-term circumstances to meet cottonwood regeneration goals.

SECTION VIII - DROUGHT MANAGEMENT STRATEGIES:

Issue VIII-1: Drought is inevitable on the DPG. The FS needs to develop and adopt proactive drought management strategies to reduce ecological and economical risks.

SECTION IX - SHEYENNE NATIONAL GRASSLANDS:

Issue IX-2a,b,c: For livestock grazing, the SRT recommends using temporary electric fencing, water development, combining grazing allotments, adopting rotational grazing plans, and stocking rate adjustments to achieve the stated goal of ecological restoration of tall grass prairie in the SNG.

In addition to the preceding sections, numerous other sections may have information that also applies to this question.

To summarize the SRT's answer to the first question, "Yes, but we are uncertain of the outcome, whether the objectives and goals will be met and when."

2. Were the projected sample AMP livestock levels similar to those projected in the FEIS?
Based on information provided, it is our opinion that the proposed stocking rates in the sample AMPs are comparable to those projected in the FEIS. However, it is impossible to determine whether the projected stocking rates are appropriate to meet management goals and objectives. The projected stocking rates are based on too many assumptions when estimating carrying capacity and are coupled with resource management goals that will be difficult if not impossible to achieve (see e.g., Issues I-1, I-2, I-3, II-3, II-4, IV-1, V-1, V-2, V-3, V-5, IX-3, IX-4, IX-6 and IX-7).

3. Did the Forest Service use the appropriate baseline data and analysis procedures (i.e. "good science") for sample AMP development?
The answer to the question of using "appropriate" baseline data for sample AMP development is, "No." The answer to the question of using "available" baseline data for sample AMP development is, "Yes." The gap between "appropriate" and "available" baseline data for developing management plans for allotments on the DPG is immense. Throughout the process of receiving, reviewing, touring, and discussing the AMPs over the past two years, the SRT members have requested detailed monitoring data needed for properly assessing management tactics or strategies to achieve the stated FS desired goals and objectives for the DPG. There was a consistent and noticeable lack of detailed plant, animal, and environmental data presented for AMP development. This deficiency resulted in increased emphasis being placed on "professional judgment" decisions being made by FS personnel. This is not a desirable position for an individual or agency to be too dependent upon. Decisions made on "sound science" are made much easier and are easier to defend while too many decisions based on "professional judgment," whatever their correctness, often appear suspect.

The SRT makes many recommendations in the SRT Report to increase and improve "appropriate" baseline data for future AMP development, assessment, and revision. Specific recommendations are:

1. The Dragon data should not be used for AMP development. We recommend the use of the NRCS soil series/ecological site methodology (Section I, Issue I-1).

2. There is a need to accurately define "Biologically Capable" land in meeting structure goals for grouse (Section I, Issue I-3).

3. The protocol for using the Robel pole to assess structure is flawed. Suggestions for improving the methodology are located in Section II, Issues II-1 to 4.
4. There is a need to monitor sharp-tailed grouse and sage-grouse on both reference and non-reference areas (Section III, Issue III-1).
5. There is a lack of information concerning vegetation response to livestock management practices and limited vegetation monitoring proposed in the LRMP. See Section IV, Issue IV-1 and 2, and Appendix D for more details on proposed protocols.
6. There are no historical data available on woody plant trends on the DPG and their potential effects on livestock carrying capacity and wildlife populations. There were no proposals given for future assessments by the FS (Section VI, Issue VI-1).
7. Riparian habitat rating is conducted by the PFC technique. Is the technique applicable to North Dakota, and is a trained, multidisciplinary team used in assessment? (Section VI, Issue VI-3).
8. There was a lack of data presented to develop a sound management plan to sustain and enhance the western prairie fringed orchid (WPFO) in the SNG. Additionally, switchgrass is not the best species to use as an MIS for the WPFO. Instead slimstem reedgrass should be used (Section IX, Issue IX-4 and 5).
9. There is a lack of detailed monitoring proposed by the FS to identify ecologically sound strategies to decrease invasive and noxious species, and assess ecological restoration practices as suggested for the SNG (Section IX, Issue IX-6 and 7).

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The SRT expresses a sincere thank-you to the USFS and its staff for their hard work and patience in responding to the questions, concerns and issues raised by the Team. We compliment their efforts and progress in developing a management plan in a climate of multiple use and multiple interests. While the SRT's focus was limited to the science of the grazing portion of the LRMP we understand the difficulty of writing the LRMP in total under such circumstances.

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APPENDIX A

PRESCRIBED BURNING SUGGESTIONS

by Karen A. Smith

INTRODUCTION

Prior to providing suggestions about prescribed burning on the DPGs, a bit of background about my experience might be beneficial. I have had experience with prescribed burning from 1978 to 2002 in northwestern North Dakota. Most of my work has been on the 27,000-acre Lostwood National Wildlife Refuge (75 miles northwest of Minot, N. D.) where we have completed 107 burns on more than 66,000 acres ranging in size from less than one acre to 5,596 acres.

Lostwood NWR's habitat and species composition is similar to that of the McKenzie Ranger District, LMNG, except it occurs in the geographic feature called the Missouri Coteau. There are many wetlands and an upland plant diversity that represents the arid west (hilltops), fescue (*Festuca* spp.) prairies, little bluestem/sideoats grama (*Schizachyrium scoparium/Bouteloua curtipendula*) communities, and tall-grass prairies, all in a plant community classified as wheatgrass-needlegrass (*Agropyron-Stipa* spp.), about 60- 40 cool vs. warm seasons.

In 1978, two main vegetative problems included an over abundance of western snowberry located from around wetlands through hilltops, and quaking aspen groves around and into many wetlands. The Refuge had lost many of the endemic grassland passerines and upland nesting shorebirds due to expansion of woody communities. We used a prescribed burn program to reduce woody communities and begin returning a native herbaceous community with associated grassland wildlife. To guide management decisions, we performed an extensive literature search on western snowberry and quaking aspen phenology, and reviewed publications on prescribed burning affects to these species.

The refuge also had mats of Kentucky bluegrass associated with western snowberry, except in snowberry stand interiors where the understories were barren. The centers of these barren snowberry stands became decadent over time, and with or without prescribed burning, were invaded by smooth brome. We re-introduced livestock onto the refuge once the snowberry was reduced (particularly the snowberry stubs) and there were enough herbaceous plants growing back to provide livestock with sufficient forage. Leafy spurge is present but has been confined to scattered areas totaling about 300 acres.

CRITICAL GROUND RULES

The most critical ground rule for a prescribed burn program is to learn as much as possible about the specific plant species that are targeted for reduction. Timing of prescribed burns is very crucial if progress is to be made towards stated objectives. If the burns are timed wrong, they can actually increase the very species desired reduced. One way to develop this knowledge is to know specific plant species phenology, particularly when root reserves are lowest so that a burn can be timed to weaken a selected species like Kentucky bluegrass. Understanding other aspects of a plant's phenology might also help. For example aspen trees have two hormones in their

roots. One or the other is triggered by what happens to the tree's trunk, which in turn affects whether the tree produces leaves on the main trunk or the plant suckers.

Another critical ground rule is to plan several burns for the same allotment/management unit over about a 10-year period, or until desired vegetative responses are being seen. This does not mean it cannot be grazed between burn years providing enough moisture is present, but not for a full grazing period at normal carrying capacities. If an area is only burned once and left without another burn for more than four years, it will return to prior burn conditions. In other words, if vegetation change is desired, it is going to take time and repeated burns with less than three years between burns.

Another critical ground rule is to be cautious about burning at the same phenological time. More than one phenological time when root reserves are low often exists, which provides a different window of opportunity for burning. However, if a given species is desired weakened, and there is a specific phenological time that is best to weaken it, proceed with repeating the same burn time but watch what is happening to other vegetation.

Soil moisture and types of fuel present are other critical ground rules to consider. If there is little ground moisture and excessive amounts of litter with lots of humus and a soil surface crust present, managers should wait for some soil moisture. If burned under this type of heavy fuel condition, the fire's heat will be held on the soil surface longer than desired. If enough fuel and/or types of fuel (e.g., woody) are present, heat will be held longer on the soil surface allowing the fire to burn into the ground through the root mass. On the other hand, if there is no thick layer of humus and a light layer of litter and residual vegetation, a burn during dry periods can enhance the reduction of woody and exotic communities, and over time will require fewer burns to reach desired objectives, unless the woody understory of multi-layer is desired.

SPECIFIC SPECIES

Kentucky bluegrass

One simple way to understand how to begin reducing Kentucky bluegrass is to learn how to produce a lush Kentucky bluegrass lawn and then plan just the opposite. Articles I have read recommend keeping it cut to spread rhizomatously (under ground creeping stem), prevent seed production, keep mulched and moist so the sun cannot reach the soil surface, and of course, fertilize and water. This information provides the very basic knowledge because many variables affect a plant before and after a prescribed burn. These factors include the amount of moisture in the soil before and after the burn, what conditions the native plant community is in, how much litter lies on the soil's surface, etc.

One prime time to weaken bluegrass is in the four to five leaf stage through early boot when the root reserves are at their lowest. Burning at this time weakens bluegrass and native cool seasons yet the natives seem to be less harmed than bluegrass, and native warm seasons are enhanced. My experience with burning earlier than this, especially before any green-up, is that bluegrass will increase. If burned too early, bluegrass and smooth brome can take advantage of the nutrients released from the fire, and with the earlier warming soils (black soil in sun), get a competitive edge ahead of the later germinating native cool seasons.

Burning at the four to five leaf stage has one complex problem. If there is insufficient dry litter to carry a fire through bluegrass sites, the fire will not penetrate into these stands, thus the fire does not achieve desired results.
Another effective burn time that has reduced Kentucky bluegrass on Lostwood NWR is a prescribed burn from late July through mid September. I suggest that the drying, hotter conditions over summer with a summer burn, and the drying conditions over the winter months with a fall burn, are conditions not favorable for bluegrass in this northern climate. On many sites, native cool and warm seasons seem to out-compete bluegrass over time with repeated summer prescribed burns.

If only one or two burns are completed over a three to four year period and no further burns are completed, expect Kentucky bluegrass to return to its original density, particularly with grazing. However, if at least three burns are completed, eventually removing all litter, humus, and soil crust, finally bluegrass is weakened and the native cool and warm seasons can compete. Once an area receives its first prescribed burn, managers must commit to prescribed burns for several years (usually six to ten) depending on how healthy Kentucky bluegrass is and the conditions of the native plant community. The number of burns also depends on past management history, i.e., grazing, idle, haying (removing the cut vegetation), mowing (leaving vegetation on the ground), burns, burn timing, and of course, weather.

The SNG is a tall-grass prairie, and even though the warm seasons are depressed, they are still present. This ecosystem will likely be easier to reduce Kentucky bluegrass when burned in the four to five leaf stage to early boot than in northwestern North Dakota.

Smooth brome
The phenological time to burn smooth brome is also in the four to five leaf stage and on into early boot. Enough litter is needed to carry a fire across this green lush growth. But smooth brome does well with burning if there are few native warm season plants to compete with it. Prescribed livestock grazing is essential to reduce this invasive species where native plants still occur.

Summer and fall burning does not quickly show reductions of brome, but some research is showing a very gradual decline in this plant with repeated prescribed burns over several years. There is a study by Willson and Stubbendieck (2000 18:34-38) in Ecological Restoration that provides some excellent information on this plant's phenology for timing of burns and relationship to native plants where smooth brome occurs.

Western snowberry
Research at Kansas State University has shown how to reduce *Symphoricarpos orbiculatus*, similar to *S. occidentalis*, or western snowberry. Their gracious help guided our initial decisions on how to treat snowberry. They described two phenological times when their species has reduced root reserves, once at first leaf maturity and again at full flower. At first leaf maturity, the root reserves are at their very lowest but the timing for us was mid-June. We tried this and it did not work well for a variety of reasons. It may work well in the SNG (I do not know of a grouse nest lost to a prescribed fire completed in mid-May through June.) Prescribed burning at full flower, mid-July to late August for us, was helpful for weakening snowberry in part because after a summer burn snowberry sprouts before winter, which uses its winter stored root reserves yet doesn't have enough time to replenish this before winter. After two or three more additional

summer burns over the next six to seven years, the root reserve is weak enough to finally suppress the plant. The summer burning worked best for us to weaken snowberry, and it was also good timing to reduce aspen. The required longevity of our treatments with fire to weaken snowberry could be related to the loss of native herbaceous plants in snowberry stands.
After a first burn, Canada thistle became abundant in locations where the fire burned the barren dense stands of snowberry, although some thistle was present before this initial burn. After a second and third burn, this invasive species was reduced to almost nothing. As mentioned above, smooth brome became a growing problem. On the first few management units treated in the late 1970s and 1980s, smooth brome was not as significant of a problem, but on areas treated more recently (the last 10 years), smooth brome was invading rapidly into the decadent stands of snowberry before the initial prescribed burn.

Over the past 20 years, a variety of native grasses, e.g., western wheatgrass, needle and thread, plains muhly, mat muhly, big bluestem, porcupine grass, prairie dropseed and more have slowly re-invaded these fire treated areas. But it is by no means a perfect northern mixed-grass prairie. It took 80 plus years without major forms of defoliation (fire and grazing) for the prairie to evolve into a decadent, dis-climax northern mixed grass prairie, and it is not likely to return to a healthy native flora community in less time.

Aspen

In general, there are two hormones in the roots of aspen trees. One causes the tree to produce leaves in its canopy and the other to sucker. The hormone switch that triggers suckering occurs when the trunk is cut off. The tree cannot put root reserves up its trunk, causing the root hormone switch and copious suckering results. If the trunk is girdled, the tree can put root reserves up the trunk, thus it does not switch the root hormone. However, it cannot put food back down. The tree each year produces leaves on its canopy, but by the fourth year, the last burst of leaves are in small clusters on twig tips, and the leaves and the entire trunk die by the end of the summer. Subsequent burns will kill what few suckers grew.

A prescribed fire can heat girdle the trunk of trees as long as the fire is not too hot. All that is needed is enough heat to damage the cambium layer under the bark, allowing an avenue for fungal infection (e.g., orange discoloring of the tree trunk) that slowly destroys the cambium layer. The first burn usually burns the aspen grove's edge, destroying the "ladder" of small aspen trees around a grove, and opens the interior of the grove to drying and hotter winds that blow through its entire canopy from ground level up, an unfavorable condition for aspen. The next two or three burns will treat the entire grove. Finally the grove is reduced to mostly a few dead tree trunks and scattered suckers. Livestock adversely affect the groves under these conditions.

But timing of killing or girdling the trunk is also important. If an aspen tree is burned so severely the trunks are killed in a spring or early summer burn, there will be extensive suckering. Future burns cannot get into this dense, cooler, wetter, and windless microclimate under most prescribed burning conditions. However, if above ground trunks are killed or heat girdled by a fire in mid summer through early fall, it suckers much less.

There is a word of caution here. At J.C. Salyer NWR in north central North Dakota where aspen groves became so large they merged into an aspen forest, they had to use different methods and their success varied. Thus, if the SNG has similar aspen conditions, contacting that office is suggested.

Drought puts tremendous stress on aspen. From 1987-1989, a severe drought hit northwestern North Dakota that weakened all groves. Prescribed burning following this drought really enhanced our ability to reduce aspen groves.

Native warm and cool seasons

The belt transects completed on Lostwood NWR in recent years across several management units with and without numbers of burns shows a gradual increase in native flora where several prescribed burns and prescribed livestock grazing has occurred.

CONCLUSIONS

What worked in northwestern North Dakota beginning in the late 1970s may not work as well today, particularly when such invasive species like smooth brome has spread so rapidly across much of the northern Great Plains, particularly in woody communities.

There are several different environmental conditions on the DPGs that differ from Lostwood NWR. Most importantly, the DPGs are in better native flora composition and abundance than what Lostwood NWR was in the late 1970s through today, thus will likely take fewer prescribed burns. DPGs do not have a current extensive problem with brome due to the livestock grazing, but beware. Also, three of the DPGs are in a warmer, often drier environment than in the northwestern North Dakota. At SNG, there is greater annual precipitation and the ground waters are very shallow, allowing tree roots to be next to water. At Lostwood NWR, ground waters are readily available to groves that have spread around and into wetlands, but when there is no runoff, ground water retreats and aspen trees no longer have easy access to a water supply and are weakened. Thus, success in aspen and other woody community reductions may vary from that at Lostwood NWR.

APPENDIX B

IMPORTANCE OF DIVERSE MANAGEMENT FOR NATIVE GRASSLAND FLORA AND FAUNA

by Karen Smith

Fires, drought, and grazing by herbivores historically maintained diverse grasslands devoid of large stands of shrubs and trees (Hillman and Jackson 1973, Driver 1987, Campbell et al. 1994, Smith 1995, Bragg 1995). The northern tall- and mixed-grass prairies are no exception to these influences (Higgins 1986, Bragg 1995, Grant and Murphy *Accepted*). Prairie fires historically occurred at different times of the year, different intensities, and varying frequencies over the years. Grazing by bison *(Bison bison)* occurred at varying times in a year, and at different intensities and frequencies over several years. Periodic, year-long rest also occurred in herbaceous grasslands. Prairie management should strive to mimic natural disturbance regimes to take advantage of the pre-selected adaptive traits of prairie endemics. Without doing this, alterations in the native plant communities occur with one group of native species favored or disfavored over the other (Towne and Owensby 1984, Dornbush 2004).

Woody expansion occurs when management does not mimic natural disturbance regimes in the northern Great Plains (McCarty 1967, Owensby and Smith 1972, Samson and Knopf 1994, Bragg 1995, Grant et al. 2004). This slow and gradual change has gone basically unnoticed by many observers. Properly timed prescribed burns at appropriate frequencies can reduce woody plants (Svedarsky and Buckley 1975, Anderson and Bailey 1980, Bailey et al.1990, Madden et al. 1999). Properly timed prescribed grazing at appropriate frequencies is important to maintain the health of the herbaceous grasslands and help reduce some woody species (Platou and Tueller 1985, Bailey et al. 1990, Bragg and Steuter 1995). However, without fire, most grazing systems eventually result in woody expansion on the northern Great Plains (Wright and Bailey 1980, Collins and Barber 1985, Smith 1995).

The effect of woody expansion on grassland wildlife is well documented (Berger 1989, Grant et al. 2004). Plains sharp-tailed grouse decline with the loss of herbaceous grassland habitats. Increasing hardwood draws within 1 km of dancing grounds in northeastern Montana caused a decline in the number of lekking males on the associated dancing ground (Swenson 1985). Density of displaying males in Alberta was inversely related to total coverage of quaking aspen within a 0.8 km of the dancing grounds (Moyles 1981). In Manitoba's aspen parkland, dancing grounds were abandoned when the area predominated by grasses fell below 58 percent (Caldwell 1976). Aspen expansion causes male plains and prairie sharp-tailed grouse to abandon dancing grounds. Subsequently, males abandon dancing grounds when females do not attend.

Greater prairie-chickens are also adversely affected by expanding woody communities. In southwestern Missouri, nest success declined substantially when woody cover at nests exceeded 5 percent (McKee et al. 1998). In western Minnesota, excessive litter and brushy components were detrimental to nest success (Svedarsky 1979). In northwestern Minnesota, landscape patterns around booming grounds had smaller amounts and smaller patches of forests, and no traditional booming ground was located within 1.6 km of a forest patch > 30 ha (Merrill et al. 1999). On the SNG, woody encroachment was identified as contributing to greater prairie-chicken decline (Kobriger et al. 1987, Jensen 1992, McCarthy et al. 1996).

Sage grouse nesting habitat is identified as sagebrush canopy cover from 15 - 40 percent at about 40 - 80 cm height and with >18 cm residual grasses (Crawford et al. 2004). Nearby areas with abundant forbs for brood habitat are also needed. If other woody species (shrubs and trees, specific species mentioned was juniper) increase, the area will become less attractive to these birds.

Other grassland-sensitive avian species are adversely affected by a gradual alteration of grassland to woody dominance (Samson and Knopf 1994, Madden et al. 1999, Bakker et al. 2002, Grant et al. 2004). Sprague's pipit nest sites had higher grass and sedge cover and low shrub cover (Sutter 1997, Madden et al. 1999, Grant et al. 2004). Baird's sparrows are adversely affected by increasing dense woody communities (Arnold and Higgins 1986, Johnson et al. 1998, Madden et al. 1999, Winter 1999, Grant et al. 2004). The number of bird species negatively affected by woody plants increased as vertical structure of woody plants changed from brush to tall brush and aspen woodland. Grasslands became unsuitable to nine grassland species as woodland cover exceeded 25 percent in north central North Dakota (Grant et al. 2004). The authors warn that woody species expansion is threatening the existence of grasslands in the northern mixed-grass prairies. Other authors (Samson and Knopf 1994) warn more grassland wildlife species will be listed under the Endangered Species Act as grasslands are further degraded or destroyed.

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APPENDIX C

BLACK-TAILED PRAIRIE DOG CONTROL

by Rod Heitschmidt and Lance Vermeire

Recreational shooting has been shown to reduce prairie dog densities and impair colony expansion (Vosburgh and Irby 1998). Likewise, colony expansion has also been limited by sterilizing prairie dogs with a synthetic estrogen, diethylstilbestrol (DES) (Garret and Franklin 1983). DES-dosed oats were fed during the peak breeding period and caused complete reproductive failure, but the effects lasted for that season only. Further work with hormonal reproductive inhibitors has not been pursued because they accumulate in tissue and may affect predator populations (Fagerstone and Ramey 1996).

Franklin and Garrett (1989) erected 1-m tall visual barriers adjacent to an active colony and reduced prairie dog use by 61 percent. However, use of the control site increased 97 percent as prairie dogs moved to areas without barriers. Attempts to contain a colony with a cement wall at MacKenzie Park in Lubbock, Texas, have been less than successful because prairie dogs burrowed under the wall and resurfaced outside of the enclosure (Lance Vermeire, personal communications).

Grazing deferment, or postponed grazing, can create a broader, vegetative barrier. Removing cattle and allowing only light grazing by bison increased the stature of vegetation and led to complete abandonment of a large colony in Oklahoma (Osborn and Allan 1949). Four years of deferred summer grazing in Kansas reduced a 45-ha colony to 5 ha (Snell and Hlavachick 1980). When the pasture was restocked, cattle congregated near the prairie dogs and the colony expanded, but a single summer of deferred grazing with good growing conditions reduced the area back to 5 ha (Snell 1985). Although prairie dogs on ungrazed sites in South Dakota increased 4 percent for each of 10 years, the rate was 20 percent per year on grazed sites and burrow density increased twice as fast (Uresk et al. 1982). Cable and Timm (1988) controlled colony expansion with two years of summer deferment in shortgrass and mixed prairie. Colony area in deferred pastures did not change the first year because drought limited vegetative production, but grazed colonies increased 25 percent the second year and those in deferred pastures decreased 37 percent. The deferments also reduced prairie dog birth rates and population growth. In this case, growing-season deferment was sufficient for effective control. Most colony expansion takes place from June through August (Franklin and Garrett 1989).

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APPENDIX D

DROUGHT MANAGEMENT STRATEGIES FOR NATIONAL GRASSLANDS

by Rod Heitschmidt

INTRODUCTION

The key to an effective drought management strategy is that management tactics be largely proactive rather than reactive and that they significantly reduce economic and ecological risks. Too often, drought management strategies center on doing nothing until available forage is essentially zero. The objectives of this section are:

1) To provide a broad overview of potential ecological and economic consequences of drought in this region;
2) To briefly outline the underlying concepts and principles used in developing a very simple, rangeland-based, drought management decision support system;
3) To discuss the potential merits of using such a system in the management of the DPG; and
4) To provide some insight into potential management actions for ameliorating the adverse effects of drought on the ecological health and well-being of grassland ecosystems and the associated economic well-being of a ranching enterprise.

ECOLOGICAL AND ECONOMIC CONSEQUENCES OF DROUGHT

From an ecological as well as a practical viewpoint, it is important to remember that drought is an inherent property of grassland/rangeland ecosystems, and the DPGs are no exception. Research from a broad array of grassland/rangelands shows drought can reduce herbage production by 50 percent with even greater declines occurring as grazing intensity increases from light to heavy (Branson 1985, Holechek et al. 1989). It is generally agreed, however, that climate is the main variable affecting primary productivity and grazing is the secondary variable. The classic Great Plains descriptive studies of the 1930's by Weaver and Albertson (1939, 1940, 1944) and other more recent studies in the Northern Great Plains (Olson et al. 1985, Biondini et al. 1995, Biondini and Manske 1996) clearly show that climate is the primary variable affecting structure and function of Great Plains grasslands. The amount of precipitation and its distribution over time are the primary factors. Still, grazing intensity does impact both primary and secondary productivity of Northern Plains' grassland/rangelands (Black 1937, Lewis et al. 1956) with light to moderate rates of stocking enhancing primary and individual animal productivity.

The effects of drought on wildlife are also important considerations in any discussion of drought. Too often, grassland/rangeland managers focus their attention only on management of livestock for the well-being of the livestock and subsequently the economic well-being of the manager. From an ecological perspective, this is risky simply because failure to consider the detrimental effects of drought and the associated drought management strategies and tactics on wildlife may reduce the overall health and well-being of a grassland ecosystem. Consider, for example, the potential impacts of drought on wildlife if a "first-use" drought management strategy is employed whereby all available forage is harvested (i.e., grazed) for livestock production. The resulting effect is that little or no forage remains to support wildlife in terms of providing needed vegetation structure for nesting, brood-rearing, escape from predators, and as a food source. As a result, the ecological balances required to maintain diverse and healthy grassland may be lost and the risk of serious, long-term ecological damage increases.

On-the-other hand, the economic impacts of drought are certainly linked to the ecological impacts as they relate to primary productivity. Obviously, as the severity of drought increases, primary productivity decreases as does secondary productivity and subsequently profitability (Conner 1990). Heitschmidt et al. (1990) showed that net returns on a per cow basis were on the average greater at moderate ($70) than heavy rates ($61) of stocking whereas net returns on a per acres basis were, on the average, greater at heavy ($5.35) than moderate ($4.50) rates of stocking. However, during the six-year study, the economic risks during drought were much greater at the heavy than moderate rate of stocking. For example, returns per cow ranged from +$14 to +$109 at a moderate rate of stocking and from -$18 to a +96 at a heavy rate of stocking. Likewise, returns per acre ranged from +$4.90 to +$7.00 at a moderate rate of stocking and from -$1.25 to +$8.60 at a heavy rate of stocking.

In the end, the key to an effective drought management plan is balance: balance between ecological and economic risks. During periods of extended drought, the goal of management personnel should center on reducing ecological and economic risks rather than attempting to optimize/maximize secondary (i.e., livestock) productivity.

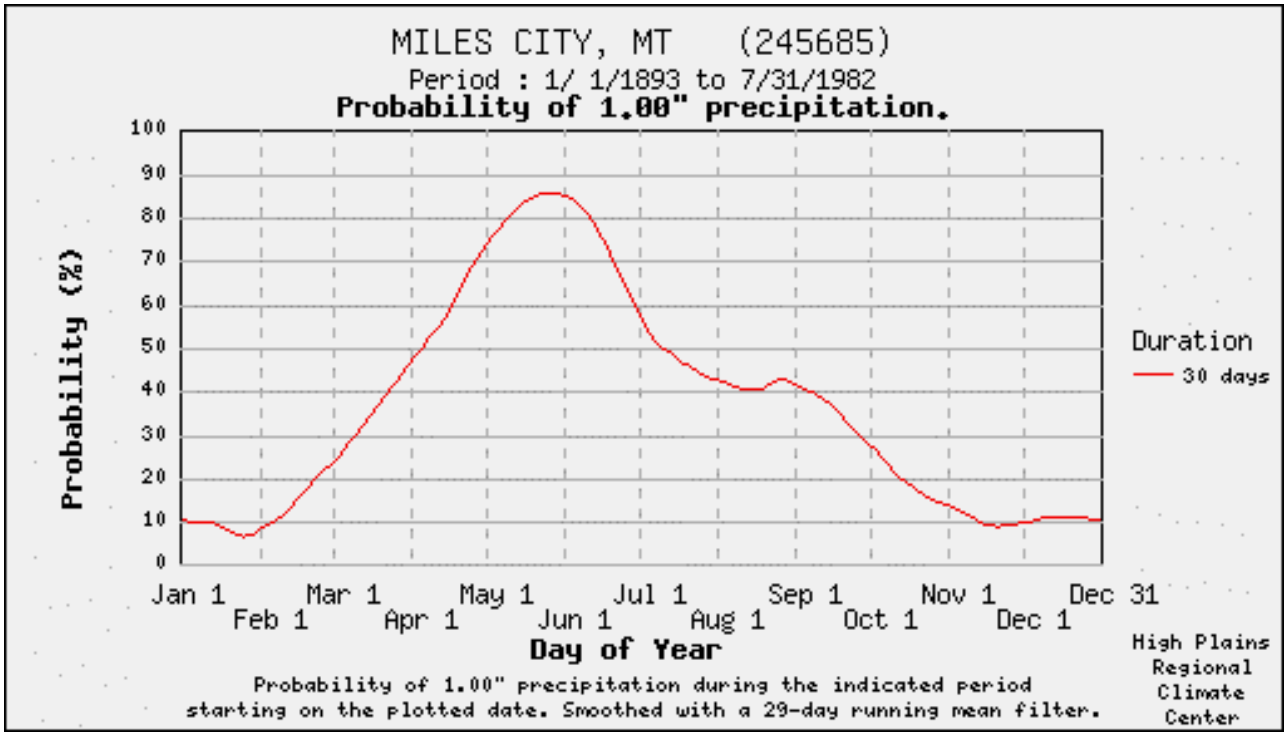
DECISION SUPPORT SYSTEM

A Decision Support System was developed at the Fort Keogh Livestock and Range Research Laboratory near Miles City, Mont. (Heitschmidt and Vermeire 2005). Data used in developing the model included correlation and regression analyses between monthly precipitation values and annual herbage production estimates (Kruse 2002), and estimates of annual herbage accumulation rates (Heitschmidt et. al. 1995, 1999, 2004). Published (http://hprcc.unl.edu/index.html), site specific, monthly precipitation values were then incorporated into the system to further enhance its predictive capacity.

Data analyses showed that herbage production was positively linked to the amount of precipitation received in April, May, and the previous year's December. The December linkage was considered a spurious correlation that had little biological meaning. This is particularly evident when considering that December precipitation is largely snow and averages < .50 inches which is less than 4 percent of total average annual precipitation. Regression analyses showed that 87 percent of the variation among years in annual herbage production could be explained by the amount of precipitation received in April and May plus the previous year's October and November.

Analyses of 14 data sets collected across 11 years, revealed that on the average 35 percent, 69 percent, and 91 percent of perennial grass production is completed in this region by May 1, June 1, and July 1, respectively. The 91 percent completion by July 1 was quite consistent as reflected by a standard deviation of only 12 percent. This in turn implies that in 19 out of 20 years (i.e., 95 percent confidence), a minimum of 67 percent of perennial grass production will be completed by July 1.

Further confidence in these analyses can be garnered when considering the rainfall probabilities during the remainder of the growing season. For example, the probability of Miles City receiving 1.0 inches of precipitation in July, August, or September is about 58 percent, 42 percent, and 42 percent, respectively. These probabilities decline even further when considering 2.0 inches of precipitation (i.e., 23 percent, 17 percent, and 15 percent, respectively) (Fig. 1).



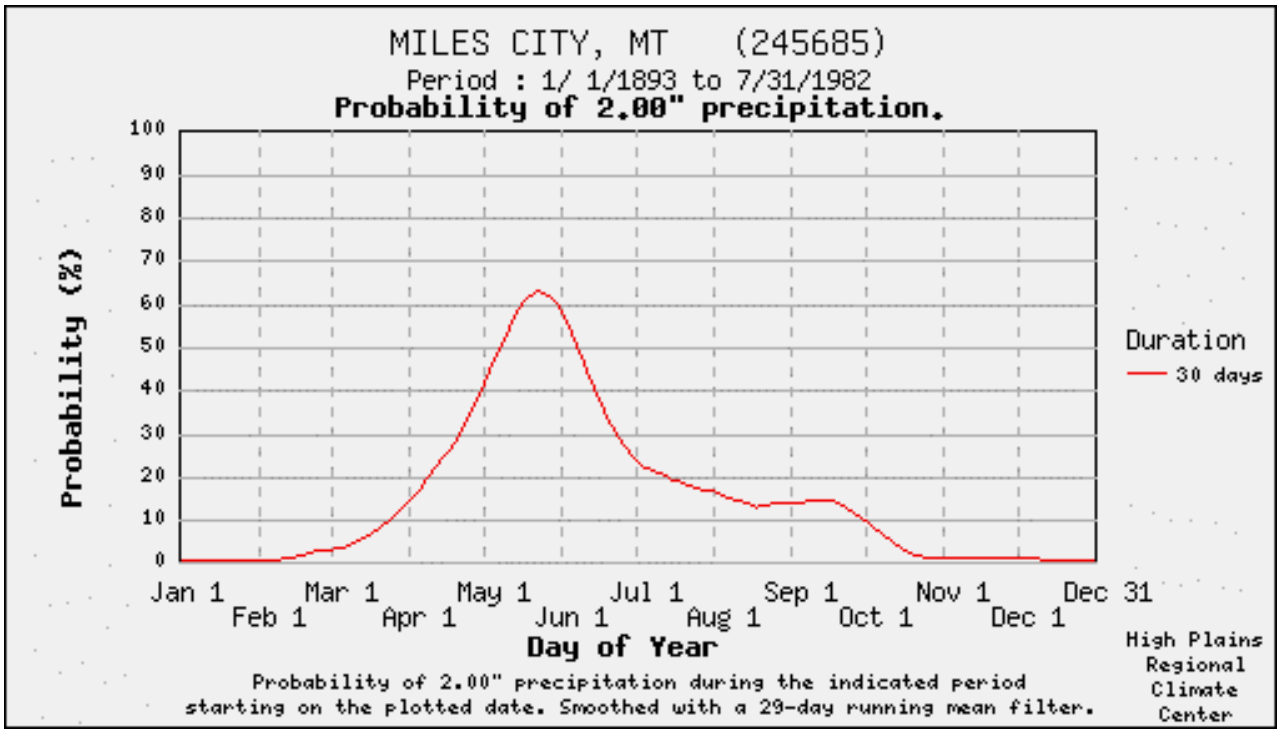


Figure 1. From http://hprcc.unl.edu/index.html.

From these analyses, it is apparent that the opportunity to grow substantial amounts of forage after July 1 is limited. Thus, proactive stocking rate adjustments can be made with considerable confidence by early July in this region, thereby reducing ecological and economic risks that arise from late season forage demand/availability imbalances.

APPLICATION OF MODEL TO DAKOTA PRAIRIE GRASSLANDS

The growth dynamics in the western regions of the DPGs are similar to those in Miles City with annual production linked closely to spring precipitation (Singh et al. 1982) but slightly less so than at Miles City. The specifics regarding each location are discussed below.

Little Missouri National Grassland (LMNG)

Herbage production in LMNG is slightly greater than in the Miles City region largely because the annual growing season precipitation is slightly greater. Average annual precipitation at Miles City is 13.48 inches as compared to 14.77 inches in Medora and 15.28 inches in Watford City. Some temporal shifts in precipitation patterns also exist. About 46 percent of Miles City's annual precipitation falls in April, May, and June compared to 45 percent and 43 percent for Medora and Watford City, respectively. Similarly, there are slight shifts in summer precipitation. About 29 percent of Miles City's annual precipitation falls in July, August, and September compared to 33 percent and 34 percent for Medora and Watford City. Also, the probabilities of receiving substantial summer precipitation are slightly greater in Medora (Fig. 2) and Watford City (Fig. 3) than Miles City (Fig. 1). Still, the general patterns are the same in that the probability of receiving substantial rains after July 1 are considerably less than before July 1. Thus, it seems reasonable to assume that normally more than 75 percent of perennial grass production is completed by July 1 when averaged across the entire LMNG and probably more than 85 percent is completed by August 1. Thus, as at Miles City, the proposed drought management model has considerable merit particularly as the season proceeds toward August 1.

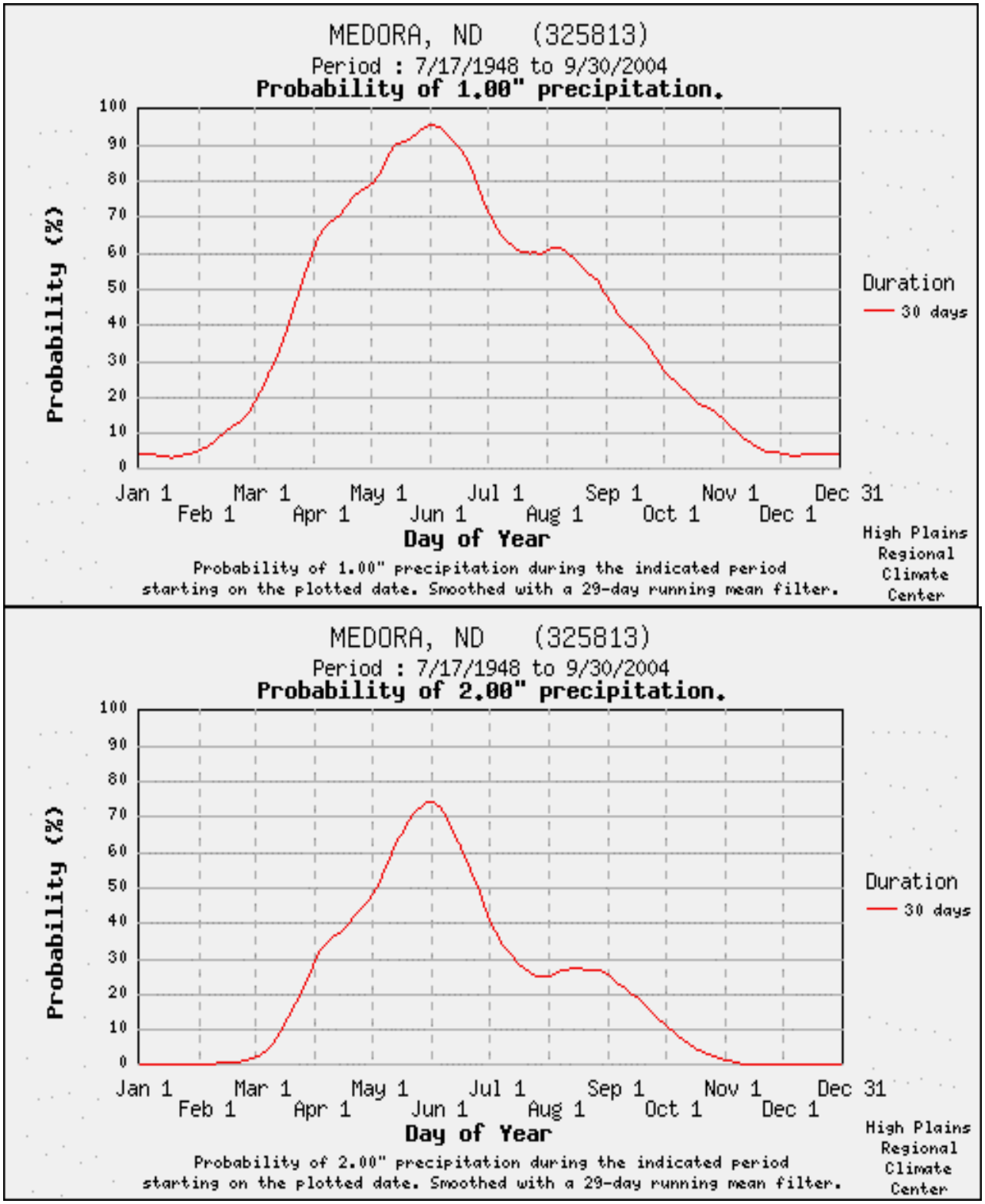


Figure 2. From http://hprcc.unl.edu/index.html

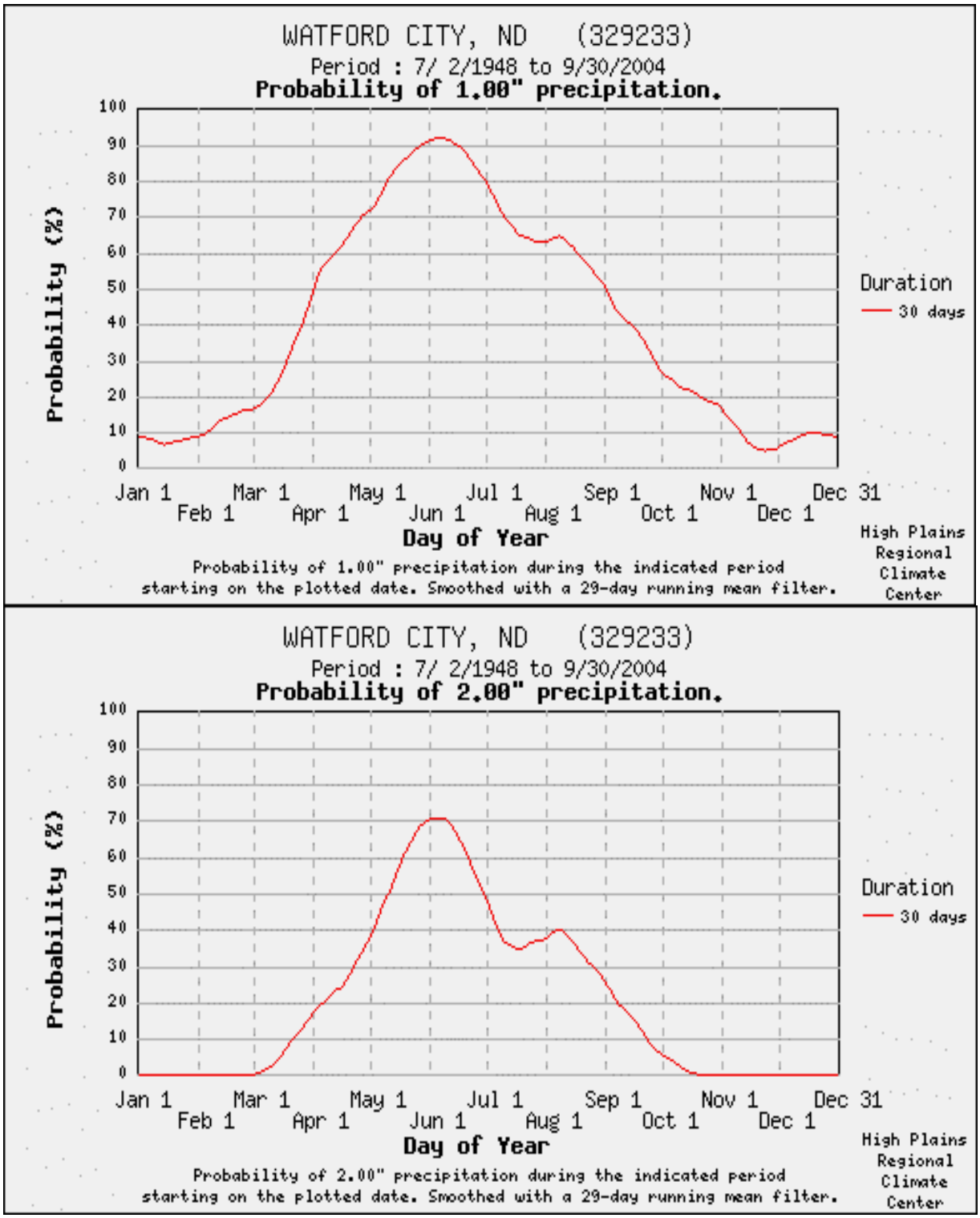


Figure 3. From http://hprcc.unl.edu/index.html.

Grand and Cedar River National Grasslands

Certainly, the model does not work as well in this region as in the more xeric (i.e. dryer) areas to the north and west. Using Lemmon, S.D., as our climate standard, we found that total annual precipitation averages 17.44 inches and of this total, 44 percent is received during spring which is similar to Miles City (46 percent), Medora (45 percent), and Watford City (43 percent). However, the amount of summer precipitation received (5.75 inches), the proportion of the annual total (41 percent), and the probability of receiving substantial summer precipitation (Fig. 4) were substantially greater at Lemmon than the other locations. Still, the patterns were quite similar to the Miles City, Medora and Watford City locations as probabilities always peaked in June before rapidly declining into fall with major declines associated with ever increasing amounts of expected precipitation. Thus, although the model is not as robust in these grasslands as the LMNG, it does have considerable merit as an early to mid-summer drought management tool.

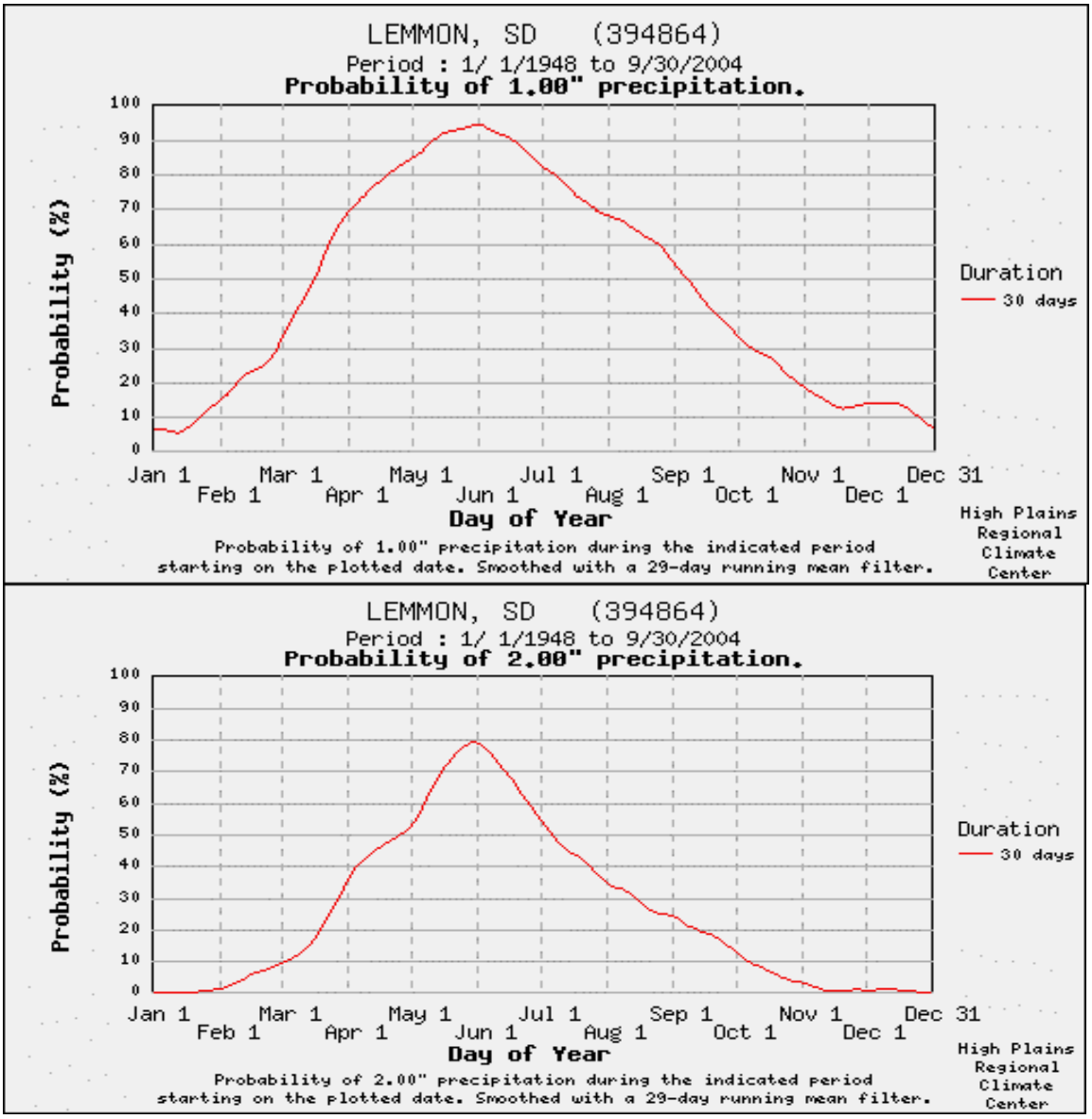


Figure 4. From http://hprcc.unl.edu/index.html..

Sheyenne National Grasslands (SNG)

The SNG are more mesic (i.e. wet) than the rest of the Dakota Prairie National Grasslands with total annual precipitation averaging almost 20.0 inches (e.g., 19.82 inches at Lisbon, N.D.). Moreover, distribution of precipitation over time is very similar to the GRNG and CRNG with 40 percent of the annual total received in spring and 37 percent during summer. Similarly, rainfall probabilities are slightly higher than previous locations (Fig. 5). Thus, the effectiveness of this model as a drought decision support tool in the SNG is limited at least until mid- to late August, after which growing conditions become sub-optimal because of both reduced amounts of precipitation and cooler temperatures.

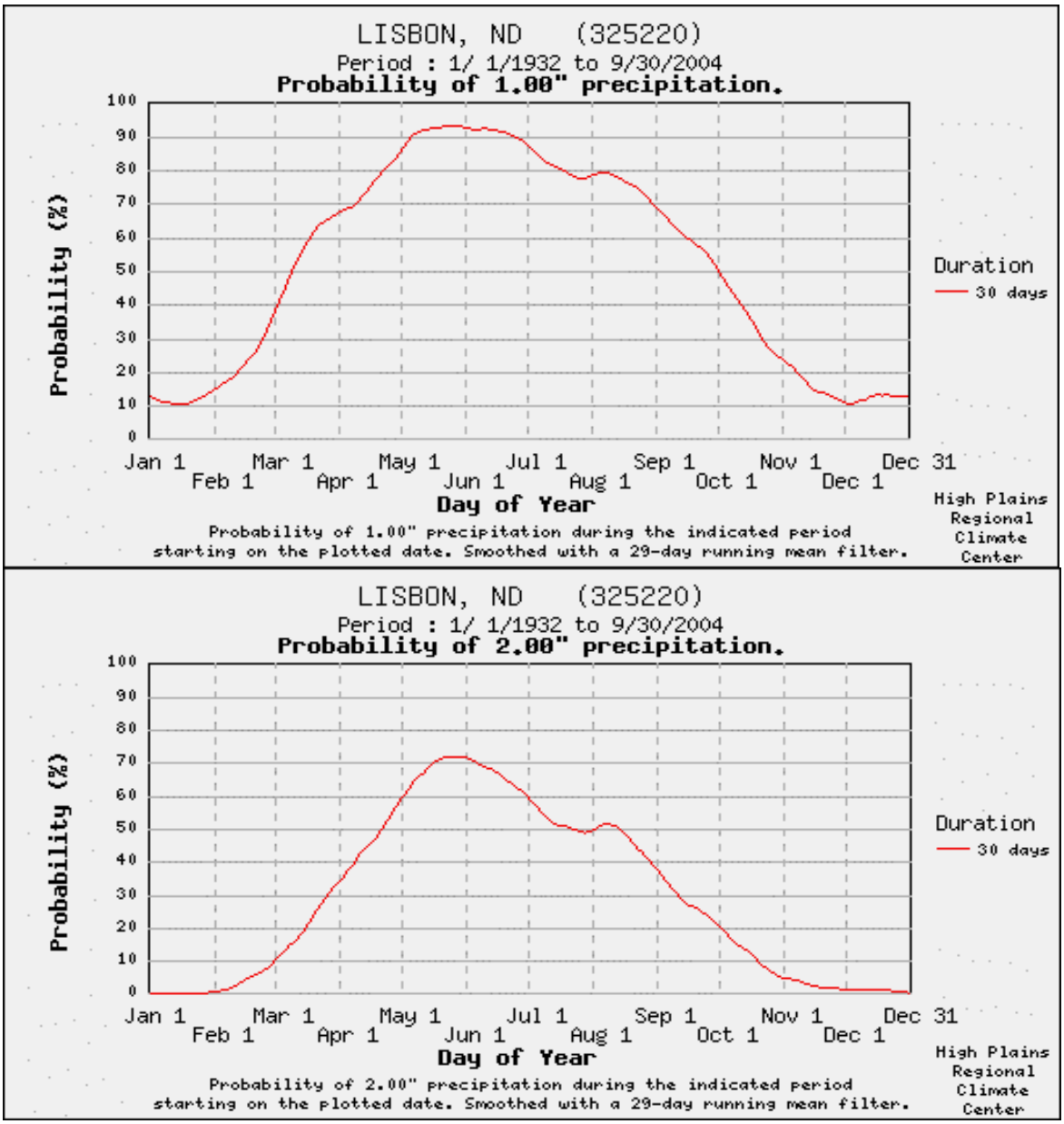


Figure 5. From http://hprcc.unl.edu/index.html.

POTENTIAL RISK REDUCTION DROUGHT MANAGEMENT TACTICS

A wide array of tactics can be employed to reduce the effects of drought on the ecological and economic well-being of a ranching enterprise. However, the preferred action will vary depending upon the specific financial conditions and desires of owners and managers. Four suggested tactics are:

1. Maintain a permanent herd size that eliminates the need to de-stock under all drought conditions, except the most severe, and either add put-and-take yearlings to the herd or lease land (i.e., recognized as not an option on National Grasslands) to other grazers as appropriate. This strategy needs to incorporate sufficient management flexibility so decisions can be made on an annual basis.

2. Wean off-spring early as research has shown weaning calves at 90-days of age and moving them to a feedlot provides greater gross margins than leaving calves on cows and feeding cows (Kruse 2002).

3. Cull heavy and early (i.e., early summer) to reduce future forage demand.

4. Lease grazing lands elsewhere. During drought, management can either take animals to feed or take feed to animals. Remember: feeding animals during drought is not supplemental feeding rather it is substitute feeding (i.e., feeding in place of managing so as to have enough forage available to maintain the herd). Seldom will substitute feeding provide a positive return.

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