Grazing Management for Wildlife Benefits

A Planning Framework Using Integrated Ecological Tools for Development of Wildlife-Oriented Grazing Strategies

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Many traditional rangeland and domestic livestock management guidelines have focused on uniform livestock distribution, often causing simplification of heterogeneous landscapes, with a goal of improvement/maintenance of rangeland function at “climax” conditions. Often it is assumed that proper rangeland management parallels proper management of the wild animals utilizing rangeland habitat. However, wildlife benefits derived from the ecological conditions created by various grazing strategies are typically limited and largely coincidental. This paper will examine 1) the concept of spatiotemporal heterogeneity and its value to wildlife, 2) how existing tools could be integrated to support wildlife-oriented rangeland planning, 3) how these concepts and tools could be applied with a planning framework, and 4) recognition of some limitations with possible opportunities for refinement and future research.

Introduction

The livestock-wildlife conundrum

"A conflict that was once centered on livestock and wild ungulates and confined to the West has expanded to include all forms of wildlife, and has become a national issue." (Severson and Urness 1994)

For decades, rangeland professionals have grappled with the apparent contradictions encountered when both livestock production and wildlife conservation are considered simultaneously; yet, there is still no consensus with regard to the compatibility – or lack thereof – between management strategies for domestic and wild animals. As an example, the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) implemented a program in 2006 targeted at landowners deemed to have achieved "high" levels of land management with consideration for a multitude of resources. One criterion for the program asked the question: "Does the landowner implement an intensive grazing program to maximize wildlife benefits?" In this case, it was assumed that ideal livestock management (as defined by NRCS standards) translated directly into ideal wildlife management; however, the uncertainty remains as to whether such management will truly "maximize wildlife benefits."

Not only will this question of compatibility continue to linger, but will likely move from a largely academic forum into the forefront of future sociopolitical discussions. Increased public interest has brought about a proliferation of programs and legal instruments such as open space agencies, conservation easements administered through a variety of governmental and private entities, and non-governmental organizations addressing wildland-urban interface concerns (Blackburn and de Haan 1998). Many of these efforts are focused on retaining existing land uses (e.g. beef production) while exploiting the potential for complementary effects, which oftentimes means finding ways to reconcile essential agricultural activities with conflicting interests.

The ranching industry is uniquely suited to provide opportunities for resolution through the pervasive influence of domestic livestock grazing which can be managed to indirectly manipulate landscapes.

Grazing as a management tool

"Grazing-induced changes in the structure and composition of plant communities can benefit some wildlife species while adversely affecting others." (Kie and Loft 1990)

Simplification of complex systems and uniformity of grazing effects have long been the objectives of many traditional grazing principles (Fuhlendorf and Engle et al. 2001). In doing so, many of the historically complex attributes of rangelands utilized by the full spectrum of wildlife are diluted or diminished (Guthery et al. 1990). Likewise, even deliberate, well-intentioned management practices targeted at a threatened species may have a similar effect in that focus is inescapably diverted away from other species which, in turn, may then experience population declines themselves.

Nevertheless, production and maintenance of seral mosaics to accommodate the habitat requirements of an assembly of wild species may be achievable with livestock, and domestic grazing can serve to influence rangeland processes, landscape mosaics, and seral transitions (Kie and Loft 1990; Severson and Urness 1994; Hobbs 1996). The connection linking seral heterogeneity to grazing management can be found in the differential effects that livestock grazing imparts on rangeland structure and function as a result of the ways landscape, animal selectivity, and management actions affect grazing behavior. This notion is not new and was addressed at length decades ago by Leopold (1933) when he stated that, "game can be restored by the creative use of the same tools which have heretofore destroyed it – axe, plow, cow, fire, and gun," and examples of this concept in practice can be found throughout the literature in various forms. For example, Boyd et al. (1997) discusses the use of grazing to create habitat mosaics to maximize bird diversity. More recently, the Forest Service (USDA/USFS 2006) used grazing management as a means to manipulate grassland structure to influence prairie dog movement, as well as maintain habitat for associated species (e.g. burrowing owls.) Examples such as these provide evidence that the judicious application of grazing effects to produce a desired heterogeneous condition could expand benefits to include more wildlife species.

Towards a solution

"No effort has been made to integrate spatially discrete disturbances into management of native grasslands." (Fuhlendorf and Engle 2004)

Land managers may influence ecosystem processes via control of grazing livestock wherein existing conditions and seral “trajectories” towards future conditions are not random, and may be deliberately – if indirectly – managed (Holechek et al. 1982; Kleyer 2007). The elements of control which can be derived from various planned grazing strategies means that management benefits realized by wildlife need not be utterly coincidental (Leopold 1933). With this in mind, this paper will ultimately propose a means by which a rangeland planner and/or land manager may utilize existing NRCS tools to formulate a wildlife-oriented approach.

Considering the wealth of prior research and rhetoric which has taken place regarding this topic, the intentions of this paper – the similarities and differences with past discussions – should be kept in mind. In contrast to earlier efforts, the focus is on overall seral conditions including (but not specific to) community attributes such as structure, composition, or nutritive quality. Discussion is from a strategic perspective with limited reference to grazing systems *per se* (tactics), economics, grazing behavior, or vegetation responses. There is no intent to “critique” existing NRCS tools or the scientific veracity of the underlying data; tools and data will be used “as-is” for demonstration purposes only.

Landscape Heterogeneity

The Big Picture

"Assumptions should not be made that any particular land use will not support elements of biodiversity in some way." (McIntyre 2007)

A primary point of contention driving livestock-wildlife conflicts is the matter of grazing effects on landscape heterogeneity. These effects can be measured at various scales, ranging from a few meters up to regional areas spanning many square miles. Therefore, before discussing landscape *heterogeneity*, the notion of a "landscape" should first be described.

Farina (2000) provides a definition of the landscape concept as, "…a spatial configuration of patches of dimensions relevant for the phenomenon under consideration." With regard to wildlife, the life history of any particular species or guild "under consideration" would determine the "relevant" scale. However, in his discussions on landscape *heterogeneity*, Farina expands on this definition to include, "…the physical and functional context in which ecological processes and related organisms take place at different spatial and temporal scales." The vital implication herein is that a landscape is manifested as a mosaic of both tangible (structural) and intangible (functional) attributes which exert an influence on species inhabiting a certain area (spatial), at certain times (temporal). While landscape ecologists traditionally delineate landscapes based strictly on biological processes, landscape scale as applied in this discussion will be largely driven by the parameters of NRCS ecological models, ownership boundaries, and pasture configurations.

The term "heterogeneity" itself is often used synonymously with the terms "patchiness," "mosaic," and "habitat diversity" (Farina 2000). This is a broad term that can refer to any attribute at any scale, and has been used in the past to describe specific site characteristics including structure, composition, and forage quality. Thus, the particular application of this term must be considered in any instance. The important point to consider is that heterogeneity of a host of landscape attributes has been a historical characteristic of many rangelands which typically benefits a range of wildlife species (West 1993). In the context of this discussion, heterogeneity will refer to *seral* classifications (as denoted by NRCS state-and-transition models,) although other attributes more commonly discussed in the literature (e.g. structure and species composition) will be implied through the general characteristics of a given seral state.

The Value of Heterogeneity

"Heterogeneity may actually be the root of biological diversity at all levels of ecological organization and should serve as the foundation for conservation…"
(Fuhlendorf and Engle 2004)

Simply recognizing that landscape heterogeneity is an inherent landscape attribute and understanding the concepts defining it does not necessarily provide any basis for actually striving to include it as a management objective; however, there are compelling rationales as to why it should be considered. West (1993) provides four reasons advocating the importance of biodiversity. These can be easily translated into a landscape heterogeneity context, and can be briefly defined as:

1. Morality – As stewards of the land, it has been argued that humans have an inherent moral responsibility to conserve the resources without assigning values in a strictly monetary sense;
2. Aesthetics – Acknowledgement that human quality of life is, at least to some degree, enhanced by a healthy environment;
3. Economics – Maintenance of resources which provide some means of income through production of food, fiber, and fuel;

4. Ecological services – Natural functions and processes of ecological systems which benefit the human population (e.g. flood attenuation, pollination, biological controls, trophic balance.)

Focusing on the more practical aspects, managers must consider that their objectives may change over time, and retention of all types of diversity will keep options open for future decisions. It was in this spirit that that Leopold (1991) stated, "to keep every cog and wheel is the first precaution of intelligent tinkering." Furthermore, the notion of "multiple use" is a not only a common goal of rangeland management in general, but also statutory directive shaping many federal environmental policies, planning processes, and conservation activities (Holechek et al. 1982; Heady 1996).

A variety of metrics are used to quantify biological conditions (e.g. species richness, diversity, and frequency) but simplified analyses of ecological conditions which reduce a complex reality to a few numbers can be misleading. As a general rule, the majority of wildlife species are uncommon, and not all species are equal with regard to their importance in ecological function or "quality" (West 1993). Thus, a single metric such as the total number of species (i.e. richness) alone is a poor gauge of ecological health (Blackburn and de Haan 1998). To truly address the intrinsic complexity of faunal rangeland communities, more emphasis could be placed on the creation and maintenance of landscape heterogeneity via robust planning processes which , "…must take into account a broad range of biota, and not be based on models of limited taxonomic scope" (Driscoll 2007). Grassland birds serve as an excellent example of the ecological value of a diverse landscape, and the resultant biodiversity (Figure 1).

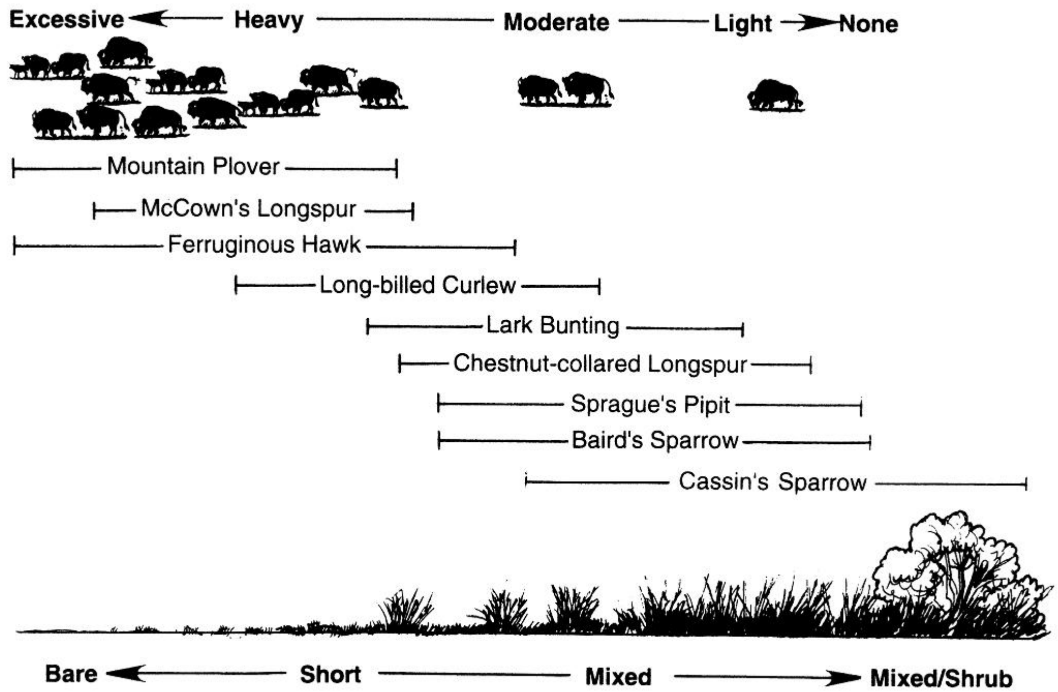


Figure 1. Expected occurrence of grassland birds as related to vegetative community structure (from Knopf 1996).

Adding the temporal aspect

"Conserving species at all localities requires local succession processes to be reset frequently." (Kleyer 2007)

Successful development of mosaics is often regarded in the literature as a "spatially-fixed" phenomenon, but temporal variation can be an important aspect (Fuhlendorf and Engle 2004). Temporal habitat arrangement and availability is frequently discussed in the context of seasonal requirements within time frames of one year or less (e.g. spring breeding, summer water, fall food, winter cover); however, habitat management constrained by such short time frames is largely limited to ephemeral structural modifications. Expanding the temporal scale to encompass multiple years would open the door for strategies aimed at longer-term manipulation of ecological function.

In 1979, Bormann and Likens introduced a forestry concept dubbed the "shifting mosaic steady state" (SMSS) as an expansion on the original Clementsian successional model in which the "climax" state may be persistent on a larger (landscape) scale, but rarely locally. Otherwise defined as the condition wherein, "the proportion of the ecosystem in states A, B, and C remains more or less constant in time, but the state of any individual plot may change…" (Bormann and Likens 1979). The implication is that climax is not a static condition, disturbances do not cease, and successional processes continue to occur locally. However, Bormann and Likens' models were specific to forests and often involved time frames of several hundred years which would be utterly meaningless to a rangeland planner. Nevertheless, the fact that many grasslands have an evolutionary history of grazing may actually ease implementation of SMSS principles due to a "greater margin of error" (Severson and Urness 1994).

The relatively dynamic processes of many grasslands (as compared to forestlands) make creation and maintenance of diverse plant communities a feasible activity occurring on a temporal scale meaningful to managers. It appears that only Fuhlendorf et al. (e.g. 1999, 2001, and 2004) has explicitly examined the practical application of the SMSS concept on rangeland with the premise that, "…diverse grassland faunal communities require heterogeneous landscapes that can best be described as a shifting mosaic…" (Fuhlendorf and Engle 2004). However, these references addressed the combined effects of both grazing and fire on tall-grass prairie, which is shaped largely by environmental conditions and fire intervals vastly different from other communities, such as shortgrass steppe. In areas where fire has historically been less important as a disturbance, or where socio-legal constraints limit the use of fire as a management tool, differential grazing can be an effective means to create spatiotemporal patchiness (Vercauteren and Gillihan 2004).

Grazing Considerations

Continuous grazing

"Reliance on fortuitous events is not a practical way to manage wildlife habitats." (Severson and Urness 1994)

"Continuous grazing" is defined as a system under which livestock "have unrestricted and uninterrupted access throughout the time period when grazing is allowed" (SRM 1998). This does not necessarily imply yearlong grazing, but may include seasonal timing; however, specific parameters (e.g. duration of graze period, stock density) which might otherwise explicitly denote a continuous grazing system are not included in the definition. As such, it may be more appropriate to label a management system as "continuous" through examination of the induced grazing behavior. Vavra (2005) offers that the term "continuous grazing" implies a scenario in which livestock selectivity is allowed to create preferred foraging areas which are subjected to recurrent use due to a particularly attractive set of conditions, while other less attractive areas within a pasture are avoided. Similarly, Fuhlendorf and Engle (2004) describe permanently situated patches where grazing pressure is focused locally. Arguably, this inherent variability produced through livestock selectivity may be construed as a simple means of habitat patch creation, rendering pasture subdivision (i.e. cross fence) unnecessary – even detrimental – in the context of wildlife management (Table 1).

Table 1. Spatial variability as related to various grazing strategies and alternative practices (from Fuhlendorf and Engle 2001).

Spatial variability of management units	Homogeneous	Heterogeneous	Shifting mosaic
Traditional rangeland practices			
Continuous grazing		X	
Rotational grazing	X		
Herbicide application	X		
Multispecies grazing	X		
Area burns	X		
Improved water distribution	X		
Alternative practices			
Patch burning			X
Patch herbicide application			X
Patch fertilization			X
Focused grazing disturbances			X
Shifting attractants			X

However, closer analysis of continuous grazing effects will show that this may only be true in the short-term as sustainability of the heterogeneous condition is precarious. Over a protracted time frame, conditions will eventually result in reduced selection for preferred grazing areas as attractiveness is reduced, with subsequent preference shifting to other previously underutilized areas. As this cycle progresses, grazing effects once limited to preferred areas may expand until an entire pasture is once again homogeneous, albeit now with the less attractive set of conditions (Urness 1990; Hobbs 1996; Bestelmeyer et al. 2003). Cross fencing and intensive grazing management are a common approach to managing this phenomenon.

Predictability, flexibility, and control

"In managed situations, control of succession or regression is desirable because we do not want random…events to overwhelm or dictate our goals."
(Severson and Urness 1994)

It's unlikely that a stocking rate adjustment on continuously grazed pastures, by itself, will affect grazing behavior to a degree which would influence vegetative community response; however, changes to stock density have been shown to influence grazing behavior, with decreased selectivity correlated to increased stock density, and thus provide a valuable management tool (Augustine and McNaughton 1998, Barnes et al. 2008). Granted, a high stocking rate could, in theory, translate to higher density and thus mitigate selective foraging; however, applying this principle under continuous grazing still will not prevent the ultimate result of a homogeneous landscape as discussed.

On the other hand, low stocking rates, which may conceivably support a sustainable heterogeneous condition, pose challenges with managerial control. At best, this option can only achieve/maintain a static spatial component, with no control afforded towards the temporal component. Additionally, the predictability of plant community response as related to deliberate management actions improves as the magnitude of the disturbance increases (Kleyer et al. 2007), implying that higher stock densities achieved through pasture subdivision would most effectively afford managers control over seral outcomes.

This control also comes with the flexibility needed to apply differential treatments across paddocks over time, such as varying graze/rest period, frequency, or timing of use (Guthery et al. 1990; Severson and Urness 1994). Through this differential management, "grazing distribution is maximized over several years but minimized within individual years," which may allow a livestock manager to create a heterogeneous mosaic while still achieving present and future multiple-use objectives (Fuhlendorf and Engle 2001).

Overgrazing (re)defined

"The issue becomes particularly murky when states are attributed as 'good', 'bad', 'disturbed', 'pristine', 'healthy', etc. Such terms carry the whiff of a moral system that can distort ecological science and conservation outcomes." (Woinarski 2007)

A major obstacle encountered throughout the evolution of the livestock-wildlife debate has been the stigma of "overgrazing." The Society for Range Management (1998) defines this term as, "continued heavy grazing which exceeds the recovery capacity of the community and creates a deteriorated range." However, the great pitfall of rangeland classification may be human perspective, and it's arguably impossible to create one type of habitat without destroying another (Vavra 2005). How does one then define "deteriorated" range? Consider Severson's (1994) point that "overgrazing" is less an ecological event than it is a managerial concern, and the point at which "overgrazing" occurs can only be determined in the context of a particular land manager's goals. Thus, "deteriorated" range might be considered simply as any departure from a desired condition (Urness 1990; Augustine and McNaughton 1998).

Boyd et al. (1997) reiterates that maximum diversity of grassland birds can be sustained by grazing-induced habitat mosaics wherein "decreases in vegetative cover associated with heavy stocking may serve as important habitat for some species…" Depending on the full range of habitats required by fauna utilizing a given parcel of land, it's feasible that a grazing strategy which involves differential pasture treatments might necessarily include a deliberate "overgrazing" component to create and maintain low-seral conditions (Knopf 1996, Samson et al. 2003).

NRCS Models

The NRCS uses a variety of models to guide conservation planning across a broad range of environmental concerns, including range and wildlife. While planning efforts are intended to address multiple resources at one time, these tools are often applied separately without consideration for intrinsic relationships between the natural components of a landscape. Typically, range plans will be developed to address rangeland health and animal performance, while wildlife plans are developed to address the needs of individual species or faunal communities. Conscientious management of rangeland plant communities and seral processes inescapably translates to the management of wildlife food and cover (Leopold 1933); yet current planning methods do not effectively address these resources together. A methodology which is “more holistic than piecemeal, crisis efforts” would allow planners to more effectively manage the resources simultaneously (West 1993).

For the purposes of discussion and demonstration, the tools and data referenced herein are limited to the Weld County, Colorado area.

Wildlife Habitat Evaluation Guides

NRCS uses the Wildlife Habitat Evaluation Guide (WHEG) as the primary tool for wildlife planning, evaluation of baseline conditions, and identification of minimum limiting factors (USDA/NRCS 2008a). Habitat factors are assigned a value from 0 to 1, and summarized as the Habitat Suitability Index (HSI) to provide a relative assessment of the overall habitat value present (or planned) on the site. The principle behind the WHEG scoring system is the concept that a population “source” is a habitat type in which birth rate exceeds mortality, and immigration exceeds emigration such that the overall contribution to a species population is positive, while a population “sink” is the opposite (Farina 2000). An HSI score of .5 or greater implies that the site is a source; a score below .5 implies a sink.

Two kinds of WHEG are available: those limited to a particular species (sometimes also referred to as “Wildlife Species Models,”) and those designed for community-level application considering a variety of species. Unless a specific animal is being targeted for conservation, the community WHEG should be used. The Shortgrass WHEG is commonly used tool on Weld County rangeland, and is intended to cover a broad spectrum of shortgrass species needs. (Note that no WHEG for grassland birds has been developed by Colorado NRCS, although this guild-level information is crucial for this discussion. Information from an agency technical note will be used instead.) Refer to Exhibit 1 for review of relevant WHEGs in their entirety.

State-and-Transition Models

For rangeland planning, the NRCS has developed Ecological Site Descriptions (ESDs) which contain a variety of information relating to recurring plant communities in areas with common topoedaphic, hydrologic, climatic, and biotic attributes (USDA/NRCS 2008b). These include four sections which are of special interest to this discussion:

1. Historic Climax Plant Community (HCPC) species composition;
2. State-and-Transition (S&T) model;
3. Plant Community Narratives;
4. Animal Community – Wildlife Interpretations.

A state-and-transition (S&T) model is a “practicable way to organize information for management” by illustrating relationships between seral conditions, the external drivers (natural or artificial), and the expected outcomes (Westoby et al. 1989). The simple act of categorizing an area with an ESD implies that it comprises a recurring and recognizable suite of structural and functional characteristics, and that management influences exerted on a particular system will have some degree of predictability (Bestelmeyer et al. 2003).

In contrast to the Clementsian model of continuous, linear succession which recognizes only the climax community as the consummate and inevitable condition, S&T models account for alternate stable states which may occur on a site (Briske et al. 2005). Bold lines indicate thresholds, connoting an ecological shift requiring time frames which may be so protracted as to be meaningless in a managerial sense. Arrows indicate transition pathways with the drivers associated with transition progression (although further insight into management drivers can be gleaned from the Plant Community Narratives.) The Clementsian model may still apply within and between groups of stable states (Briske et al. 2003).

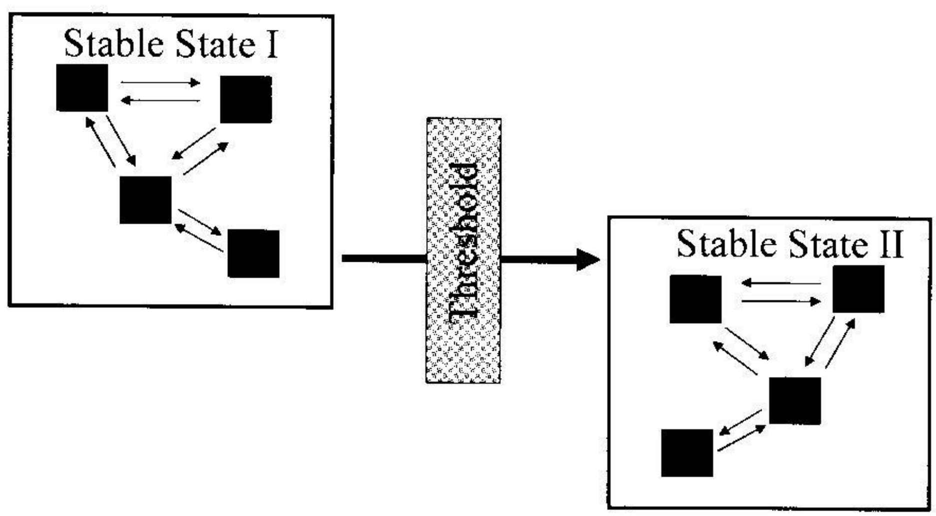


Figure 2: Generic example of an S&T model (from Briske et al. 2005).

There are 24 ecological site descriptions available for Major Land Resource Area (MLRA) 67B which cover the Weld County area. Specifically, the “Loamy” and “Sandy” ecological sites are very common in Weld County, and their ESDs are often utilized for rangeland planning (state-and-transition models, Figures 3 and 4). For brevity, only these two sites will be referenced. Refer to Exhibit 2 for review of relevant ESD sections.

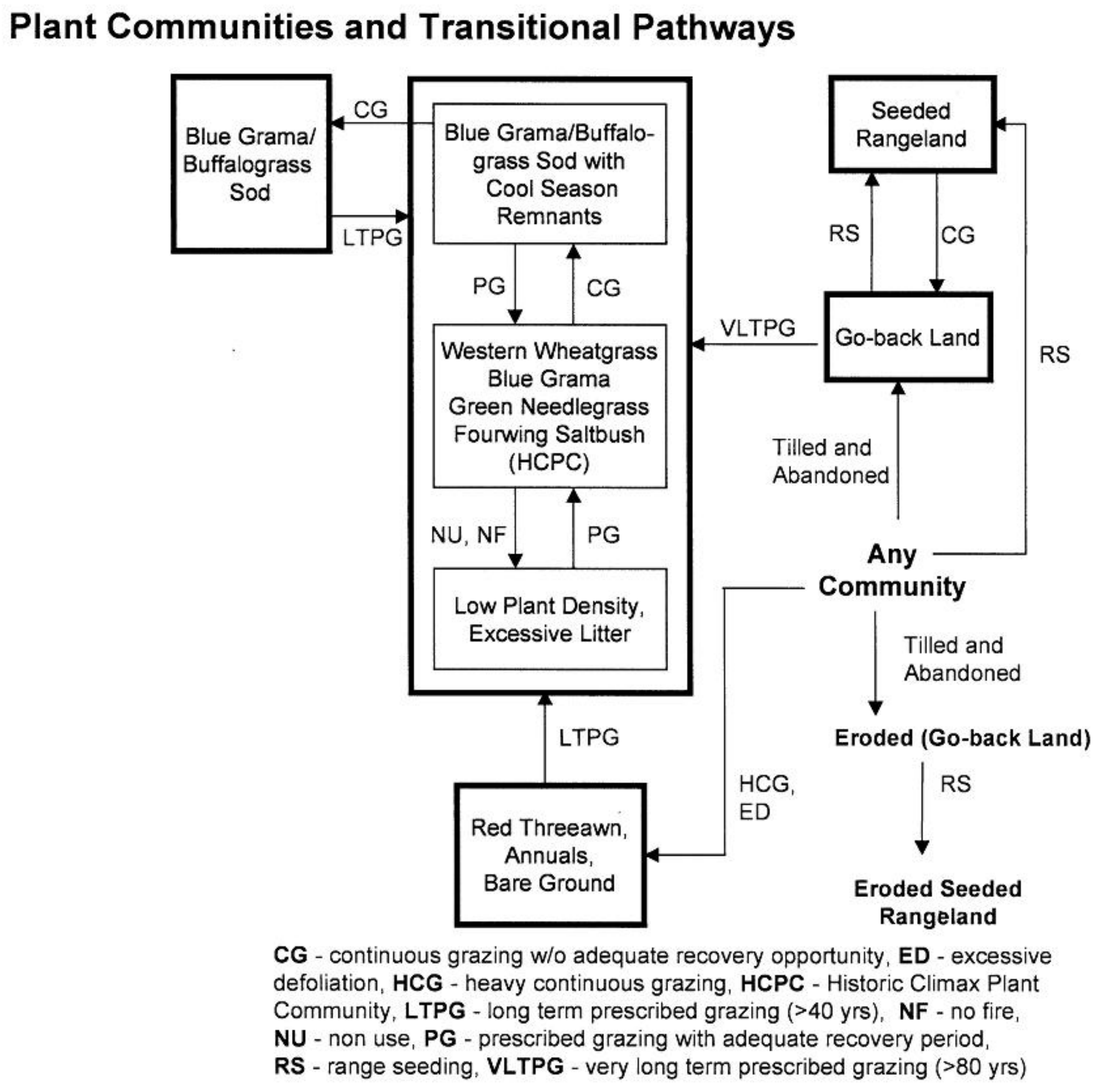
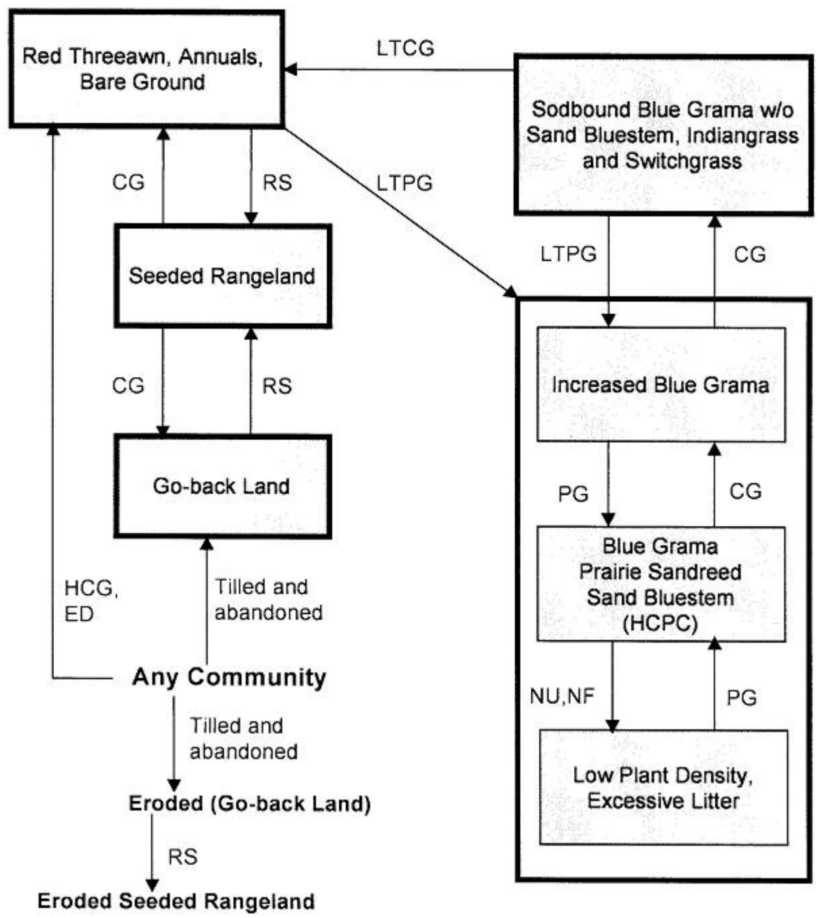


Figure 3: State-and-transition model for Loamy ESD, MLRA 67B (from USDA/NRCS 2008b)

Plant Communities and Transitional Pathways



CG - continuous grazing without adequate recovery opportunity, **ED** - excessive defoliation, **HCG** - heavy continuous grazing, **HCPC** - Historic Climax Plant Community, **LTCG** - long term continuous grazing (>25 yrs), **LTPG** - long term prescribed grazing (>40 yrs), **PG** - prescribed grazing with adequate recovery period, **NF** - no fire, **NU** - non-use, **RS** - range seeding

Figure 4: State-and-transition model for Sandy ESD, MLRA 67B (from USDA/NRCS 2008b)

Integration of models

Rangeland is habitat, yet methods used for classification of the respective resources are largely independent. Integration of these methods calls for a system with common criteria and terminology that would allow for simultaneous classification, elucidating the relationship between habitat value and range conditions. Severson and Urness (1994) identify two planning considerations which would ideally lead planning efforts for range and wildlife: 1) knowledge of seral dynamics, and 2) how wildlife will be affected. Given a common starting point based on these considerations, the tools could still be applied individually, but may also be considered together (Figure 5).

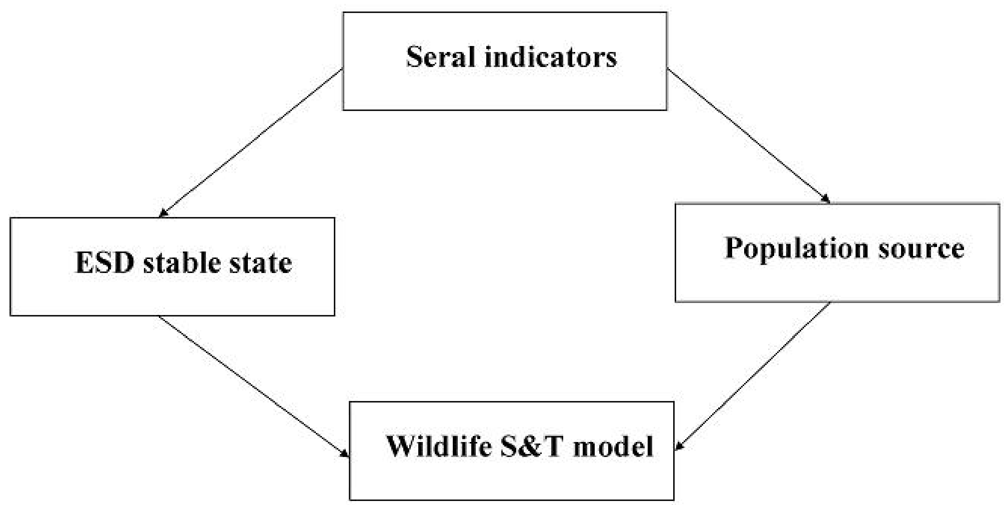


Figure 5: A standardized set of "seral indicators" as a means of integrating rangeland and wildlife classification tools.

Instead of limiting the definition of site conditions to specific attributes, an expanded interpretation of stable states as a robust proxy for any and all seral conditions which may have managerial importance could encompass attributes relevant to a variety of situations (Fritcher et al. 2004). In the past, attributes such as structure and species composition have been commonly examined, but seral indicators could also include many other characteristics such as canopy cover, bare ground, or species richness of a particular functional group. Seral indicators could be applied to the existing tools to define both the specific rangeland state, and the specific habitat afforded, in a way that is adaptable to changes in both existing tool application, and future tool revisions. Ultimately, a set of standardized indicators will indicate both rangeland and wildlife values, wherein the indicated stable state and the habitat(s) sustained by it become “synonymous” (Figure 6).

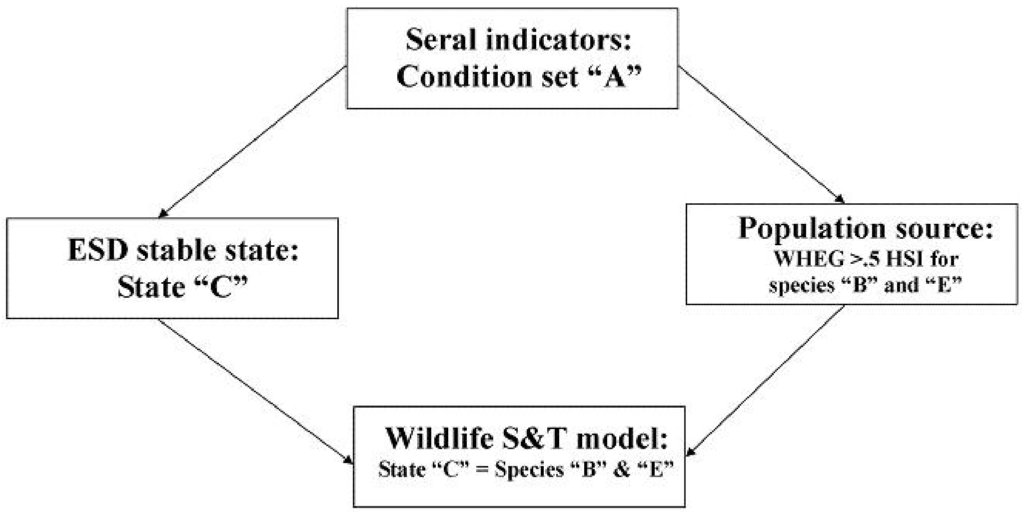


Figure 6: Example of application of a common system for rangeland and wildlife classification.

Existing wildlife interpretations contained within the ESDs are essentially informal, subjective estimations produced by NRCS biologists based on their professional knowledge and experience (Marymor, N. [NRCS Wildlife Biologist] Personal communication, 12/4/09). While this approach may very well produce reasonable and accurate interpretations for use with the S&T models, it is not derived through a structured methodology or data comparison, and does not lend itself to a systematic integration of the tools.

The primary challenge to developing a common system for data comparison is determining the meaningful and appropriate data to be utilized as seral indicators. As it stands now, there is limited standardization between the WHEGs themselves, and the addition of rangeland models only confounds the issue. One possibility for establishing this common starting point was developed simply by examining apparent commonalities among comparable factors, and is tabulated in “Seral indicators for integrated rangeland and wildlife classification” (Appendix A). Given this arrangement, WHEG information can be directly related to defining ecological site characteristics. From this, WHEGs can then be individually correlated to a state-and-transition model to determine which stable states qualify as a population source for a given species (Appendices B-I). As a last step, the rangeland model can then be rewritten in terms of habitat value to create a “Wildlife S&T model” which exploits the synonymy to display habitat values in the context of ecological dynamics.

Note that WHEGs contain some criteria which are not well-suited for use in an integrated approach, such as “pesticide use” and “distance from roads.” These items were not used in the integration process, but were accounted for as “site-specific factors” which may nonetheless remain useful criteria for stand-alone use of the wildlife tools.

Consider the results when a strict application of the ESD wildlife interpretations are graphically correlated to their associated stables states (Figures 7 and 8).

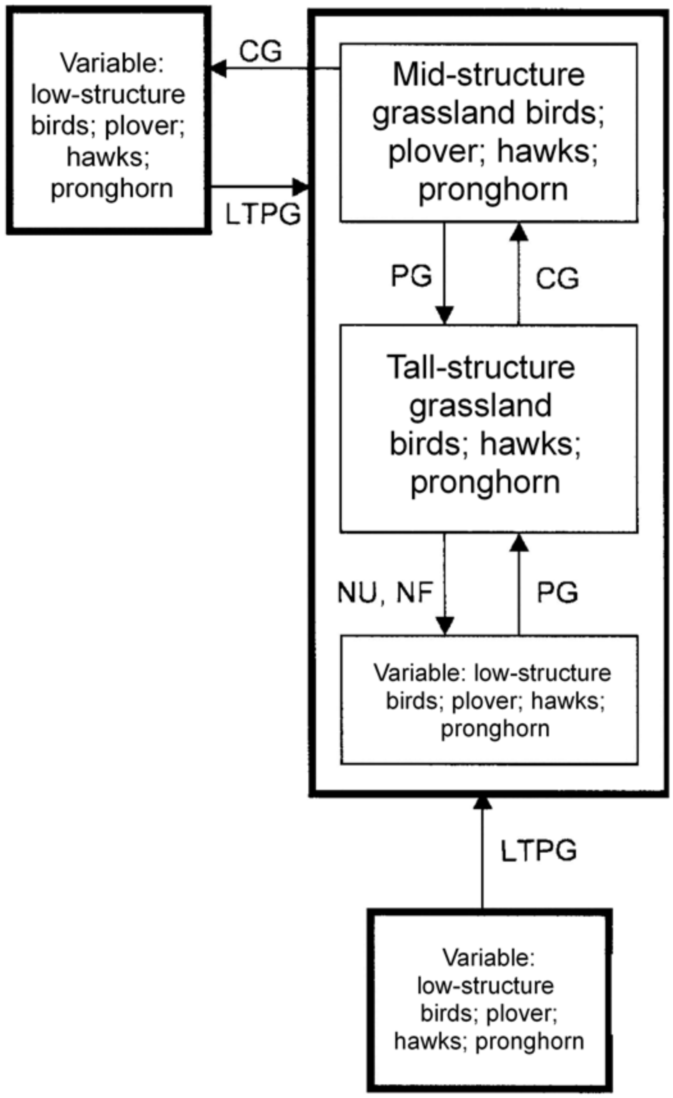


Figure 7: "Wildlife S&T model" based on Loamy ESD Wildlife Interpretations.

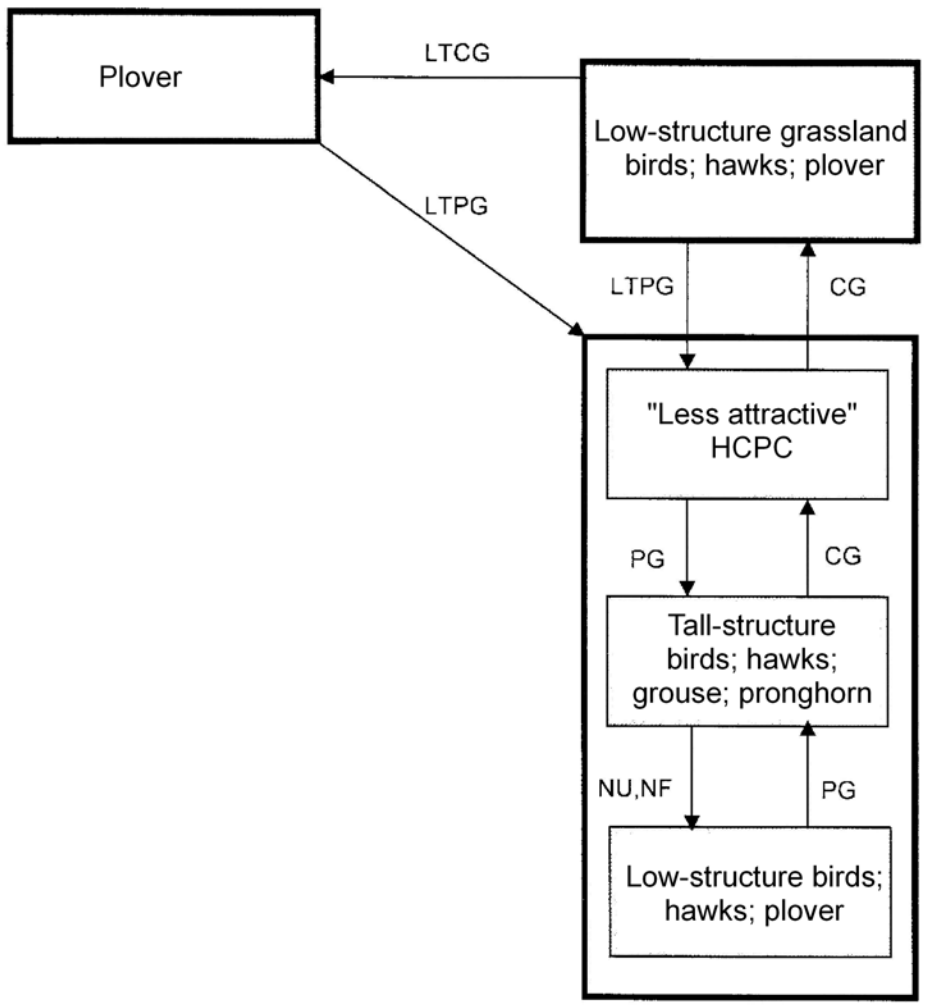


Figure 8: “Wildlife S&T model” based on Sandy ESD Wildlife Interpretations.

This application of ESD wildlife interpretations may have some value for integrated planning, but still lacks an ecologically tenable basis. Furthermore, much of the information is ambiguous and with limited utility. For example, the Loamy ESD combines the *Low Plant Density/Excessive Litter*, *Sodbound*, *Annuals/Bare Ground*, and *Go-Back Land* communities into one interpretation. However, the *Low Plant*

Density/Excessive Litter and *Annuals/Bare Ground* communities, in particular, could be expected to exhibit dramatically different characteristics, and hence support dramatically different wildlife populations.

Compare the wildlife interpretation results to the models produced when a common suite of seral indicators is used to correlate habitat value to stable state characteristics (Appendices B-I) and displayed graphically (Figures 9 and 10).

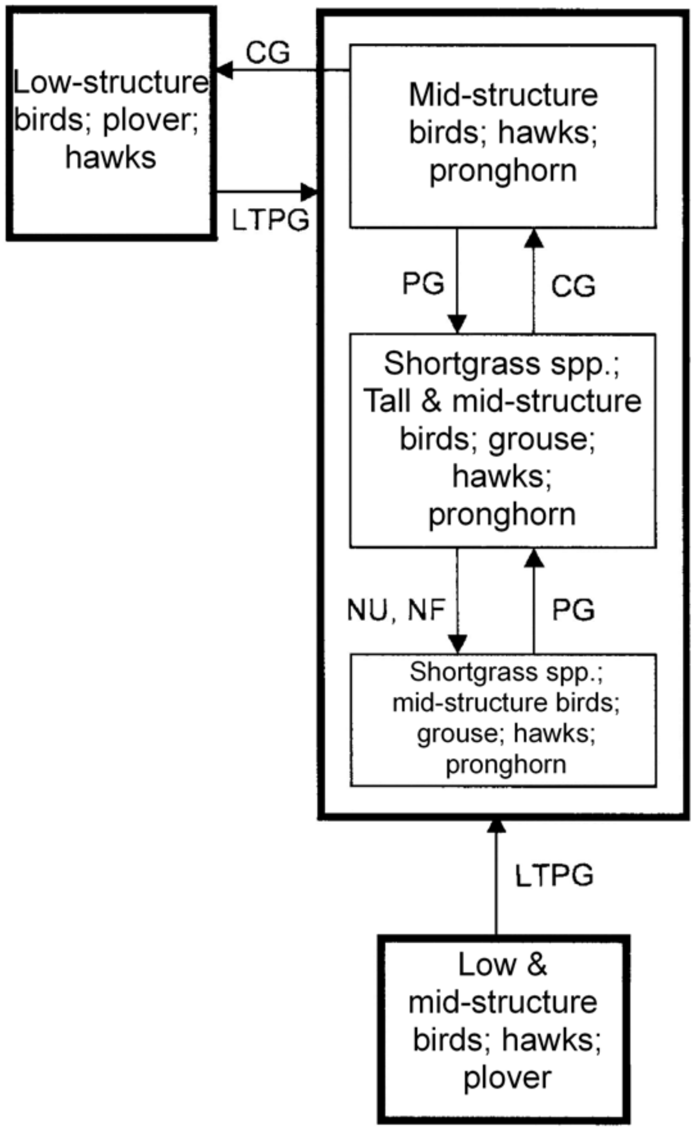


Figure 9: "Wildlife S&T model" based on Loamy ESD seral indicators.

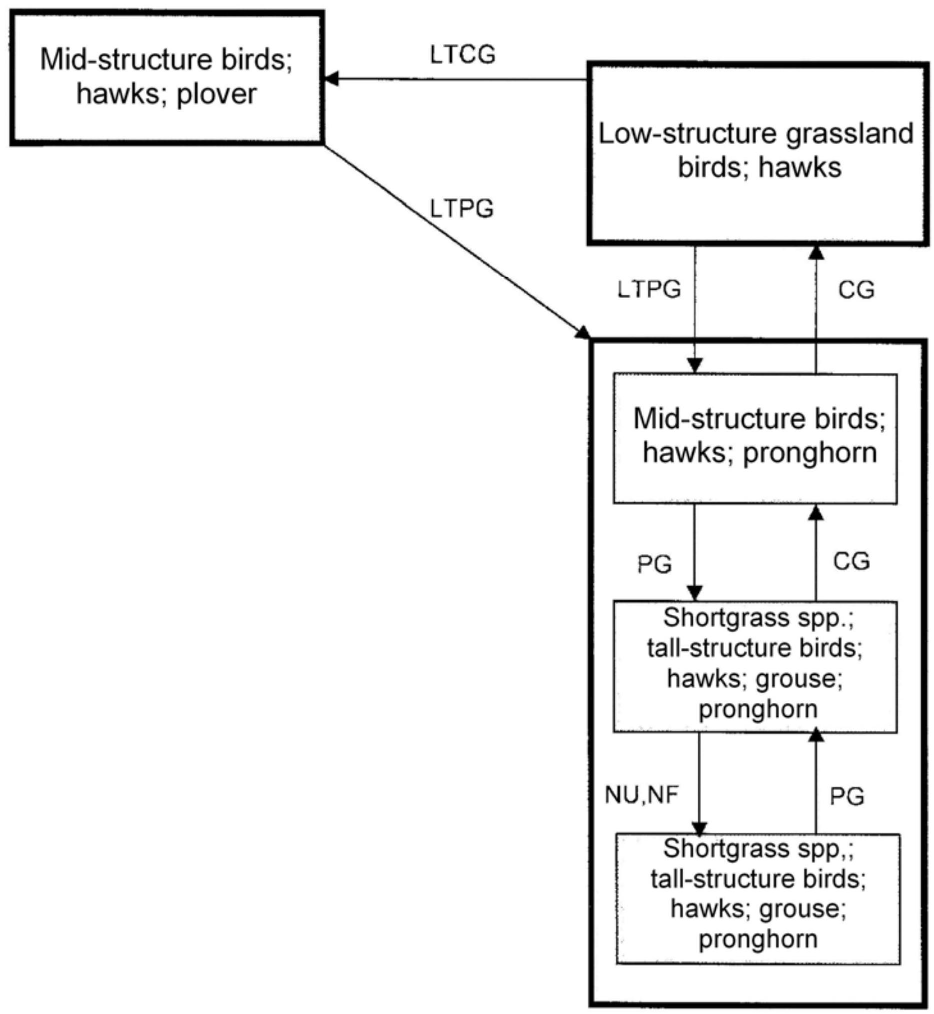


Figure 10: "Wildlife S&T model" based on Sandy ESD seral indicators.

While there is admittedly substantial overlap in results between the two approaches, there are also some notable differences. In particular, using a common set of indicators allows for evaluation of the Shortgrass WHEG. Generalizations such as community-scale tools can be problematic, and quickly become ambiguous when the full breadth and complexity of habitat factors on a landscape is combined (Holechek et al. 1982). Although being designed to capture optimal shortgrass conditions at a community level, only the *HCPC* and *Low Plant Density* on both ecological sites are shown to have broad spectrum value. The implication is that all other stable states are population sinks for shortgrass species, despite the fact that even a high-interest species such as mountain plover occurs outside these shortgrass population sources.

Application of Integrated Tools

While S&T models are traditionally designed around vegetative communities, the "Wildlife S&T" approach integrates the tools, and provides planners with insight as to how management prescriptions will affect animal communities. A planner could then examine the S&T model(s) for the site to determine which communities – or stable states – would feasibly provide the desired habitat, and the seral transitions to get there (Vavra 2005).

Planning Framework

A planning framework built on the aforementioned concepts will be needed to assist planners in evaluating existing conditions, potential needs for infrastructure changes, and grazing management indicated to meet wildlife objectives. Such a methodology might be structured as:

1) Determine operation size
2) Determine average pasture size
3) Select target species
4) Determine management scale
5) Determine number of possible seral management units (SMU)
    a. For each SMU –
        i. SMU #1
            1. # of ESDs:
                a. ESD #1 –
                    i. Baseline state
                    ii. Desired state
                    iii. Management indicated

1) Operation size

One of the primary factors in planning an operation-scale strategy is the spatial extent of managerial control, primarily determined by land ownership and/or leases. While the larger landscape context could be considered when deciding on the most valuable habitat for a specific land unit, for the purposes of this discussion it will be assumed that scale under consideration cannot be larger than the size of the operation.

2) Pasture size

Converse to operation size which defines the *maximum* scale, pasture size will be a factor in determining the *minimum* scale of practical management. While large pastures and/or light stock densities may arguably produce variable grazing effects within the pasture, for the purposes of this discussion it will be assumed that pastures are equal in size, and grazing effects within a pasture are uniform.

3) Target species

Another factor influencing management scale is the home range of the species (individually, as a guild, or as a community) being considered. Ideally, a parcel would provide the requisite habitat components within their home range or "cruising radius," which may also be defined as "the scale at which organisms perceive their environment" (Leopold 1933, Farina 2000). Explicitly, an individual with a home range of 1mi^2 would not benefit significantly from management at a 20mi^2 scale; although this may conceivably be warranted when managing for larger populations.

4) Management scale

The final determinants of management scale will be a combination of operation size, average pasture size, and the meaningful scale of management for your target species. Management scale will match either pasture size or home range, whichever is larger, up to the size of the operation. This rule is based largely on the operational constraints of managing livestock without cross fence, but also considers that habitat scales smaller than home range extents may produce fragmentation and edge effect, which is detrimental to some wildlife (West 1993, Driscoll 2007). On the other hand, pastures may be combined as needed to create larger units by removing fence, although it would be preferable to retain the infrastructure to provide flexibility needed to address changing objectives (Heady 1996; Fuhlendorf and Engle 2001).

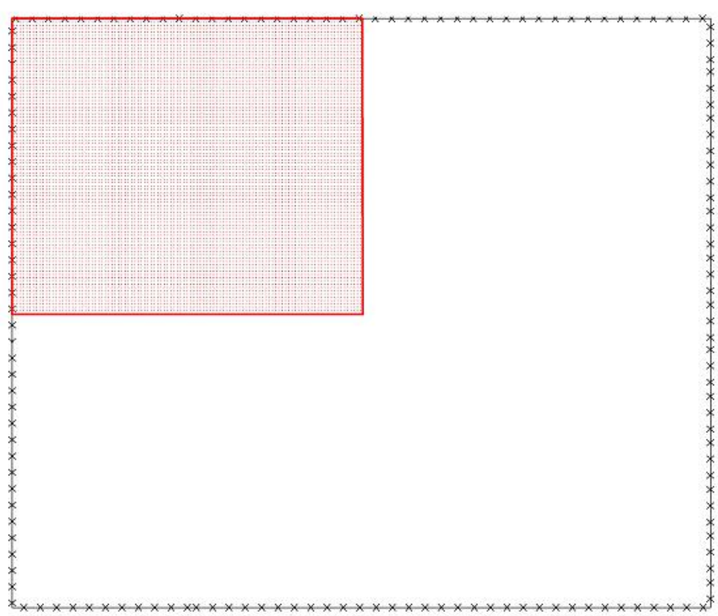


Figure 11: Meaningful scale for the target species (red) is smaller than the pasture (black). Management control is constrained by pasture size. Unless subdivision is planned, scale will follow fence line.

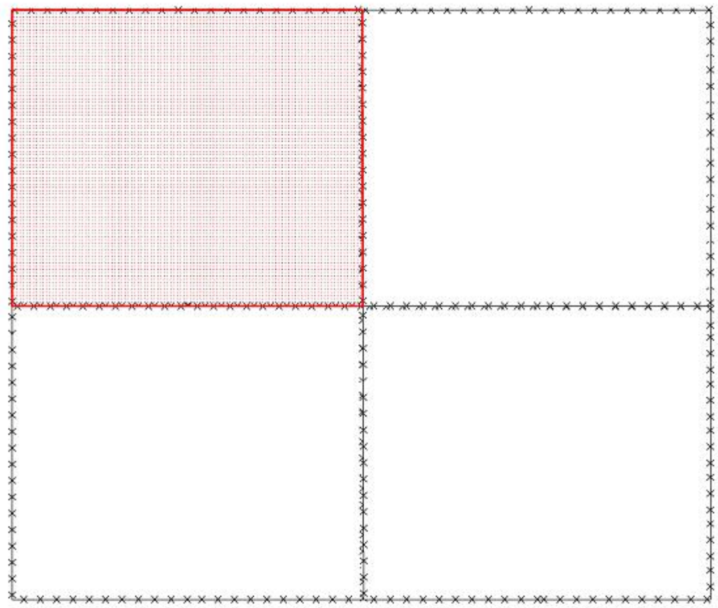


Figure 12: Meaningful scale for target species is same size as existing pastures. No further adjustments to infrastructure needed.

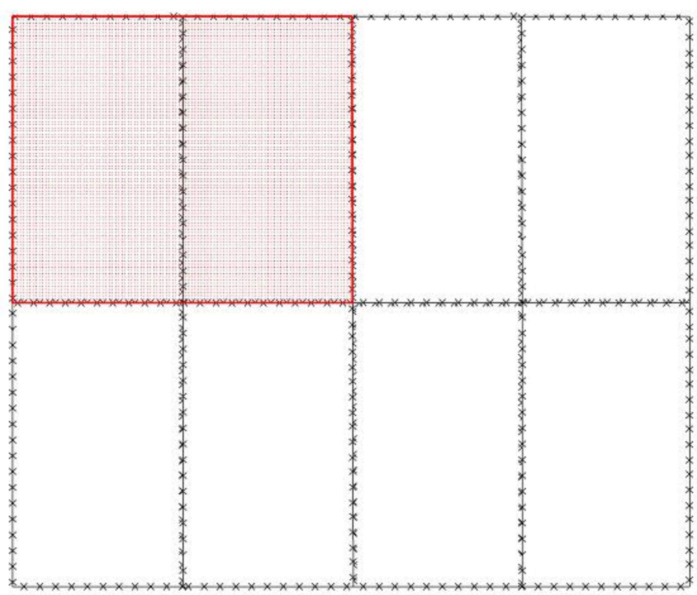


Figure 13: Meaningful scale for target species is larger than existing pastures. No further adjustments to infrastructure needed; however pastures within red area could be intensively managed individually, or combined (e.g. gates left open, livestock watering sources turned on.)

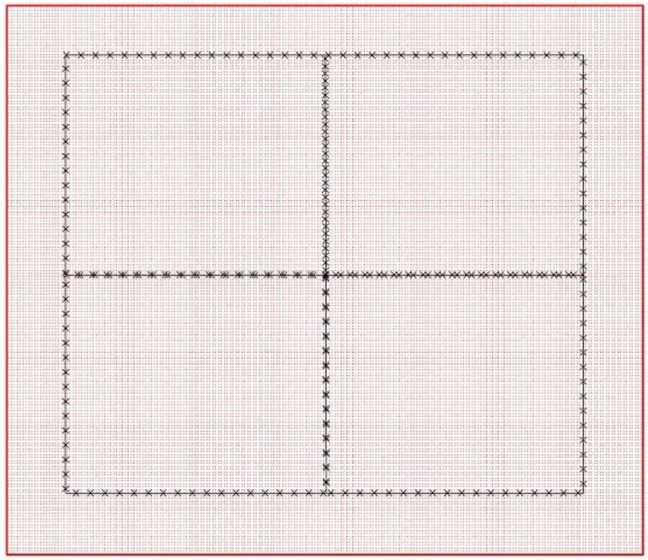


Figure 14: Meaningful scale for target species is larger than entire operation. Management control is constrained by operation size. Differential management may be not necessary.

The absolute spatial extent of both the species-specific (red) and infrastructure (black) scales are irrelevant, as long as this principle is applied relatively. Hence, these illustrations may appear very similar for both plover on a 640 acre pasture, and grouse on a 50,000 acre landscape.

5) Number of possible seral management units (SMU)

At the core of this framework is the concept of a "seral management unit." The realized effects of differential grazing treatments will occur in discrete spatial patterns in relation to fencing, and each SMU will be managed for a particular stable state. The number of SMU's is found by dividing operation size by the management scale. For example, the operations in both figures 12 and 13 would have four SMU's, despite the latter having eight pastures.

a. **For each SMU –**

SMU's are evaluated separately as they may be managed for different conditions; however, this decision will remain largely subjective based on planner experience and managerial input.

i. **SMU #1**

Inherent variability may be produced by multiple ecological sites occurring within an SMU. Each site will bring with it a unique S&T model with different stable states and transition pathways, and there can be significant differences in ecological site responses to the same disturbance (Burnett et al. 1998; Harrison et al. 2003; Vavra 2005).

1. **# of ESDs:**

a. **ESD #1 –**

i. **Baseline state**

Using appropriate rangeland inventory and classification protocols, the planner establishes the existing stable state.

ii. **Desired state**

Using the Wildlife S&T model for this ecological site, the planner can determine which states have value for the target species. In most cases, this will probably require that the desired state be one transition (or "step") away from the baseline; although, in theory, intermediate stable states may be considered merely "transient" when extreme disturbance is applied (Westoby et al. 1989). This is particularly true when using pathways such as *"Any Community"* subjected to a heavy continuous grazing (HCG) regime. This may be ascribed to the magnitude of HCG effects which negate or "override" much of the inherent heterogeneity (e.g. topoedaphic) that may exist on a parcel (Fuhlendorf and Smeins 1999).

iii. Management indicated

The transition pathway, along with the noted management driver, provides the planner with the grazing strategy appropriate for initiating a transition to the desired state.

b. ESD #2 (if applicable) –

i. **Existing state:** *Same as above*
ii. **Desired state:** *Same as above*
iii. **Management indicated:** *Confirm reconciliation with management denoted by ESD #1*

Iterations of this process can be repeated for all other ecological sites within the SMU, but the planner will need to ensure that the management indicated by the first iteration will produce desirable results when applied to other S&T models. If management cannot be reconciled, other options will need to be considered and/or conflicting objectives pared down.

In summary, given a baseline condition (as defined by rangeland assessment,) a desired condition (as defined by wildlife assessment,) and the management drivers which produce the transition (as indicated by the Wildlife S&T model,) a differential grazing strategy can be developed (Figure 15).

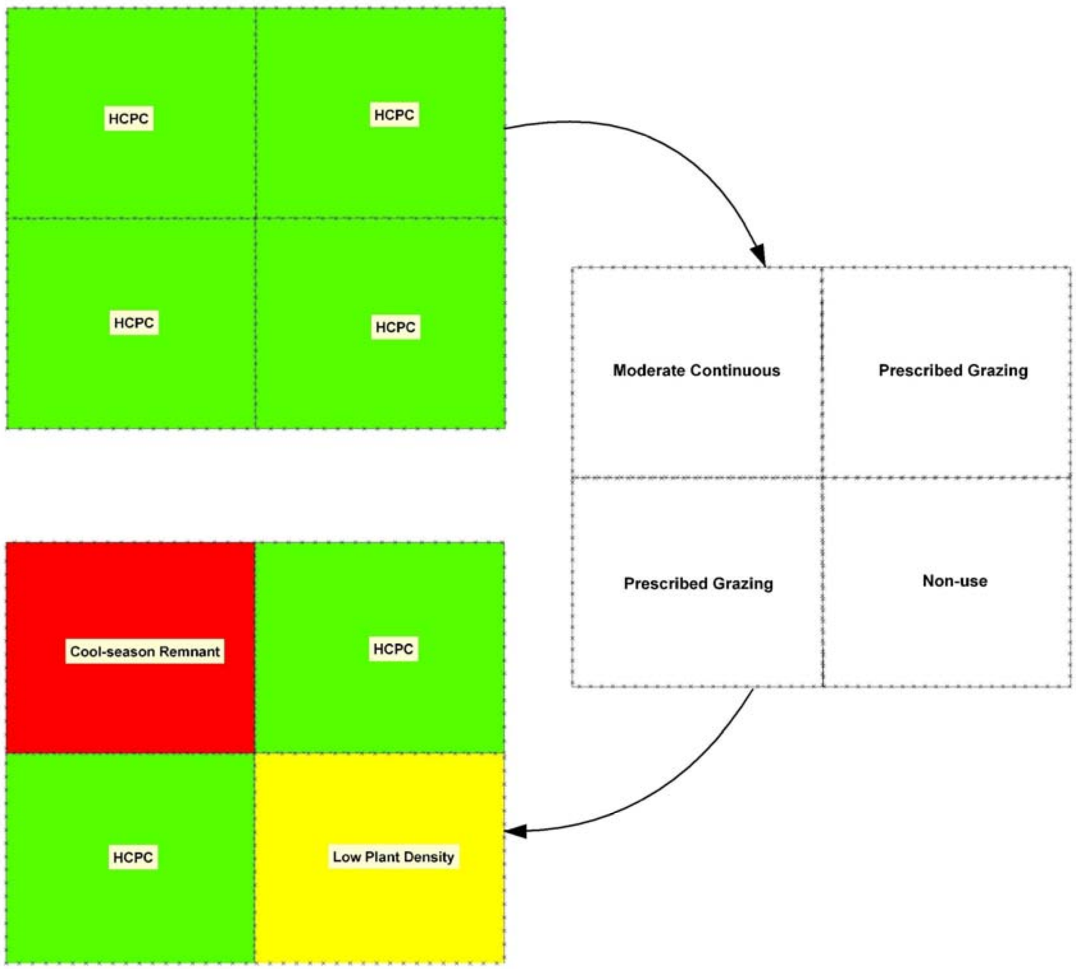


Figure 15: Generic example with 4 seral management units on a Loamy ecological site. The associated Wildlife S&T model indicates the appropriate differential grazing strategy to produce the desired stable states (habitat).

It may be the case that implementation of a differential grazing treatment is easier if the overall strategy includes management actions which “offset” one another. After all, cows have to go somewhere. Particularly when a state such as *Low Plant Density* is included in the plan, another area will need to accommodate the herd while the indicated management of “Non-use” is applied. A stable state calling for heavier use might counterbalance the rested area.

Shifting Mosaic Steady State

The examples thus far have only examined possible strategies for initiation of a wildlife grazing regime which provides managerial control of *spatial* heterogeneity. However, the non-equilibrium concepts embodied by the S&T paradigm lend themselves to *temporal* application as well. Utilizing these principles and methodologies, a grazing strategy can be expanded to address temporal heterogeneity, very much like Bormann and Likens’ (1979) description of forestry dynamics.

A set of stable states brought about by differential treatment is not necessarily the final step. By applying a second iteration of the planning framework, this new condition becomes the baseline and SMU’s can be transitioned again to a different state (Figure 16). Particularly in cases where transition from “baseline” to “desired” cannot be achieved in one transition, SMSS can provide a long-term strategy to navigate the model pathways to an ultimate objective.

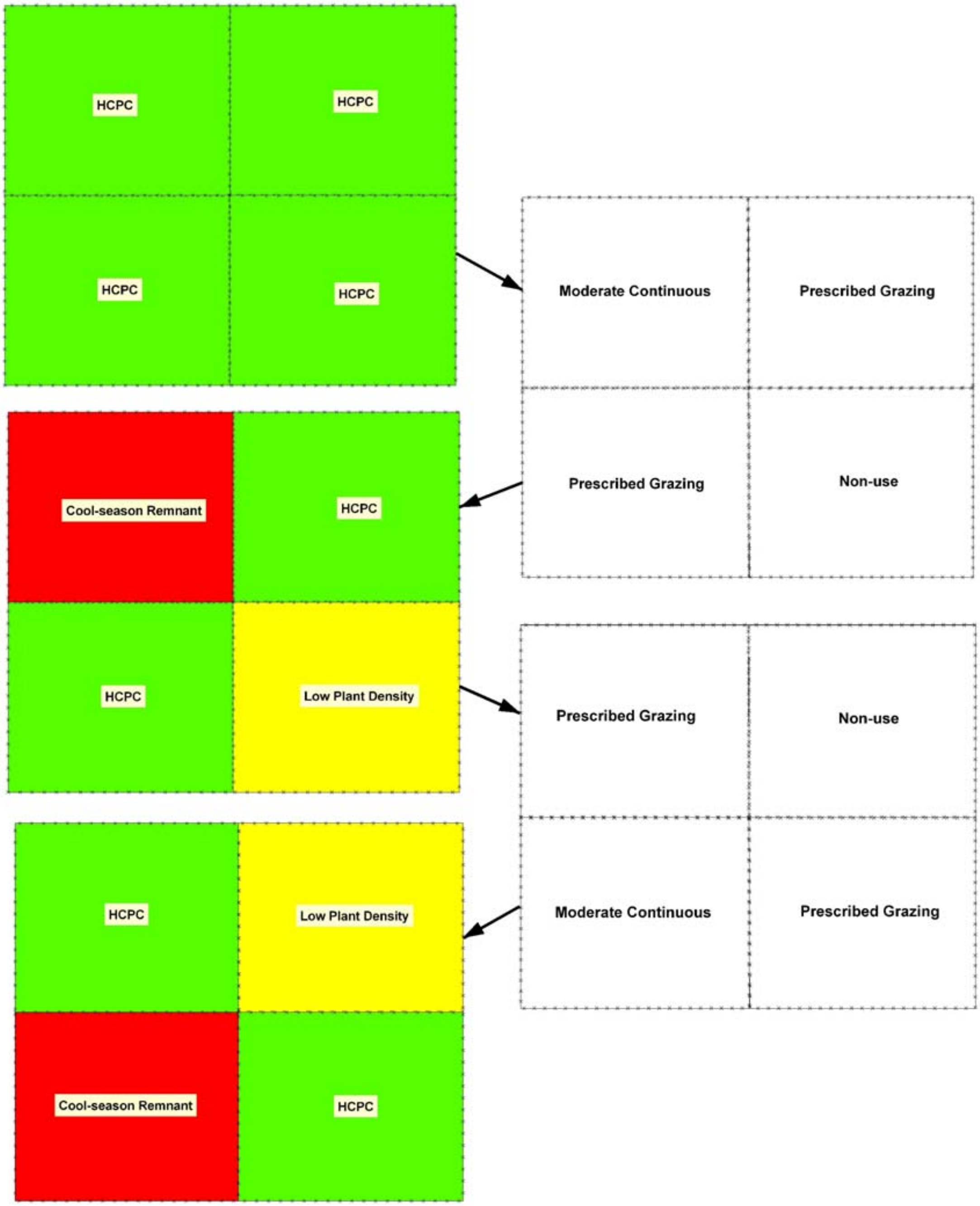


Figure 16: Implementation of the SMSS principle on a 4 pasture operation with 4 seral management units. Seral conditions within each SMU are dynamic temporally, but the overall heterogeneous character remains static.

Application in practice

This methodology has been applied in a real-life situation in which a landowner worked with the NRCS, Rocky Mountain Bird Observatory, and the U.S. Fish and Wildlife Service to develop a grazing strategy for improved wildlife values. This particular project was limited to a 640 acre parcel on which the primary objective was playa conservation (SMU #5, Figure 17); although upland grazing management in surrounding pastures involved a "complimentary" strategy of differential grazing treatments targeted at grassland birds in general (SMU #1-#4, Figure 17).

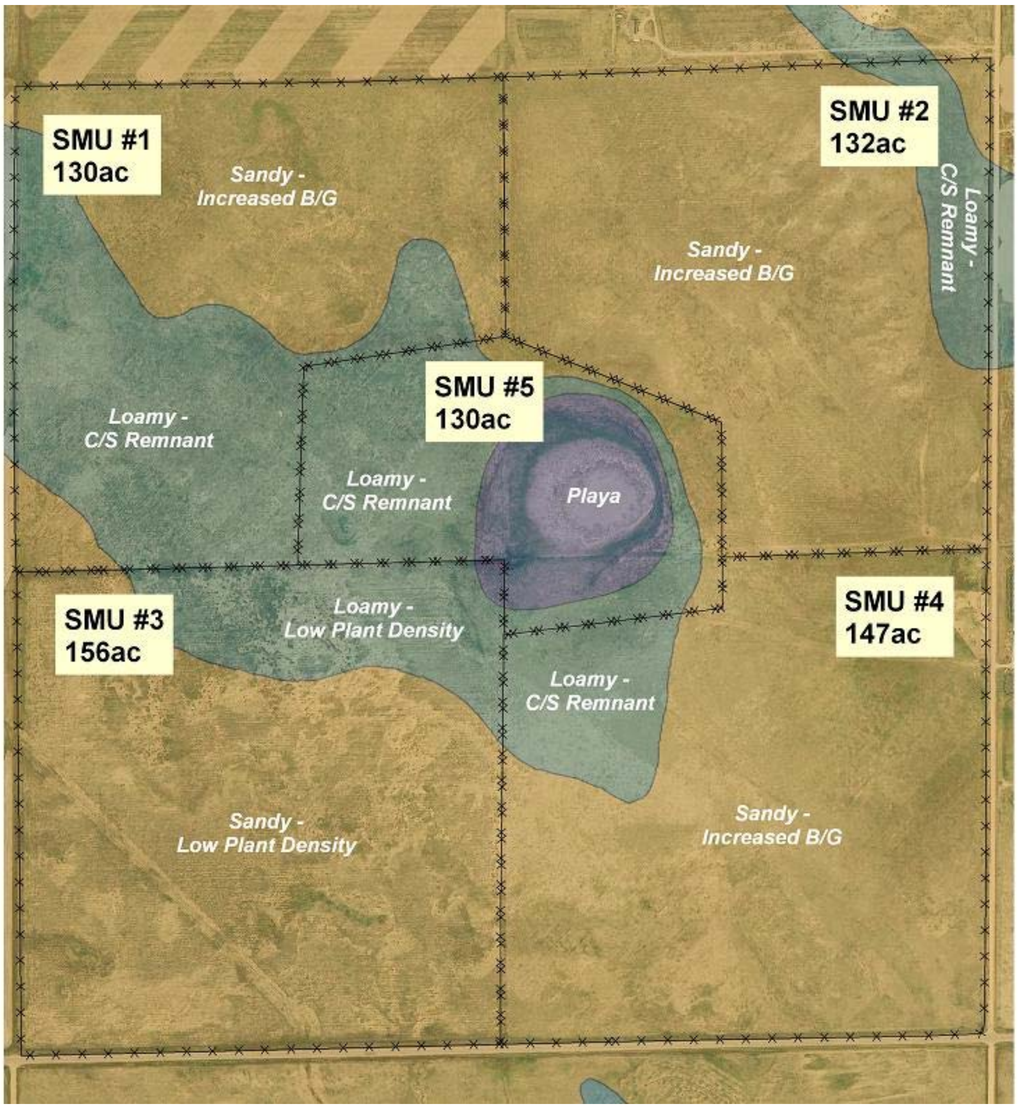


Figure 17: Baseline conditions on example parcel.

The approach for this project involved a crude, nascent form of this proposed planning framework. However, this can provide a good portrayal of how this framework appears when applied to actual agency activities.

1) Determine operation size: ***640ac***
2) Determine average pasture size: ***141ac***
3) Select target species: ***Grassland birds in general (70+ac)***
4) Management scale: ***Pastures (141ac)***
5) Determine number of possible seral management units (SMU)
    b. For each SMU –
        i. SMU #1
            1. # of ESDs: ***2***
                a. ESD #1 ***(Loamy)*** –
                    i. Baseline state: ***Cool-season Remnant***
                    ii. Desired state: ***HCPC***
                    iii. Management indicated: <u>***Prescribed Grazing***</u>
                b. ESD #2 ***(Sandy)*** –
                    i. Baseline state: ***Increased blue grama***
                    ii. Desired state: ***HCPC***
                    iii. Management indicated: <u>***Prescribed Grazing***</u>
        ii. SMU #2
            1. # of ESDs: ***2***
                a. ESD #1 ***(Loamy)*** –
                    i. Baseline state: ***Cool-season Remnant***
                    ii. Desired state: ***Annuals/Bare Ground***
                    iii. Management indicated: <u>***Heavy Continuous***</u>
                b. ESD #2 ***(Sandy)*** –
                    i. Baseline state: ***Increased blue grama***
                    ii. Desired state: ***Annuals/Bare Ground***
                    iii. Management indicated: <u>***Heavy Continuous***</u>

iii. SMU #3

   1. # of ESDs: ***2***

      a. ESD #1 ***(Loamy)*** –

         i. Baseline state: ***Low Plant Density***

         ii. Desired state: ***Low Plant Density***

         iii. Management indicated: ***Maintain Management; Non-use (CRP)***

      b. ESD #2 ***(Sandy)*** –

         i. Baseline state: ***Low Plant Density***

         ii. Desired state: ***Low Plant Density***

         iii. Management indicated: ***Maintain Management; Non-use (CRP)***

iv. SMU #4

   1. # of ESDs: ***2***

      a. ESD #1 ***(Loamy)*** –

         i. Baseline state: ***Cool-season Remnant***

         ii. Desired state: ***HCPC***

         iii. Management indicated: ***Prescribed Grazing***

      b. ESD #2 ***(Sandy)*** –

         i. Baseline state: ***Increased blue grama***

         ii. Desired state: ***HCPC***

         iii. Management indicated: ***Prescribed Grazing***

In the end, the planner has a tenable strategy for differential grazing treatment to achieve a particular wildlife objective (Figure 18). Inherent heterogeneity may produce multiple habitat types within an SMU, but the planner will need to decide if this is actually problematic (Figure 19). This scenario actually worked well on this project given the broad wildlife objective.

Figure 18: Baseline and desired stable states with the indicated management (per "Wildlife S&T models") to achieve desired conditions.

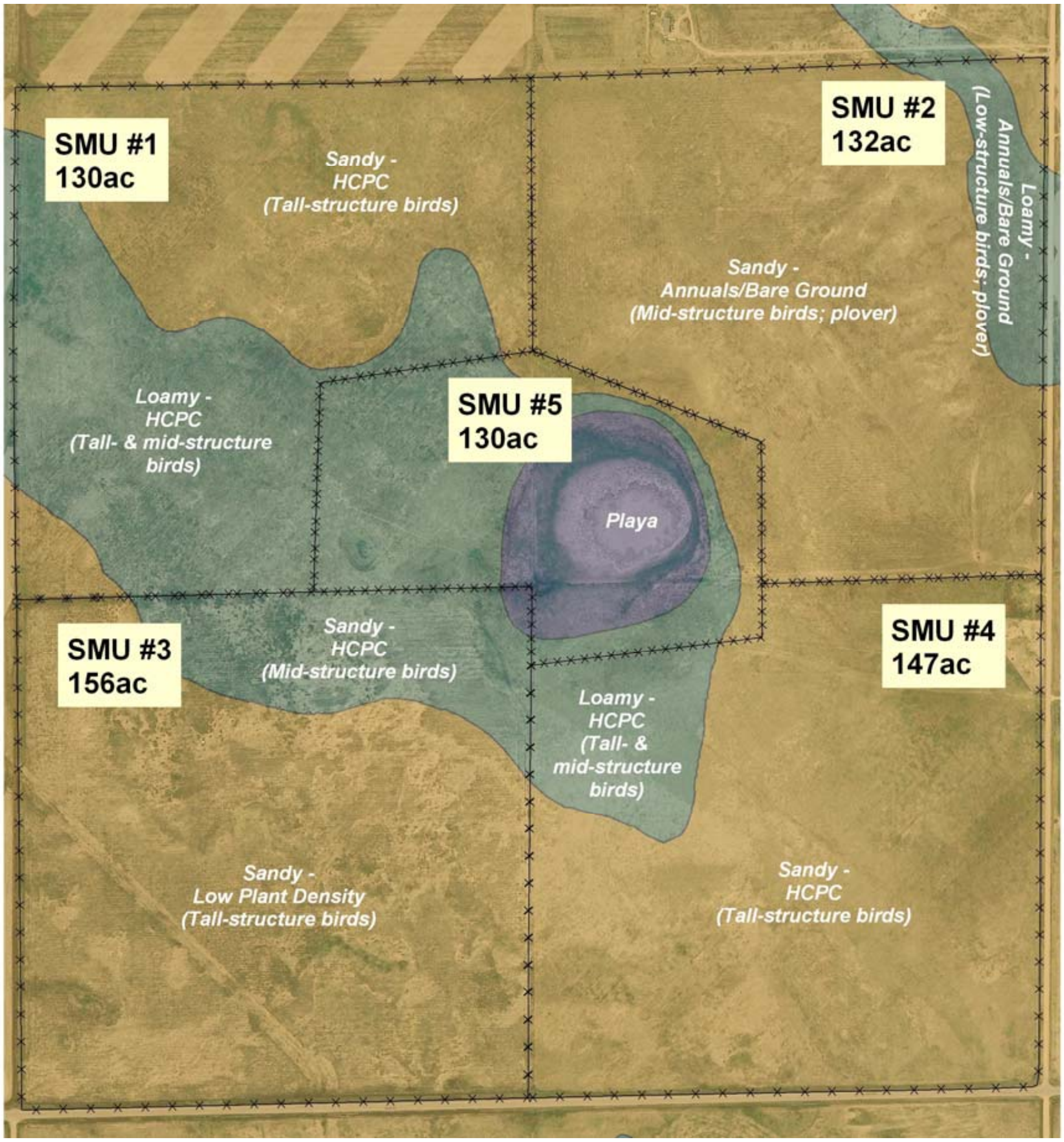


Figure 19: Desired outcome of management implementation with notation of eventual wildlife values by ecological site.

Limitations and Future Refinement

"Until man duplicates a blade of grass, nature can laugh at his so-called scientific knowledge." (Thomas Edison)

Integration challenges

First and foremost, this approach assumes the successful creation of a suite of common indicators to be applied in both a rangeland and wildlife context, along with corresponding standardization of criteria within the tools. The indicators used for this discussion are admittedly extremely subjective, and were developed based on one interpretation of the multitude of criteria comprising the various range and wildlife tools. Much of the rangeland data itself is either tenuously implied in the tools, or anecdotal information obtained simply to facilitate demonstration of an integrated paradigm. The NRCS's National Resources Inventory (NRI) data collection process may prove to be an excellent source of definitive data, particularly for individual ESDs and stable states; however, as of writing, this data is not readily available.

Once the supporting data is obtained, the Rangeland Health protocol may provide a useful analogous template for organizing the data into a meaningful suite of indicators. Consider that Rangeland Heath organizes its 17 indicators into 3 overarching attributes which influence rangeland function (Pellant et al. 2005):

1. Biotic Integrity (vegetation)
2. Site Stability (soils)
3. Hydrologic Function (water)

Similarly, the 7 indicators used here to link stable states and habitat values might be organized into larger categories (or "attributes" to borrow the terminology) for a broader perspective of habitat function. Severson and Urness (1994) list four aspects of habitat which may be influenced through grazing management:

1. Species composition
2. Productivity
3. Nutritive quality
4. Diversity of structure

Likewise, Kie and Loft (1990) lists three aspects:

1. Biomass
2. Structure (height, cover)
3. Species composition

Furthermore, Driscoll (2007) also mentions that structure and community composition should be considered. There's substantial overlap between these perspectives on habitat elements and the proposed "seral indicators," and a combination of these perspectives may help to organize common seral indicators into attributes such as:

1. Vertical cover (vegetation height, shrub composition),
2. Lateral cover (canopy cover, bare ground), and
3. Habitat composition (shrub composition, woody species richness, herb composition, forb species richness).

Ecological Reference Sheets have been developed in conjunction with ESDs describing the conditions defining HCPC, to be used as a reference for evaluation of observed rangeland conditions (Pellant et al. 2005). The implied assumption is that HCPC will always be the desired condition. However, if a land manager is to pursue other stable states within an ecological site (as is proposed with this planning framework) it would be crucial that additional, similar reference sheets are developed for these others states as well.

Further refinement of existing agency tools will also be required before this process will work as desired. As one example, Appendices B-I use a simplistic formula wherein WHEG/ESD parity must only be =>50%. However, the case in actuality may be that four of the indicators score a .5, while the other three score a .1. In this scenario, the true HSI score would fall under .5, despite the stable state having been considered a population source. The ability to discern these “true” WHEG scores would increase accuracy and allow for “weighting” of stable states based on calculated HSI and the identified minimum limiting factor(s).

Scaling challenges

Arguably, one of the weakest aspects of this framework is the failure to account for scales smaller than pastures, or larger than an operation. In no small part, predictability of grazing patterns and plant community response will vary depending on scale, especially within the gamut from a few m^2 to many mi^2, and no single scale can account for all factors in play (Fuhlendorf and Smeins 1999).

The spatial purview of this framework might include phenomena occurring at sub-pasture scales; however, integrative output resolution will always be limited by the coarsest input scale being integrated. While Ecological Reference Sheets include data with sub-foot precision (i.e. bare ground patch diameter), the WHEGs are designed to be applied to management units (i.e. pastures) and evaluate conditions at this larger scale, thereby limiting the lower end at which this framework can be applied spatially. Although, that’s not to say that the tools couldn’t be revised to address sub-pasture scale indicators. As an example, the plover WHEG could be expanded to consider not only the percent bare ground, but also whether bare ground patches are greater than 6’ diameter. In this way, data comparison could approach a scale which accounts for variable effects of management actions (e.g. prescribed fire) and livestock impacts (e.g. grazing patterns) within a pasture.

Conversely, this framework could be overlain on a landscape at the true meaningful scale of a target species to achieve scales larger than an operation. When this scale exceeds that of the parcel under consideration, the entirety of an operation may comprise a single SMU within a larger mosaic with the accepted stipulation that it would be the only SMU within which active management can be implemented. Alternatively, planning outreach could be targeted at multiple landowners to develop a cooperative project achieving meaningful scales, as well as consideration of other valuable habitat features such as connectivity (Lindenmayer and Hobbs 2007).

A landscape-scale approach may benefit from expansion of the stable state HSI scores to include values based on combinations of states (habitat types). The ferruginous hawk WHEG is a good example of an assessment which attempts to account for more than one habitat type in that two criteria address the same element, namely the percentage of total area comprising a specified range of shrub cover (i.e. factors #3 and #4.) This approach would facilitate accounting for habitat mosaics specific to a species, as well as inclusion of habitat values present on adjacent land. Cale (2007) explores an interesting possibility in the expansion of the S&T paradigm to address heterogeneity at a large scale which may provide the means to deal with collective stable states and habitat types (Figure 21).

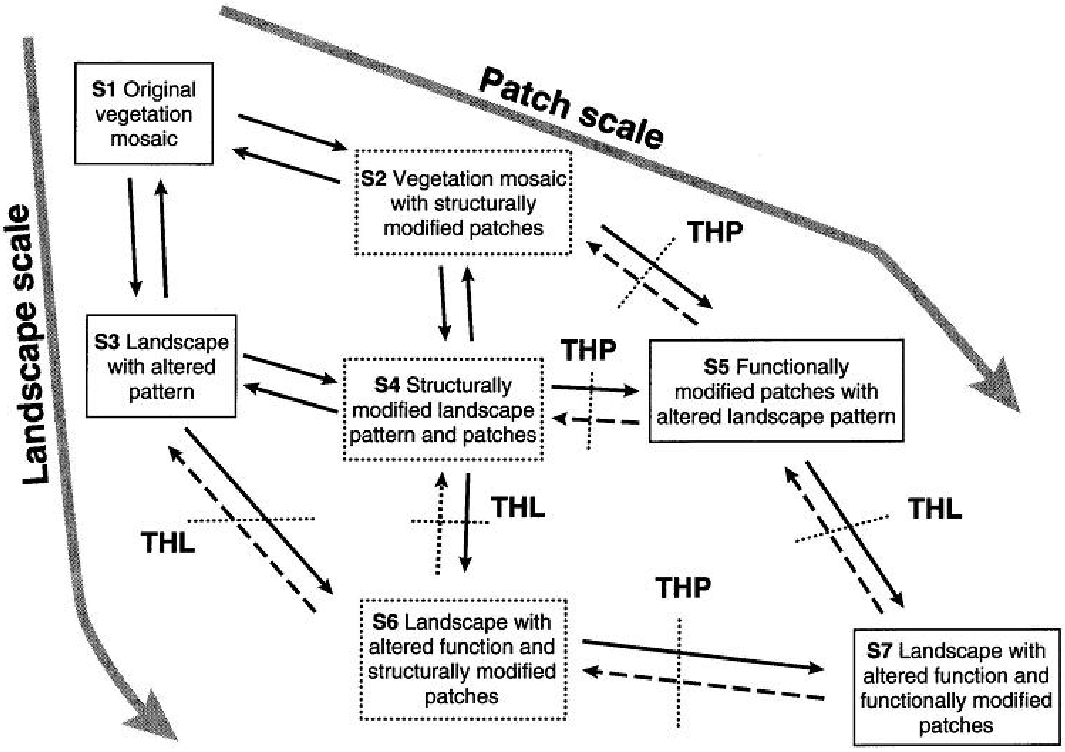


Figure 21: "Landscape S&T model" to account for larger scale mosaics (from Cale 2007).

Implementation challenges

The biggest obstacle to successful long-term implementation of a differential grazing strategy, and particularly an SMSS approach, is the ability to monitor seral conditions and transition progression so that 1) success can be recognized, and 2) transition reversal can be initiated while still possible. The answer, in part, may be found in that changes in functional processes tend to lag behind changes in structural elements, and these "residual properties" from a previous stable state may facilitate a favorable change in seral trajectory with the caveat that these properties will diminish, and the intransigence of a stable state will increase with time (Briske et al. 2005, Briske et al. 2006). In this sense, SMSS may offer an avenue for maintaining important overall habitat conditions without pushing ecological function irretrievably beyond "property extinction" thresholds wherein system memory of previous states is completely forfeited (Briske et al. 2006.)

Diligent monitoring will be paramount for proper implementation, albeit there is a persisting information gap that will need to be filled before the planning framework can be fully utilized. Past research largely fails to provide information relevant to the processes and scales involved in this type of management, and at the least, existing quantitative data will need to be applied differently (Briske et al. 2008); although, the functional time lag implies that a traditional quantitative monitoring program may suffice for seral evaluation. Even if data is limited to smaller scale (e.g. patch-scale) plots and/or transects, it could feasibly be extrapolated to indicate trends for larger SMU's (Bestelmeyer et al. 2003).

Regardless of the quality of data available or the competence of the land manager, deliberate seral management will always retain an element of uncertainty. Inducing ecological systems into extreme states may produce long-term effects with adverse ramifications. The site conservation threshold, defined as "the kind, amount, and/or pattern of vegetation needed as a minimum on a given site to prevent accelerated erosion" (SRM Task Group 1995), would likely be a prudent sideboard for sound application of this paradigm. Likewise, Fischer and Lindenmayer (2007) relate 4 general guidelines to minimize the chances of failure and "irreversible" change:

1. Maintain good native cover (at least within the mosaic, if not on a specific parcel)
2. Understand the evolutionary history of the ecosystem, and mimic the disturbance regimes to which it is adapted
3. Do not completely forfeit key vegetative species or functional groups
4. Strive to recreate historic landscape patterns.

Conclusion

"Development of a grazing plan to benefit species of interest may be more interpretation and art, and less the application of scarce science." (Vavra 2005)

Despite this effort to form a concrete, systematic methodology for integrated ecological planning tools, natural resource management will always retain an element of art, with deference to the knowledge and experience of planners and land managers. Indeed, the ultimate goal is not to remove the creative human element from the process, but simply to provide a more easily comprehensible roadmap of the complex principles and interrelationships which abstrusely, yet necessarily, guide conservation efforts.

Any land use will have its benefits and detriments, depending on your perspective, and the issue of wildlife-livestock conflicts will likely persist as long as rangelands are utilized for domestic livestock. Leopold (1933) frames the issue by asking, "how do we conserve wild life without evicting ourselves?" Given that large native herbivores, particularly bison, have been removed from the rangelands which evolved under their hooves, the answer likely is not wholesale cessation of domestic grazing. Therefore, the common ground which produces a complimentary outcome should continue to be sought and developed.

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Appendices A-I

Seral Indicators

Footnote references

[1]Shortgrass WHEG (USDA/NRCS 2008a)

[2]Ferruginous Hawk WHEG (USDA/NRCS 2008a)

[3]Mountain Plover WHEG (USDA/NRCS 2008a)

[4]Plains Sharp-tailed Grouse WHEG (USDA/NRCS 2008a)

[5]Pronghorn WHEG (USDA/NRCS 2008a)

[6]Grassland Birds Technical Note (USDA/NRCS 2008a)

[7]Loamy ESD, MLRA 67B (USDA/NRCS 2008b)

[8]Sandy ESD, MLRA 67B (USDA/NRCS 2008b)

[9]Berlinger, B. [NRCS Rangeland Management Specialist]
Personal communication, 11/24/09

[10]Trainor, N. [NRCS Rangeland Management Specialist]
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[11]Loamy Ecological Reference Sheet (USDA/NRCS 2008b)

[12]Sandy Ecological Reference Sheet (USDA/NRCS 2008b)

Appendix A: Seral indicators for integrated rangeland and wildlife classification

Seral indicators	Shortgrass WHEG[1]	Ferruginous Hawk[2]	Plover[3]	Grouse[4]	Pronghorn[5]	Grassland birds[6]	Loamy ESD					Sandy ESD				
							HCPC	Low Plant Density	C/S Remnants	Annuals/Bare Ground	Sodbound	HCPC	Low Plant Density	Increased blue grama	Annuals/Bare ground	Sodbound
Canopy cover (%)	2. 20-60% herbaceous cover	3. 20-30% of area w/25-90% shrub cover 4. >70% area w/1-30% cover		1. >25% herbaceous nesting/brood canopy cover	4. 5-65% shrub canopy cover 7. 5-75% forb canopy cover		80% herbaceous; 20% woody[9,10]	65% herbaceous; 25% woody[9,10]	70% herbaceous; 10% woody[9,10]	30% herbaceous; <5% woody[9,10]	60% herbaceous; <5% woody[9,10]	85% herbaceous; 15% woody[9,10]	75% herbaceous; 20% woody[9,10]	70% herbaceous 10% woody[9,10]	35% herbaceous <2% woody[9,10]	50% herbaceous; <2% woody[9,10]
Bare ground (%)			3. >30%				<3%[11]	3-5%[9,10]	0-1%[9,10]	50-70%[9,10]	10-15%[9,10]	<3%[12]	0%[9,10]	3-5%[9,10]	50-80%[9,10]	10-15%[9,10]
Vegetation height (in)	3. 1-12" stubble height through winter and nesting (Nov - July)	2. 6-24"	1. <1-3"	2. >8" veg height "in spring prior to growing season"	1. 20"+ height 5. 4-20" average height	short, medium, and tall veg height	4-18"[9,10]	4-15"[9,10]	>8"[9,10]	2-15"[9,10]	3"[9,10]	30"[9,10]	20"[9,10]	15"[9,10]	8"[9,10]	4"[9,10]
Shrub/woody community composition (%)	1. Shrub cover within 10% HCPC range	3. 20-30% w/25-90% shrub cover 4. >70% w/1-30% cover		6. 5-60% of area with shrubs	2. shortgrass prairie w/shrubs; shrublands	<5% woody cover in grasslands	10-20%[7]	5-15%[9,10]	"Reduced to remnant amounts" (1-5%)[7]	<5%[9,10]	<2%[9,10]	5-15%[8]	5%[9,10]	5-10%[9,10]	<2%[9,10]	<2%[9,10]
Woody species richness	6. Desirable shrubs present (as listed)			5. Desirable shrubs present (as listed)	6. 2+ shrub spp present		4-wing saltbush, winterfat, other[7]	4-wing saltbush, winterfat[7]	4-wing saltbush, winterfat[7]	snakeweed[9,10]	fringed sage; pricklypear, rabbitbrush[9,10]	sandcherry, saltbush[8]	Sand sagebrush[9,10]	Sand sagebrush[8]	snakeweed, yucca[9,10]	snakeweed, fringed sage, pricklypear[9,10]
Herbaceous community composition (%)	5. 5-40% of area containing legumes and forbs			8. 20-80% of area w/legumes/forbs in summer 3. Grasses "stand up through winter"	7. 5-75% forb canopy cover		9-24%[7]	9-24%[7]	2-10%[9,10]	0-2%[9,10]	0-2%[9,10]	10-15%[8]	5-10%[9,10]	5-10%[9,10]	<2%[9,10]	<2%[9,10]
Legume/forb species richness					8. 4+ forb spp present		8+ spp minimum[7]	5-8 spp[9,10]	5-8 spp[9,10]	0-5 spp[9,10]	0-5 spp[9,10]	9+ spp minimum[8]	5-8 spp[9,10]	5-8 spp[9,10]	3-6 spp[9,10]	3-6 spp[9,10]
Relevant management scale	8. 90+ acres contiguous grassland	Info: 2-3 sq mi	6. 70+ acres contiguous grassland	Info: 20 sq mi	Info: 4.5-11.8 sq mi	40+ ac guideline										

Site-specific factors

Management activities/ disturbance	4. no disturb during nesting (Apr 15 - July 15) 7. Spring grazed/prairie dog town 9. Insecticide after June 30	6. No disturb within .5mi Mar 1-Aug 1 8. No rodent control 9. Rest or deferred grazing rotation	5. Spring grazed/prairie dog town	4. No disturbance Apr 15 - July 15		mixture of land uses	Proper stocking; adequate recovery periods[7]	No fire or grazing use[7]	moderate cont grazing; heavy winter use[7]	Heavy cont grazing; prairie dogs[7]	Long-term cont grazing[7]	Proper stocking; adequate recovery periods[8]	No fire or grazing use[8]	Cont grazing[8]	Heavy cont grazing; prairie dogs[8]	Long-term cont grazing[8]
Topography			2. <1-5% slopes		3. 0-25% slopes		Nearly level to gently sloping plains; 0-6% slopes[7]	Nearly level to gently sloping plains; 0-6% slopes[7]	Nearly level to gently sloping plains; 0-6% slopes[7]	Nearly level to gently sloping plains; 0-6% slopes[7]	Nearly level to gently sloping plains; 0-6% slopes[7]	Level to hilly uplands and plains; 0-9% slopes[8]	Level to hilly uplands and plains; 0-9% slopes[8]	Level to hilly uplands and plains; 0-9% slopes[8]	Level to hilly uplands and plains; 0-9% slopes[8]	Level to hilly uplands and plains; 0-9% slopes[8]
Landscape/ misc factors		1. Rock outcrop, trees, artificial nests 5. <50% cropland 7. Roads >.5mi	4. rocks/dung "occasional"	7. 5-30% area with cropland food source (waste grain)		Account for habitat present in surrounding areas on a relevant scale	No surface texture modifier, no surface fragments[7]; Manure may be common[9,10]	No surface texture modifier, no surface fragments[7]; Manure may be absent[9,10]	No surface texture modifier, no surface fragments[7]; Manure may be common[9,10]	No surface texture modifier, no surface fragments[7]; Manure may be common[9,10]	No surface texture modifier, no surface fragments[7]; Manure may be common[9,10]	No surface texture modifier, no surface fragments[8]; Manure may be common[9,10]	No surface texture modifier, no surface fragments[8]; Manure may be absent[9,10]	No surface texture modifier, no surface fragments[8]; Manure may be common[9,10]	No surface texture modifier, no surface fragments[8]; Manure may be common[9,10]	No surface texture modifier, no surface fragments[8]; Manure may be common[9,10]

Appendix B: Stable states meeting Shortgrass WHEG criteria

Seral indicators	Shortgrass WHEG[1]	Loamy ESD - HCPC	Loamy - Low Plant Density	Loamy ESD - C/S Remnants	Loamy ESD - Annuals/Bare Ground	Loamy ESD - Sodbound	Sandy ESD - HCPC	Sandy ESD - Low Plant Density	Sandy ESD - Increased blue grama	Sandy ESD - Annuals/Bare ground	Sandy ESD - Sodbound
Canopy cover (%)	2. 20-60% herbaceous cover	80% herbaceous; 20% woody[9,10]	65% herbaceous; 25% woody[9,10]	70% herbaceous; 10% woody[9,10]	30% herbaceous; <5% woody[9,10]	60% herbaceous; <5% woody[9,10]	85% herbaceous; 15% woody[9,10]	75% herbaceous; 20% woody[9,10]	70% herbaceous 10% woody[9,10]	35% herbaceous <2% woody[9,10]	50% herbaceous; <2% woody[9,10]
Bare ground (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vegetation height (in)	3. 1-12" stubble height through winter and nesting (Nov - July)	4-18"[9,10]	4-15"[9,10]	>8"[9,10]	2-15"[9,10]	3"[9,10]	30"[9,10]	20"[9,10]	15"[9,10]	8"[9,10]	4"[9,10]
Shrub/woody community composition (%)	1. Shrub cover within 10% HCPC range	10-20%[7]	5-15%[9,10]	"Reduced to remnant amounts" (1-5%)[7]	<5%[9,10]	<2%[9,10]	5-15%[8]	5%[9,10]	5-10%[9,10]	<2%[9,10]	<2%[9,10]
Woody species richness	6. Desirable shrubs present (as listed)	4-wing saltbush, winterfat, other[7]	4-wing saltbush, winterfat[7]	4-wing saltbush, winterfat[7]	snakeweed[9,10]	fringed sage; pricklypear, rabbitbrush[9,10]	sandcherry, saltbush[8]	Sand sagebrush[9,10]	Sand sagebrush[8]	snakeweed, yucca[9,10]	snakeweed, fringed sage, pricklypear[9,10]
Herbaceous community composition (%)	5. 5-40% of area containing legumes and forbs	9-24%[7]	9-24%[7]	2-10%[9,10]	0-2%[9,10]	0-2%[9,10]	10-15%[8]	5-10%[9,10]	5-10%[9,10]	<2%[9,10]	<2%[9,10]
Legume/forb species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stable states with >50% scores >.5		X	X				X	X			

Blue cells indicate stable state attributes achieving a WHEG factor score of =>.5
If =>50% of the applicable indicators are positive, the state is assumed to have an overall HSI score of =>.5

Appendix C: Stable states meeting Pronghorn WHEG criteria

Seral indicators	Pronghorn[5]	Loamy ESD - HCPC	Loamy - Low Plant Density	Loamy ESD - C/S Remnants	Loamy ESD - Annuals/Bare Ground	Loamy ESD - Sodbound	Sandy ESD - HCPC	Sandy ESD - Low Plant Density	Sandy ESD - Increased blue grama	Sandy ESD - Annuals/Bare ground	Sandy ESD - Sodbound
Canopy cover (%)	4. 5-65% shrub canopy cover 7. 5-75% forb canopy cover	80% herbaceous; 20% woody[9,10]	65% herbaceous; 25% woody[9,10]	70% herbaceous; 10% woody[9,10]	30% herbaceous; <5% woody[9,10]	60% herbaceous; <5% woody[9,10]	85% herbaceous; 15% woody[9,10]	75% herbaceous; 20% woody[9,10]	70% herbaceous 10% woody[9,10]	35% herbaceous <2% woody[9,10]	50% herbaceous; <2% woody[9,10]
Bare ground (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vegetation height (in)	1. 20"+ height 5. 4-20" average height	4-18"[9,10]	4-15"[9,10]	>8"[9,10]	2-15"[9,10]	3"[9,10]	30"[9,10]	20"[9,10]	15"[9,10]	8"[9,10]	4"[9,10]
Shrub/woody community composition (%)	2. shortgrass prairie w/shrubs; shrublands	10-20%[7]	5-15%[9,10]	"Reduced to remnant amounts" (1-5%)[7]	<5%[9,10]	<2%[9,10]	5-15%8	5%[9,10]	5-10%[9,10]	<2%[9,10]	<2%[9,10]
Woody species richness	6. 2+ shrub spp present	4-wing saltbush, winterfat, other[7]	4-wing saltbush, winterfat[7]	4-wing saltbush, winterfat[7]	snakeweed[9,10]	fringed sage; pricklypear, rabbitbrush[9,10]	sandcherry, saltbush[8]	Sand sagebrush[9,10]	Sand sagebrush[8]	snakeweed, yucca[9,10]	snakeweed, fringed sage, pricklypear[9,10]
Herbaceous community composition (%)	7. 5-75% forb canopy cover	9-24%[7]	9-24%[7]	2-10%[9,10]	0-2%[9,10]	0-2%[9,10]	10-15%[8]	5-10%[9,10]	5-10%[9,10]	<2%[9,10]	<2%[9,10]
Legume/forb species richness	8. 4+ forb spp present	8+ spp minimum[7]	5-8 spp[9,10]	5-8 spp[9,10]	0-5 spp[9,10]	0-5 spp[9,10]	9+ spp minimum[8]	5-8 spp[9,10]	5-8 spp[9,10]	3-6 spp[9,10]	3-6 spp[9,10]
Stable states with >50% scores >.5		X	X	X			X	X	X		

Blue cells indicate stable state attributes achieving a WHEG factor score of =>.5
If =>50% of the applicable indicators are positive, the state is assumed to have an overall HSI score of =>.5

Appendix D: Stable states meeting PST Grouse WHEG criteria

Seral indicators	Grouse[4]	Loamy ESD - HCPC	Loamy - Low Plant Density	Loamy ESD - C/S Remnants	Loamy ESD - Annuals/Bare Ground	Loamy ESD - Sodbound	Sandy ESD - HCPC	Sandy ESD - Low Plant Density	Sandy ESD - Increased blue grama	Sandy ESD - Annuals/Bare ground	Sandy ESD - Sodbound
Canopy cover (%)	1. >25% herbaceous nesting/brood canopy cover	80% herbaceous; 20% woody[9,10]	65% herbaceous; 25% woody[9,10]	70% herbaceous; 10% woody[9,10]	30% herbaceous; <5% woody[9,10]	60% herbaceous; <5% woody[9,10]	85% herbaceous; 15% woody[9,10]	75% herbaceous; 20% woody[9,10]	70% herbaceous 10% woody[9,10]	35% herbaceous <2% woody[9,10]	50% herbaceous; <2% woody[9,10]
Bare ground (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vegetation height (in)	2. >8" veg height "in spring prior to growing season"	4-18"[9,10]	4-15"[9,10]	>8"[9,10]	2-15"[9,10]	3"[9,10]	30"[9,10]	20"[9,10]	15"[9,10]	8"[9,10]	4"[9,10]
Shrub/woody community composition (%)	6. 5-60% of area with shrubs	10-20%[7]	5-15%[9,10]	"Reduced to remnant amounts" (1-5%)[7]	<5%[9,10]	<2%[9,10]	5-15%[8]	5%[9,10]	5-10%[9,10]	<2%[9,10]	<2%[9,10]
Woody species richness	5. Desirable shrubs present (as listed)	4-wing saltbush, winterfat, other[7]	4-wing saltbush, winterfat[7]	4-wing saltbush, winterfat[7]	snakeweed[9,10]	fringed sage; pricklypear, rabbitbrush[9,10]	sandcherry, saltbush[8]	Sand sagebrush[9,10]	Sand sagebrush[8]	snakeweed, yucca[9,10]	snakeweed, fringed sage, pricklypear[9,10]
Herbaceous community composition (%)	8. 20-80% of area with legumes and forbs in summer 3. Grasses that stand up through winter	9-24%[7]	9-24%[7]	2-10%[9,10]	0-2%[9,10]	0-2%[9,10]	10-15%[8]	5-10%[9,10]	5-10%[9,10]	<2%[9,10]	<2%[9,10]
Legume/forb species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stable states with >50% scores >.5		X	X				X	X			

Blue cells indicate stable state attributes achieving a WHEG factor score of =>.5
If =>50% of the applicable indicators are positive, the state is assumed to have an overall HSI score of =>.5

Appendix E: Stable states meeting Mountain Plover WHEG criteria

Seral indicators	**Plover[3]**	**Loamy ESD - HCPC**	**Loamy - Low Plant Density**	**Loamy ESD - C/S Remnants**	**Loamy ESD - Annuals/Bare Ground**	**Loamy ESD - Sodbound**	**Sandy ESD - HCPC**	**Sandy ESD - Low Plant Density**	**Sandy ESD - Increased blue grama**	**Sandy ESD - Annuals/Bare ground**	**Sandy ESD - Sodbound**
Canopy cover (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bare ground (%)	3. >30%	<3%[11]	3-5%[9,10]	0-1%[9,10]	50-70%[9,10]	10-15%[9,10]	<3%[12]	0%[9,10]	3-5%[9,10]	50-80%[9,10]	10-15%[9,10]
Vegetation height (in)	1. <1-3"	4-18"[9,10]	4-15"[9,10]	>8"[9,10]	2-15"[9,10]	3"[9,10]	30"[9,10]	20"[9,10]	15"[9,10]	8"[9,10]	4"[9,10]
Shrub/woody community composition (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Woody species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Herbaceous community composition (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Legume/forb species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stable states with >50% scores >.5					X	X				X	

Blue cells indicate stable state attributes achieving a WHEG factor score of =>.5
If =>50% of the applicable indicators are positive, the state is assumed to have an overall HSI score of =>.5

Appendix F: Stable states meeting Ferruginous Hawk WHEG criteria

Seral indicators	Ferruginous Hawk[2]	Loamy ESD - HCPC	Loamy - Low Plant Density	Loamy ESD - C/S Remnants	Loamy ESD - Annuals/Bare Ground	Loamy ESD - Sodbound	Sandy ESD - HCPC	Sandy ESD - Low Plant Density	Sandy ESD - Increased blue grama	Sandy ESD - Annuals/Bare ground	Sandy ESD - Sodbound
Canopy cover (%)	3. 20-30% of area with 25-90% shrub cover 4. >70% area with 1-30% cover	80% herbaceous; 20% woody[9,10]	65% herbaceous; 25% woody[9,10]	70% herbaceous; 10% woody[9,10]	30% herbaceous; <5% woody[9,10]	60% herbaceous; <5% woody[9,10]	85% herbaceous; 15% woody[9,10]	75% herbaceous; 20% woody[9,10]	70% herbaceous 10% woody[9,10]	35% herbaceous <2% woody[9,10]	50% herbaceous; <2% woody[9,10]
Bare ground (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vegetation height (in)	2. 6-24"	4-18"[9,10]	4-15"[9,10]	>8"[9,10]	2-15"[9,10]	3"[9,10]	30"[9,10]	20"[9,10]	15"[9,10]	8"[9,10]	4"[9,10]
Shrub/woody community composition (%)	3. 20-30% of area with 25-90% shrub cover 4. >70% area with 1-30% cover	10-20%[7]	5-15%[9,10]	"Reduced to remnant amounts" (1-5%)[7]	<5%[9,10]	<2%[9,10]	5-15%[8]	5%[9,10]	5-10%[9,10]	<2%[9,10]	<2%[9,10]
Woody species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Herbaceous community composition (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Legume/forb species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stable states with >50% scores >.5		X	X	X	X	X	X	X	X	X	X

Blue cells indicate stable state attributes achieving a WHEG factor score of =>.5
If =>50% of the applicable indicators are positive, the state is assumed to have an overall HSI score of =>.5

Appendix G: Stable states meeting low-structure grassland birds WHEG criteria

Seral indicators	Grassland birds - Short structure[6]	Loamy ESD - HCPC	Loamy - Low Plant Density	Loamy ESD - C/S Remnants	Loamy ESD - Annuals/Bare Ground	Loamy ESD - Sodbound	Sandy ESD - HCPC	Sandy ESD - Low Plant Density	Sandy ESD - Increased blue grama	Sandy ESD - Annuals/Bare ground	Sandy ESD - Sodbound
Canopy cover (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bare ground (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vegetation height (in)	>4"[10]	4-18"[9,10]	4-15"[9,10]	>8"[9,10]	2-15"[9,10]	3"[9,10]	30"[9,10]	20"[9,10]	15"[9,10]	8"[9,10]	4"[9,10]
Shrub/woody community composition (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Woody species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Herbaceous community composition (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Legume/forb species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stable states with >50% scores >.5					X	X					X

Blue cells indicate stable state attributes achieving a WHEG factor score of =>.5
If =>50% of the applicable indicators are positive, the state is assumed to have an overall HSI score of =>.5

Appendix H: Stable states meeting mid-structure grassland birds WHEG criteria

Seral indicators	**Grassland birds - Mid structure**[6]	**Loamy ESD - HCPC**	**Loamy - Low Plant Density**	**Loamy ESD - C/S Remnants**	**Loamy ESD - Annuals/Bare Ground**	**Loamy ESD - Sodbound**	**Sandy ESD - HCPC**	**Sandy ESD - Low Plant Density**	**Sandy ESD - Increased blue grama**	**Sandy ESD - Annuals/Bare ground**	**Sandy ESD - Sodbound**
Canopy cover (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bare ground (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vegetation height (in)	4-16"[10]	4-18"[9,10]	4-15"[9,10]	>8"[9,10]	2-15"[9,10]	3"[9,10]	30"[9,10]	20"[9,10]	15"[9,10]	8"[9,10]	4"[9,10]
Shrub/woody community composition (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Woody species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Herbaceous community composition (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Legume/forb species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stable states with >50% scores >.5		X	X	X	X				X	X	

Blue cells indicate stable state attributes achieving a WHEG factor score of =>.5
If =>50% of the applicable indicators are positive, the state is assumed to have an overall HSI score of =>.5

Appendix I: Stable states meeting tall-structure grassland birds WHEG criteria

Seral indicators	Grassland birds - Tall structure[6]	Loamy ESD - HCPC	Loamy - Low Plant Density	Loamy ESD - C/S Remnants	Loamy ESD - Annuals/Bare Ground	Loamy ESD - Sodbound	Sandy ESD - HCPC	Sandy ESD - Low Plant Density	Sandy ESD - Increased blue grama	Sandy ESD - Annuals/Bare ground	Sandy ESD - Sodbound
Canopy cover (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bare ground (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vegetation height (in)	>16"[10]	4-18"[9,10]	4-15"[9,10]	>8"[9,10]	2-15"[9,10]	3"[9,10]	30"[9,10]	20"[9,10]	15"[9,10]	8"[9,10]	4"[9,10]
Shrub/woody community composition (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Woody species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Herbaceous community composition (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Legume/forb species richness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stable states with >50% scores >.5		X					X	X			

Blue cells indicate stable state attributes achieving a WHEG factor score of =>.5
If =>50% of the applicable indicators are positive, the state is assumed to have an overall HSI score of =>.5

Exhibit 1

Wildlife Habitat Evaluation Guides

NRCS	Wildlife Habitat Evaluation Guide – Shortgrass Prairie

December 2008

Owner/Operator:		District:	
County:		Field Office:	
Assisted By:		Acres:	
Location:		Date:	
Farm & Tract #:		Contract #:	

General Information: Midgrass prairie is found in Eastern Colorado. It is used primarily as grazing land. The vegetation is dominated by native mid to tall-grasses and forb species. Shrubs such as fourwing saltbush and winterfat may be found in varying amounts on these prairies. This model may be used on all mid-tall grass prairie in Colorado. A score of 0.5 or higher meets NRCS Quality Criteria for a Resource Management System.

Cover Factors

1) Percent composition of shrubs	Value	Before	After
a) Within the range specified in the Ecological Site Description (ESD) for the Historic Climax Plant Community (HCPC)	1.0		
b) Within 10% (either higher or lower) of the range in the ESD for the HCPC	0.5		
c) 11-25% of the range in the ESD for the HCPC	0.3		
d) More than 25% outside the HCPC range	0.1		
Enter value here ------->			

2) Percent canopy cover of grasses and forbs	Value	Before	After
a) 30-50%	1.0		
b) 20-29% or 51-60%	0.5		
c) 10-19% or 61-75%	0.3		
d) <10% or >75%	0.1		
Enter value here ------->			

3) Minimum height of standing grass/forb cover over winter and through nesting season	Value	Before	After
a) 3-6"	1.0		
b) 1-2.9" or 6.1-12"	0.5		
d) <1 or >12"	0.1		
Enter value here ------->			

4) Management of cover area (pick the highest applicable score)	Value	Before	After
a) Cover area not mowed, plowed, burned, harvested, etc. between April 1 - July 15. If grazed during this time, a grazing plan that addresses wildlife concerns is followed.	1.0		
b) Cover area not mowed, plowed, burned, harvested, etc. between April 15 – June 15. If grazed during this time, a grazing plan that addresses wildlife concerns is followed	0.5		
c) Cover area not mowed, plowed, burned, harvested, etc. between April 15 – June 1. If grazed during this time, a grazing plan that addresses wildlife concerns is followed.	0.1		
d) Cover area is mowed, plowed, burned, or harvested between April 1 – June 1 or is grazed at any time without a grazing plan.	0.0		
Enter value here ------->			

Food Factors

5) Summer food-Percent of planning unit containing legumes and forbs in the plant communit	Value	Before	After
a) 10-25%	1.0		
b) 5-9% or 26-40%	0.5		
c) <5% or >40%	0.1		
Enter value here ------->			

6) Winter food-Type of shrubs (species composition) on planning unit	Value	Before	After
a) Saltbush, winterfat	1.0		
b) Leadplant, rabbitbrush, fringed sage	0.5		
c) Snakeweed, prickly pear, yucca	0.1		
d) No shrubs	0.0		
Enter value here ------->			

7) Other food sources-insects and rodents	Value	Before	After
a) Grazed prairie dog town	1.0		
b) Spring grazed area with no prairie dogs	0.5		
c) Fall grazed area with no prairie dogs	0.1		
Enter value here ------->			

General Habitat Factors

7) Tract Size	Value	Before	After
a) More than 140 contiguous grassland acres	1.0		
b) 90-140 contiguous grassland acres	0.5		
c) 70-89 contiguous grassland acres	0.3		
d) <70 contiguous grassland acres	0.1		
Enter value here ------->			

8) Pesticide Use Pattern	Value	Before	After
a) No insecticides used, or use delayed until after July 15	1.0		
b) Use of insecticides delayed until after June 30	0.5		
c) Use of insecticides delayed until after June 15	0.3		
d) Insecticides used before June 15th	0.0		
Enter value here ------->			

HSI Value is the lowest value for the above 8 factors. To improve the HSI, the lowest value in the before condition must be increased by implementing changes that will increase the value in the after condition.

	Before	After
Overall HSI --->	0.00	0.00

NRCS	Wildlife Species Model – Ferruginous Hawk

March 2009

Owner/Operator:		District:	
County:		Field Office:	
Assisted By:		Acres:	
Location:		Date:	
Farm & Tract #:		Contract #:	

General Information: This model may be used where ferruginous hawks occur and where they are the targeted species. Ferruginous hawks are found most commonly on grasslands, shrublands, or steppe-desert areas (Jasikoff 1982). They winter and nest in Colorado. Jackrabbits, ground squirrels, and prairie dogs are important foods. Trees, rock outcrops, bluffs, cliffs, and habitat edges with trees are used for nesting.

Nesting Factor

1) Nesting Site Availability	Value	Before	After
a) Rock outcroppings, lone trees, or man made raptor nests present (greater than 3' tall).	1.0		
b) Tree groves or grouped trees present on small amount of property with no outcroppings present	0.5		
c) No trees or outcroppings present or property is completely forested	0.0		
	Enter value here ------->		

Cover Factors

2) Vegetative height	Value	Before	After
a) 6-10" average vegetative height	1.0		
b) 10-24" average vegetative height	0.5		
c) >24" or <6" vegetative height	0.0		
	Enter value here ------->		

3) Shrub Cover (food production)	Value	Before	After
a) 20-30% of the area is dominated by 60-75% shrub cover	1.0		
b) 20-30% of the area is dominated by 25-60% or 75-90% shrub cover	0.5		
c) Less than 20% of the area is dominated by shrub cover or shrub cover is 0-25%, 90-100%	0.0		
	Enter value here ------->		

4) Shrub Cover (hunting)	Value	Before	After
a) >70% of the area is dominated by 1-10% shrub cover	1.0		
b) >70% of the area is dominated by 10-30% shrub cover	0.5		
c) Any other amounts of shrub cover	0.0		
	Enter value here ------->		

5) Percent cultivated cropland in management area	Value	Before	After
a) 0%	1.0		
b) <50%	0.5		
c) >50%	0.0		
	Enter value here ------->		

Disturbance Factors

6) Disturbance		Value	Before	After
a)	No disturbance within 1/2 mile of potential nest sites between March 1 and August 1.	1.0		
b)	Disturbance occurs within 1/2 mile of potential nest sites between March 1 and August 1.	0.0		
		Enter value here ------->		

7) Distance to well traveled roads (paved 2 or more lanes).		Value	Before	After
a)	> 1.2 Miles	1.0		
b)	> 0.5 Miles	0.5		
c)	< 0.5 Miles	0.0		
		Enter value here ------->		

Food Factors

8) Maintenance of rodent populations		Value	Before	After
a)	Rodents left to natural control mechanisms	1.0		
b)	Rodents killed but not completely eradicated using non poison methods timing used to smooth off peaks in rodent population.	0.5		
c)	Rodents mostly eradicated leaving only a few surviving.	0.3		
d)	Rodents completely eradicated or killed with poison to any extent.	0.0		
		Enter value here ------->		

9) Grazing Patterns		Value	Before	After
a)	Grazing system incorporating a rest rotation or deferred rotation.	1.0		
b)	Grazing system with no rest rotation.	0.3		
c)	Currently not grazed or overgrazed on 100% of area.	0.0		
		Enter value here ------->		

HSI Value is the lowest value for the above 9 factors. To improve the HSI, the lowest value in the before condition must be increased by implementing changes that will increase the value in the after condition. An overall score of 0.5 or higher meets NRCS Quality Criteria for a Resource Management System. In order to report practice 645, Upland Wildlife Habitat Management, you must show an improvement to 0.5 or greater after application; or if all values are at 0.5 or greater to begin with, you must show an improvement in one or more factor values.

	Before	After
Overall HSI --	0.00	0.00

References:

Jasikoff, T.M. 1982. Habitat Suitability Models: Ferruginous Hawk. U.S. Fish & Wildlife Svc. FWS/OBS-82/10.10. 18pp.

Rocky Mountain Bird Observatory SARE manual

NRCS	Wildlife Habitat Evaluation Guide – Mountain Plover

March 2009

Owner/Operator:		District:	
County:		Field Office:	
Assisted By:		Acres:	
Location:		Date:	
Farm & Tract #:		Contract #:	

General Information: This Guide models habitat conditions needed by mountian plover for nesting in Colorado. Plovers arrive in Colorado as early as late March. Potential nesting habitat is found in most Eastern Plains counties beginning at the base of the Front Range foothills and eastward to the State line, and in Park, Moffat, Jackson, Rio Blanco, Saguache, Alamosa, and Rio Grande Counties. See the attached map of shortgrass prairie for suitable plover habitat.

Cover Factors

1) Average vegetation height	Value	Before	After
a) 1 inch or less	1.0		
b) 2 - 3 inches	0.5		
d) Between 3 and 4 inches	0.1		
e) >4 inches	0.0		
Enter value here ------->			

2) Land slope	Value	Before	After
a) <1%	1.0		
b) 2 - 5%	0.5		
c) >5%	0.1		
Enter value here ------->			

3) Bare ground - percent aerial coverage	Value	Before	After
a) >50%	1.0		
b) 30 - 49%	0.7		
c) <30%	0.0		
Enter value here ------->			

4) Presence of rocks and/or dung	Value	Before	After
a) Common, widespread	1.0		
b) Occasional	0.5		
c) Absent	0.1		
Enter value here ------->			

Food Factor

5) Food sources - potential for insects	Value	Before	After
a) Grazed prairie dog town	1.0		
b) Spring grazed area-no prairie dogs	0.5		
c) Fall grazed area-no prairie dogs	0.1		
Enter value here ------->			

Interspersion Factor

6) Size of tract	Value	Before	After
a) More than 140 contiguous grassland acres	1.0		
b) 90-140 contiguous acres	0.7		
c) 70-90 contiguous acres	0.5		
d) <70 contiguous acres	0.1		
Enter value here ------->			

HSI Value is the lowest value for the above 6 factors. To improve the HSI, the lowest value in the before condition must be increased by implementing changes that will increase the value in the after condition. To meet quality criteria, the overall HSI must be at 0.5 or higher in the after condition.

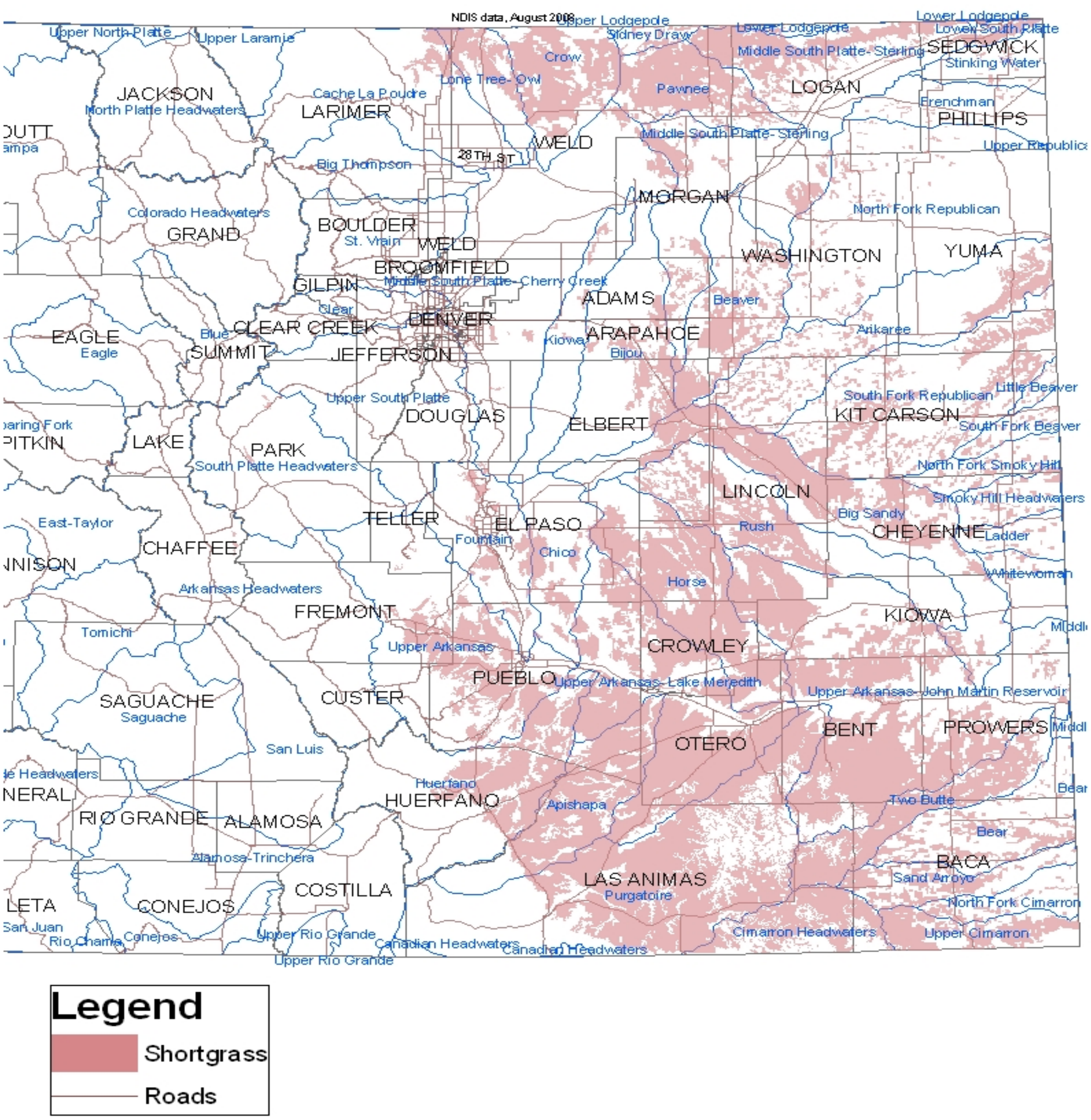
	Before	After
Overall HSI -->	0.00	0.00

References:

Knopf, F.L. 2003. Personal Communication

Leachman, R. 2003. Personal Communication.

Shortgrass Prairie



United States Department of Agriculture	CO WSM-18
Natural Resources Conservation Service	May 2004

WILDLIFE SPECIES MODEL
PLAINS SHARP-TAILED GROUSE
COLORADO

Customer Name: ____
Location: ____
Planner Name: ____
Date: ____

General Information

Self sustaining populations of plains sharp-tailed grouse have been extirpated in Douglas County. Plains sharp-tails poineered into Weld County following establishment of CRP fields and have established a sustainable population near Grover and Herford. The Weld County population is the largest in the State. They are known to hybridize with greater prairie chickens in one area of Logan County. The Division of Wildlife is transplanting sharptails into southeastern Weld and northeastern Morgan Counties in an attempt to increase distribution and population size. Leks have been documented in Logan and Sedgwick Counties. Las Animas County has a very small, transplanted population. Plains sharp-tails use mid-grass areas in CRP. Other habitats such as riparian areas, cropland, and leks may be seasonally important. Recent findings have concluded shrubs are less important habitat components than previously thought. Preferred foods shift seasonally and with the bird's life stage. Insects comprise a large part of the chick's diet. Plant foods such as grains and buds from trees and shrubs become more important in the winter and as the chicks mature. All habitat components should be within 5 miles for optimum habitat conditions. Grouse obtain adequate water through their diet in the form of insects, plants, and dew. Supplemental water is not needed.

Life Requisite	Factor	Value	Value Before	Value After
COVER	**1. Nesting and brood cover-percent canopy cover of grasses/forbs**			
	a.>40% --	1.0		
	b. 25-39% ---	0.6		
	c. 10-24% ---	0.3		
	d. <10% ---	0.1	________	________
	2. Residual cover-average height of grasses and forbs in spring prior to growing season			
	a. >12 inches --	1.0		
	b. 8-12 inches ---	0.6		
	c. 4-7 inches ---	0.3		
	d. <4 inches --	0.1	________	________
	3. Dominant species composition			
	a. Predominantly native grasses with tall structure that stand up through winter and spring (Western wheat, needlegrass, sandsage, bluestem) -----------------------------	1.0		
	b. Predominantly non-native grasses that stand up through winter (orchardgrass, crested wheat, other wheatgrasses) --	0.5		
	c. Sod forming or non-native or short grasses that do			

			Before	After
	not stand up through winter (smooth brome, blue grama, buffalograss) ---	0.1	________	________
	4. Cover management			
	a. Cover area not mowed, plowed, grazed, burned, harvested, etc. between April 1 - July 15 ---------------------	1.0		
	b. Cover area not mowed, plowed, grazed, burned, harvested, etc. between April 15 - June 15 -------------------	0.5		
	c. Cover areas are mowed, plowed, grazed, burned, harvested, etc. between April 15 - June 1 --------------------	0.1	________	________
FOOD	**5. Winter food-Type of shrubs (species comp.) in distinct stands on planning unit**			
	a. Rose, chokecherry, serviceberry, oak, hawthorn, cottonwood. aspen, sumac, buffaloberry, snowberry, juniper, currant --	1.0		
	c. Sagebrush, Russian-olive -------------------------------------	0.5		
	d. No shrubs ---	0.0	________	________
	6. Winter food-percent of planning unit in winter shrublands adequate for winter foods			
	a. 20-40% --	1.0		
	b. 5-19% or 41-60% --	0.5		
	c. <5% or >60% --	0.1	________	________
	7. Percent of planning unit in grain left over winter			
	a. 10-20% ---	1.0		
	b. 5-9% or 20-30% ---	0.5		
	c. <5% or >30% --	0.1	________	________
	8. Summer food-Percent of planning unit containing legumes and forbs in the plant community.			
	a. 40-60% --	1.0		
	b. 20-30% or 61-80% --	0.6		
	c. 10-19% or 81-90% --	0.3		
	d. <10% or >90% --	0.1	________	________
WATER	**See general information**			

Scoring - Plains Sharp-Tailed Grouse

An overall HSI value of 0.5 or greater is required to meet quality criteria for wildlife. In order to report practice 645, upland wildlife habitat management, you must show an improvement to 0.5 or greater after application; or if all values are at 0.5 or greater to begin with, you must show an improvement in the overall HSI value.

The overall HSI for sharp-tailed grouse consists of two parts, a cover HSI value and a food HSI value.

	Before	After
COVER HSI VALUE ---	________	________

Look at the before values for factors 1-4 and pick the lowest value. This factor is the HSI for cover and is the most limiting factor for cover on this unit. It must be the first factor targeted when improving cover on this unit.

FOOD HSI VALUE -- ________ ________
Look at the before values for factors 5-8 and pick the lowest value. This factor is the HSI for food and is the most limiting factor for food on this unit. It must be the first factor targeted when improving food on this unit.

OVERALL HSI VALUE --- ________ ________
The overall HSI value is the lowest of the food and cover HSI values.

References:

Gorman, E. 2004. Personal communication.

Remington, T. 2004. Personal communication.

Rogers, G.E. 1969. The sharp-tailed grouse in Colorado. Colorado Game, Fish, and Parks Tech. Pub. No. 23. 94 pp.

NRCS	Wildlife Habitat Evaluation Guide – Pronghorn

March 2009

Owner/Operator:		District:	
County:		Field Office:	
Assisted By:		Acres:	
Location:		Date:	
Farm & Tract #:		Contract #:	

General Information: Home range is 165-2300 square km or 0.64-8.8 square miles. Daily movements are less than 10 km or 6.2 miles. The minimum habitat area is 11.8 square miles or a 2.4 mile diameter circle of contiguous habitat. Habitats of this size are assumed to meet minimum winter food and cover needs. Ground level water is readily used, but may not be essential to survival. Succulent vegetation provides some of the water needs for pronghorn during cool parts of the year. During hot weather, pronghorn may drink 3-5 quarts of water per animal per day. Although pronghorn herds have been known to survive without free water, if a herd is accustomed to drinking water, removal of that water (e.g. fencing the herd out of an area) may prove fatal to some or all of that herd.

Cover Factors

1) Fawning and daytime bedding sites	Value	Before	After
a) Rolling hills with bunchgrasses and/or yucca or shrubs that are at least 20 inches tall	1.0		
b) Flat sites with low shrubs that are 20-36 inches tall	0.5		
c) Sites with tall shrub species or grasses less than 20 inches tall	0.3		
d) Other cover types	0.0		
Enter value here ------->			

2) Plant communities	Value	Before	After
a) Shortgrass prairie grasslands with shrubs or sagebrush-steppe	1.0		
b) Desert shrublands such as but not limited to pinon-juniper	0.5		
c) Other communities	0.1		
Enter value here ------->			

3) Topography	Value	Before	After
a) 9-25% slope with well defined drainage patterns	1.0		
b) 3-8% slope; gently rolling terrain	0.8		
c) 0-2% slope	0.5		
e) >25 % slope; mountains	0.1		
Enter value here ------->			

Food Factors

4) Percent shrub canopy cover	Value	Before	After
a) 15-25%	1.0		
b) 10-14% or 26-35%	0.7		
c) 5-9% or 36-65%	0.5		
d) 1-4% or 66-75%	0.2		
e) <1% or >75%	0.0		
Enter value here ------->			

5) Average height of vegetative canopy	Value	Before	After
a) 7-18 inches	1.0		
b) 4-6 inches or 19-20 inches	0.5		
c) 1-3 inches or 21-24 inches	0.2		
d) < 1 inch or > 24 inches	0.0		
Enter value here ------->			

6) Number of shrub species	Value	Before	After
a) More than 4	1.0		
b) 3	0.7		
c) 2	0.5		
d) 1	0.2		
e) 0	0.0		
	Enter value here ------->		

7) Percent canopy cover in forbs	Value	Before	After
a) 10-40%	1.0		
b) 5-9% or 41-75%	0.5		
c) 0-4% or 76-100%	0.1		
	Enter value here ------->		

8. Number of forb species	Value	Before	After
a) >10 species	1.0		
b) 7-10 species	0.7		
c) 4-6 species	0.5		
d) 2-4 species	0.1		
e) <2 species	0.0		
	Enter value here ------->		

HSI Value is the lowest value for the above 8 factors. To improve the HSI, the lowest value in the before condition must be increased by implementing changes that will increase the value in the after condition

	Before	After
Overall HSI --->	0.00	0.00

<u>Exhibit 2</u>

Selected sections from

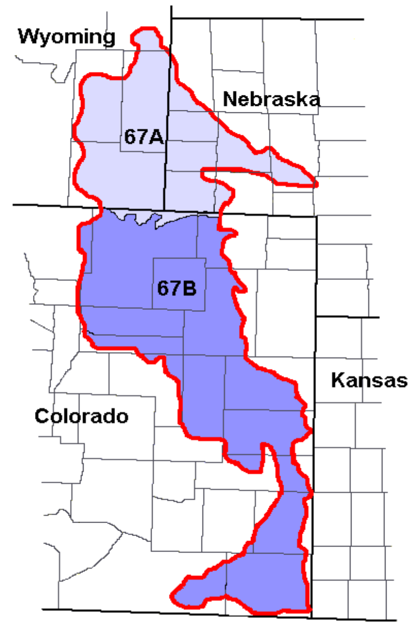
Ecological Site Descriptions

With

Ecological Reference Sheets

United States Department of Agriculture
Natural Resources Conservation Service

Ecological Site Description



Site Type: Rangeland

Site Name: Loamy

Site ID: R067BY002CO

Major Land Resource Area: 67B – Central High Plains, Southern Part

Physiographic Features

This site occurs on nearly level to gently sloping plains.

Landform: plain, terrace **Aspect:** N/A

	Minimum	Maximum
Elevation (feet):	3800	5600
Slope (percent):	0	6
Water Table Depth (inches):	60	60
Flooding:		
Frequency:	none	none
Duration:	none	none
Ponding:		
Depth (inches):	0	0
Frequency:	none	none
Duration:	none	none
Runoff Class:	low	medium

Climatic Features

The mean average annual precipitation varies from 12 to 16 inches per year depending on location and ranges from less than 8 inches to over 20 inches per year. Approximately 75 percent of the annual precipitation occurs during the growing season from mid-April to late-September. Snowfall can vary greatly from year to year but averages 35 to 45 inches per year. Winds are estimated to average about 9 miles per hour annually, ranging from 10 miles per hour during the spring to 9 miles per hour during late summer. Daytime winds are generally stronger than nighttime and occasional strong storms may bring periods of high winds with gusts to more than 90 miles per hour.

The average length of the growing season is 142 days, but varies from 129 to 154 days. The average date of first frost in the fall is September 28, and the last frost in the spring is about May 9. July is the hottest month and December and January are the coldest. It is not uncommon for the temperature to exceed 100 degrees F during the summer. Summer humidity is low and evaporation is high. The winters are characterized with frequent northerly winds, producing severe cold with temperatures dropping to -35 degrees F or lower.

Plant Communities

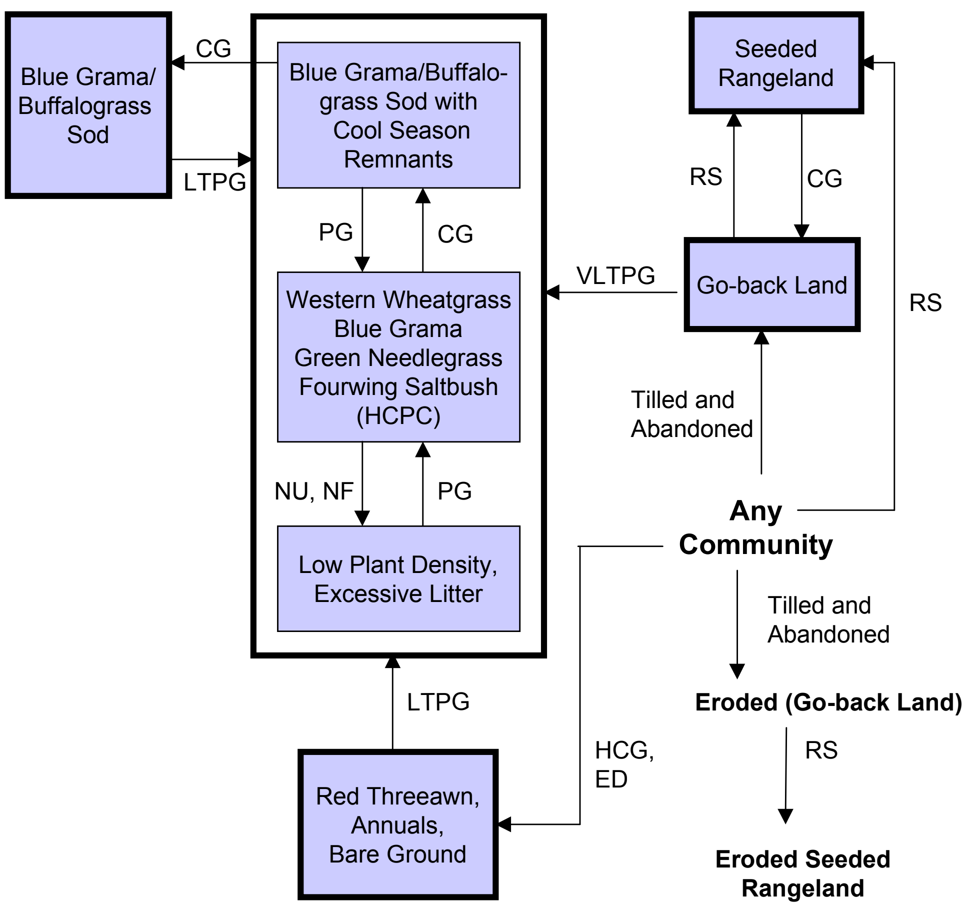
Ecological Dynamics of the Site:

Deterioration of this site, due to continuous grazing without adequate recovery periods following each grazing occurrence, will cause blue grama and buffalograss to increase and eventually form a sod. Cool season grasses such as green needlegrass and western wheatgrass will decrease in frequency and production as well as key shrubs such as fourwing saltbush and winterfat. American vetch and other highly palatable forbs will decrease also. Red threeawn, annuals and bare ground increases under heavy continuous grazing or excessive defoliation. Much of this ecological site has been tilled and used for crop production.

The historic climax plant community (description follows the plant community diagram) has been determined by study of rangeland relic areas, areas protected from excessive disturbance, seasonal use pastures, short durationl/time controlled grazing and historical accounts.

The following diagram illustrates the common plant communities that can occur on the site and the transition pathways (arrows) among communities. Bold lines surrounding each plant community or communities represent ecological thresholds. The ecological processes are discussed in more detail in the plant community descriptions following the diagram.

Plant Communities and Transitional Pathways



CG - continuous grazing w/o adequate recovery opportunity, **ED** - excessive defoliation, **HCG** - heavy continuous grazing, **HCPC** - Historic Climax Plant Community, **LTPG** - long term prescribed grazing (>40 yrs), **NF** - no fire, **NU** - non use, **PG** - prescribed grazing with adequate recovery period, **RS** - range seeding, **VLTPG** - very long term prescribed grazing (>80 yrs)

Plant Community Composition and Group Annual Production

COMMON/GROUP NAME	SCIENTIFIC NAME	SYMBOL	Western Wheatgrass, Blue Grama, Green Needlegrass, Fourwing Saltbush (HCPC) Group	lbs./acre	% Comp
GRASSES & GRASS-LIKES					
COOL SEASON MID RHIZOMATOUS GRASS			***1***	***260 - 390***	***20 - 30***
western wheatgrass	Pascopyrum smithii	PASM	1	260 - 390	20 - 30
COOL SEASON MID BUNCH GRASSES			***2***	***65 - 195***	***5 - 15***
bottlebrush squirreltail	Elymus elymoides ssp. elymoides	ELELE	2	0 - 13	0 - 1
green needlegrass	Nassella viridula	NAVI4	2	65 - 195	5 - 15
Indian ricegrass	Achnatherum hymenoides	ACHY	2	0 - 13	0 - 1
needleandthread	Hesperostipa comata ssp. comata	HECOC8	2	0 - 13	0 - 1
WARM SEASON SHORT BUNCH GRASS			***3***	***260 - 325***	***20 - 25***
blue grama	Bouteloua gracilis	BOGR2	3	260 - 325	20 - 25
WARM SEASON SHORT STOLENIFEROUS GRASS			***4***	***13 - 65***	***1 - 5***
buffalograss	Buchloe dactyloides	BUDA	4	13 - 65	1 - 5
WARM SEASON MID BUNCH GRASSES			***5***	***13 - 33***	***1 - 3***
little bluestem	Schizachyrium scoparium	SCSC	5	0 - 13	0 - 1
sideoats grama	Bouteloua curtipendula	BOCU	5	0 - 13	0 - 1
sand dropseed	Sporobolus cryptandrus	SPCR	5	13 - 39	1 - 3
COOL SEASON ANNUAL GRASSES			***6***	***0 - 13***	***0 - 1***
sixweeks fescue	Vulpia octoflora	VUOC	6	0 - 13	0 - 1
MISCELLANEOUS GRASSES			***7***	***13 - 22***	***1 - 2***
red threeawn	Aristida purpurea var. longiseta	ARPUL	7	0 - 13	0 - 1
ring muhly	Muhlenbergia torreyi	MUTO2	7	0 - 13	0 - 1
SEDGES			***8***	***13 - 26***	***1 - 2***
sun sedge	Carex inops ssp. heliophila	CAINH2	8	13 - 26	1 - 2
needleleaf sedge	Carex duriuscula	CADU6	8	0 - 13	0 - 1
OTHER NATIVE GRASSES		2GP	***9***	***13 - 39***	***1 - 3***
FORBS					
LEGUMES			***10***	***22 - 77***	***2 - 7***
American vetch	Vicia americana	VIAM	10	13 - 65	1 - 5
purple prairie clover	Dalea purpurea var. purpurea	DAPUP	10	13 - 26	1 - 2
slimflower scurfpea	Psoralidium tenuiflorum	PSTE5	10	0 - 13	0 - 1
woolly locoweed	Astragalus mollissimus	ASMO7	10	0 - 13	0 - 1
silky crazyweed	Oxytropis sericea	OXSE	10	0 - 13	0 - 1
silky sophora	Sophora nuttalliana	SONU	10	0 - 13	0 - 1
COOL SEASON			***11***	***22 - 44***	***2 - 4***
scarlet globemallow	Sphaeralcea coccinea	SPCO	11	13 - 39	1 - 3
narrowleaf penstemon	Penstemon angustifolius	PEAN4	11	13 - 26	1 - 2
variable senecio	Packera neomexicana var. mutabilis	PANEM	11	0 - 13	0 - 1
WARM SEASON			***12***	***33 - 77***	***3 - 7***
dotted gayfeather	Liatris punctata	LIPU	12	13 - 26	1 - 2
ironplant goldenweed	Machaeranthera pinnatifida ssp. pinnatifida	MAPIP4	12	13 - 26	1 - 2
upright prairie coneflower	Ratibida columnifera	RACO3	12	13 - 26	1 - 2
plains bahia	Picradeniopsis oppsitifolia	PIOP	12	0 - 13	0 - 1
Colorado four o'clock	Mirabilis multiflora	MIMU	12	0 - 13	0 - 1
cutleaf evening-primrose	Oenothera coronopifolia	OECO2	12	0 - 13	0 - 1
Louisiana sagewort	Artemisia ludoviciana	ARLU	12	0 - 13	0 - 1
rush skeletonplant	Lygodesmia juncea	LYJU	12	0 - 13	0 - 1
scarlet gaura	Gaura coccinea	GACO5	12	0 - 13	0 - 1
wavyleaf thistle	Cirsium undulatum	CIUN	12	0 - 13	0 - 1
western ragweed	Ambrosia psilostachya	AMPS	12	0 - 13	0 - 1
ANNUALS			***13***	***0 - 13***	***0 - 1***
woolly Indianwheat	Plantago patagonica	PLPA2	13	0 - 13	0 - 1
OTHER NATIVE FORBS		2FP	***14***	***26 - 65***	***2 - 5***
SHRUBS, HALF-SHRUBS, ETC.					
SHRUBS			***15***	***66 - 260***	***6 - 20***
fourwing saltbush	Atriplex canescens	ATCA2	15	65 - 195	5 - 15
winterfat	Krascheninnikovia lanata	KRLA2	15	13 - 65	1 - 5
rubber rabbitbrush	Ericameria nauseosa ssp. nauseosa	ERNAN5	15	0 - 13	0 - 1
HALF-SHRUBS			***16***	***0 - 13***	***0 - 1***
broom snakeweed	Gutierrezia sarothrae	GUSA2	16	0 - 13	0 - 1
fringed sagebrush	Artemisia frigida	ARFR4	16	0 - 13	0 - 1
SUCCULENTS			***17***	***0 - 13***	***0 - 1***
plains pricklypear	Opuntia polyacantha	OPPO	17	0 - 13	0 - 1
purple pincushion	Escobaria vivipara var. vivipara	ESVIV	17	0 - 13	0 - 1
EVERGREEN			***18***	***0 - 13***	***0 - 1***
small soapweed	Yuca glauca	YUGL	18	0 - 13	0 - 1
OTHER NATIVE SHRUBS		2SHRUB	***19***	***13 - 39***	***1 - 3***

Annual Production lbs./acre	LOW - RV* - HIGH
GRASSES & GRASS-LIKES	415 - 1007 - 1400
FORBS	60 - 130 - 200
SHRUBS	125 - 163 - 200
TOTAL	600 - 1300 - 1800

This list of plants and their relative proportions are based on near normal years. Fluctuations in species composition and relative production may change from year to year dependent upon precipitation or other climatic factors. *RV - Representative Value

Plant Community Narratives

Following are the narratives for each of the described plant communities. These plant communities may not represent every possibility, but they probably are the most prevalent and repeatable plant communities. The plant composition table shown above has been developed from the best available knowledge at the time of this revision. As more data are collected, some of these plant communities may be revised or removed, and new ones may be added. None of these plant communities should necessarily be thought of as "Desired Plant Communities". According to the USDA NRCS National Range and Pasture Handbook, Desired Plant Communities will be determined by the decision-makers and will meet minimum quality criteria established by the NRCS. The main purpose for including any description of a plant community here is to capture the current knowledge and experience at the time of this revision.

Western Wheatgrass, Blue Grama, Green Needlegrass, Fourwing Saltbush Plant Community

This is the interpretive plant community and is considered to be the Historic Climax Plant Community (HCPC). This plant community evolved with grazing by large herbivores, is well suited for grazing by domestic livestock and can be found on areas that are properly managed with prescribed grazing that allows for adequate recovery periods following each grazing event. The potential vegetation is about 70-85% grasses and grass-like plants, 5-15% forbs and 10-15% woody plants.

The major grasses include western wheatgrass, green needlegrass and blue grama. Sub-dominant grasses include needleandthread, buffalograss and sand dropseed. Major forbs and shrubs include American vetch, upright prairie coneflower, scarlet globemallow, dotted gayfeather, fourwing saltbush and winterfat.

This plant community is diverse, stable, and productive. Litter is properly distributed with very little movement off-site and natural plant mortality is very low. It is well suited to carbon sequestration, water yield, wildlife use by many species, livestock use and is esthetically pleasing. Community dynamics, nutrient cycle, water cycle and energy flow are functioning properly. This community is resistant to many disturbances except continuous grazing, tillage and/or development into urban or other uses.

Total annual production ranges from 600 to 1800 pounds of air-dry vegetation per acre and will average 1300 pounds during an average year.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6701
Growth curve name: Cool season/warm season co-dominant; MLRA-67B; upland fine textured soils.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	2	8	20	28	15	12	10	5	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- Continuous grazing without adequate recovery periods between grazing events will shift this plant community to the *Blue Grama/Buffalograss Sod with Cool Season Remnants Plant Community.*
- Non-use (rest) and lack of fire will move this plant community to the *Low Plant Density, Excessive Litter Plant Community.*

- <u>Prescribed grazing</u> that allows for adequate recovery opportunity following each grazing event and proper stocking will maintain the *Western Wheatgrass, Blue Grama, Green Needlegrass, Fourwing Saltbush Plant Community (HCPC).*

Blue Grama/Buffalograss Sod with Cool Season Remnants Plant Community

This plant community evolved with long-term continuous grazing, moderate stocking, and in some instances heavy winter stocking. Recognition of this plant community will enable the land user to implement key management decisions before a significant economic/ecological threshold is crossed.

Key species such as green needlegrass, western wheatgrass, American vetch, fourwing saltbush and winterfat have been reduced to remnant amounts. Blue grama and buffalograss have increased in abundance, dominate the community, and are beginning to take on a sod appearance. Sand dropseed, red threeawn, sixweeks fescue, plains pricklypear, hairy goldaster and bottlebrush squirreltail have also increased. This plant community is at risk of losing western wheatgrass, which is the major cool season grass left at this point. Once the key species are completely removed and other plants have increased, it will take a long time to bring them back by management alone. Substantial increases in money and other resources will be required to replace the lost species in a shorter period of time.

Total aboveground carbon has been reduced due to decreases in forage and litter production. Reduction of rhizomatous wheatgrass, nitrogen fixing forbs, shrub component and increased warm season short grasses has begun to alter the biotic integrity of this community. Water and nutrient cycles may be impaired.

Total annual production can vary from 200 to 900 pounds of air-dry vegetation per acre and will average 700 pounds during an average year.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6702
Growth curve name: Warm season dominant, cool season sub-dominant; MLRA-67B, upland fine textured soils.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	0	2	15	45	20	15	3	0	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- <u>Continuous grazing</u> without adequate recovery periods between grazing events shifts this plant community across an ecological threshold toward the *Blue Grama/Buffalograss Sod Plant Community.*
- <u>Prescribed grazing</u> with adequate recovery periods after each grazing occurrence during the growing season with a proper stocking rate will return the plant community back to the *Western Wheatgrass, Blue Grama, Green Needlegrass, Fourwing Saltbush Plant Community (HCPC)*.

Low Plant Density, Excessive Litter Plant Community

This plant community occurs when grazing is removed for long periods of time (rest) in the absence of fire. Plant composition is similar to the HCPC, however individual species production and frequency will be lower. Prickley pear cactus and fringed sagebrush have increased.

Much of the nutrients are tied up in excessive litter. The semiarid environment and the absence of animal traffic to break down litter slow nutrient recycling. Aboveground litter also limits sunlight from reaching plant crowns. Many plants, especially bunchgrasses die off. Thick litter and absence of grazing or fire reduce seed germination and establishment.

In advanced stages, plant mortality can increase and erosion may eventually occur if bare ground increases. Once this happens it will require increased energy input in terms of practice cost and management to bring back.

Total annual production can vary from 400 to 1300 pounds of air-dry vegetation per acre and will average 850 pounds during an average year.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6703
Growth curve name: Cool season/warm season co-dominant, excess litter; MLRA-67B; upland fine textured soils.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	0	10	20	25	15	15	10	5	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- Prescribed grazing with adequate recovery periods between each grazing event and proper stocking can restore this plant community back to the *Western Wheatgrass, Blue Grama, Green Needlegrass, Fourwing Saltbush Plant Community (HCPC)*.

Blue Grama/Buffalograss Sod Plant Community

This plant community evolved with repeated continuous grazing and occurs frequently throughout most of the eastern plains of Colorado. Fourwing saltbush, winterfat, American vetch and green needlegrass have been removed. Western wheatgrass may persist in trace amounts, greatly reduced in vigor and not readily seen. Blue grama and buffalograss dominate the community with a tight "sodbound" structure. Plains pricklypear, hairy goldaster, red threeawn, sixweeks fescue and bottlebrush squirreltail have increased.

This plant community is resistant to change due to grazing tolerance of buffalograss and blue grama. A significant amount of production and diversity has been lost when compared to the HCPC. Loss of cool season grasses, shrub component and nitrogen fixing forbs have negatively impacted energy flow and nutrient cycling. Water infiltration is reduced significantly due to the massive shallow root system "root pan", characteristic of sodbound blue grama and buffalograss. Soil loss may be obvious where flow paths are connected.

It will take a very long time to restore this plant community back to the HCPC with improved management. Renovation would be very costly. Desertification is advanced.

Production ranges from 100 to 800 pounds of air-dry vegetation per acre per year and averages 600 pounds.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6707
Growth curve name: Warm season dominant; MLRA-67B; upland fine textured soils.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	0	3	20	45	20	10	2	0	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- Heavy continuous grazing or excessive defoliation without adequate recovery periods following each grazing event will shift this plant community toward the *Red threeawn, Annuals, Bare Ground Plant Community.* This transition may take greater than 40 years. Erosion and loss of organic matter/carbon reserves are concerns.
- Long term prescribed grazing with adequate recovery periods following each grazing event and proper stocking over long periods of time move this plant community toward the *Blue Grama/Buffalograss Sod with Cool Season Remnants Plant Community* and will eventually return to the *HCPC* or associated successional plant community stages assuming an adequate seed/vegetative source is available. This process may take greater than 40 years.

Red Threeawn, Annuals, Bare Ground Plant Community

This plant community develops with heavy continuous grazing and/or occupation by prairie dogs. Red threeawn is the dominant species. Blue grama may persist in localized areas. Introduced annuals such as kochia and Russian thistle are present. Introduced species such as field bindweed can also be present, especially on prairie dog towns.

Litter levels are extremely low. Erosion is evident where flow paths are continuous. Rills may occur on steeper slopes. Wind scoured areas may be apparent on knolls or unprotected areas. The nutrient cycle, water cycle and overall energy flow are greatly impaired. Organic matter/carbon reserves are greatly reduced. This community is not stable. Desertification is obvious.

Total annual production can vary from 50 to 200 pounds of air-dry vegetation per acre and will average 100 pounds during an average year.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6707
Growth curve name: Warm season dominant; MLRA-67B; upland fine textured soils.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	0	3	20	45	20	10	2	0	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- Long term prescribed grazing with adequate recovery periods between each grazing event and proper stocking can eventually move this community back to the *Historic Climax Plant Community* or associated successional plant community stages, but it will take a long time (40 to 80 years or more).
- Range seeding followed by prescribed grazing may be used as an alternative to convert this plant community to a *Seeded Rangeland* community, which can closely resemble the *HCPC* however, at a substantial cost.

Go-back Land

Go-back land is created when the soil is tilled or farmed (sodbusted) and abandoned. All of the native plants are destroyed, soil organic mater is reduced, soil structure is changed and a plowpan or compacted layer is formed. Residual synthetic chemicals often remain from past farming operations and erosion processes may be active.

Go-back land evolves through several plant communities beginning with an early annual plant community, which initiates the revegetation process. Plants such as Russian thistle, kochia and other annuals begin to establish. These plants give some protection from erosion and start to build minor levels of soil organic matter. This early annual plant community lasts for two to several years. Red threeawn, sand dropseed and several other early perennials can dominate the plant community for five to eight years or more. Buffalograss establishes next and dominates for many years. Eventually western wheatgrass, blue grama and other natives become reestablished.

Transitions or pathways leading to other plant communities are as follows:

- Very long term prescribed grazing that allows adequate recovery periods following each grazing event and proper stocking will most likely take this plant community to a buffalograss dominated plant community and eventually back to the *HCPC.* This process takes many years (40-80 years or more).
- Range seeding followed with prescribed grazing can be used to convert *Go-back Land* to *Seeded Rangeland* which can resemble the *HCPC.*

Go-back Land (eroded)

Eroded go-back land is created where tillage or farming and severe erosion has occurred. If the parent material that the original soil developed from is lost, then another ecosite will evolve. If the same parent material is present, then re-seeding or the slow process of developing soil and vegetation will start by similar processes as shown in the non-eroded *Go-back Land* above. This is a very slow process (100 years or more).

Seeded Rangeland

This plant community can vary considerably depending on how eroded the soil was, the species seeded, the stand that was established, how long ago the stand was established and the management of the stand since establishment.

- Continuous grazing without adequate recovery period between grazing events can shift this plant community to *Go-back Land.*

Ecological Site Interpretations

Animal Community – Wildlife Interpretations

Western Wheatgrass, Blue Grama, Green Needlegrass, Fourwing Saltbush Plant Community-Historic Climax Plant Community (HCPC) and Blue Grama/Buffalograss Sod, Western Wheatgrass and Shrubs Plant Community

Common bird species expected on these communities include Cassin's sparrow, chestnut collared longspur, lark bunting, western meadowlark, and ferruginous and Swainson's hawks. White-tailed and black-tailed jackrabbit, badger, pronghorn, coyote, swift fox, plains pocket gopher, long-tailed weasel, and several species of mice are mammals that commonly use these plant communities. Reptiles using these communities include western rattlesnake, bullsnake, plains garter snake (if water is in home range), western hognose snake, racer, western box turtle, and six-lined racerunner.

Blue Grama/Buffalograss Sod with Cool Season Remnants Plant Community

The reduction of shrubs and taller grasses in this plant community results in a shift of bird species away from the HCPC birds. Lark bunting, chestnut-collared longspur, and western meadowlark use declines and Cassin's sparrow stop using the community altogether. Habitat conditions are ideal for long-billed curlew. McCown's longspur, burrowing owl, mountain plover, killdeer, and horned lark begin using this community. Ferruginous and Swainson's hawks are frequent users of this community Most mammals will be the same as in the HCPC, however jackrabbit, black-tailed prairie dog, desert cottontail, and thirteen-lined ground squirrel use will increase because of the changing plant community. Reptiles using this community are the same as in the HCPC.

Low Plant Density, Excessive Litter Plant Community; Blue Grama/Buffalograss Sod Plant Community; Red Threeawn, Annuals, Bare Ground Plant Community; and Go-back Land Plant Community

Burrowing owl, mountain plover, horned lark, McCown's longspur, killdeer, and long-billed curlew use these plant communities. With the exception of the hawk species, no HCPC bird species would frequent these communities. Jackrabbit, black-tailed prairie dog, thirteen-lined ground squirrel, and desert cottontail rabbit are frequent users of these communities. All other mammal species from the HCPC may use the community. Reptiles using these communities exclusively are short-horned lizard and lesser earless lizard. Other reptiles using these communities include the species listed for the HCPC.

Seeded Rangeland

The wildlife species expected on seeded rangeland would be those listed for the plant community the seeding most resembles.

Other Potential Species

The plains spadefoot is the only common species of frog or toad inhabiting grasslands in Eastern Colorado. This species requires water for breeding. Tiger salamanders may be found on grassland sites, but require a water body for breeding. Either of these species may be found in any plant community if seasonal water requirements are met. Mule and white-tailed deer may use this ecological site, however the shrub cover is too low to expect more than occasional use. Big brown bats will use any plant community on this ecological site if a building site is in the area. The gray wolf, black-footed ferret, and wild bison used this ecological site in historic times. The wolf and ferret are thought to be extirpated from Eastern Colorado. Bison are currently found only as domestic livestock.

Ecological Reference Sheet

MLRA: 67B Ecological Site: Loamy

Date: 11/16/04 **Author(s)/participant(s):** Harvey Sprock, Ben Berlinger, Dan Nosal
Contact for lead author: ____

This *must* be verified based on soils and climate (see Ecological Site Description). Current plant community *cannot* be used to identify the ecological site.

Composition (indicators 10 and 12) based on: X Annual Production, __Cover Produced During Current Year __Biomass

Indicators. For each indicator, describe the potential for the site. Where possible, (1) use numbers, (2) include expected range of values for above- and below-average years and natural disturbance regimes for **each** community within the reference state, when appropriate & (3) cite data. Continue descriptions on separate sheet.

1. Number and extent of rills: None

2. Presence of water flow patterns: Typically none, if present (steeper slopes following intense storms) short and not connected.

3. Number and height of erosional pedestals or terracettes: None

4. Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are *not* bare ground): 3% or less bare ground, with bare patches generally less than 2-3 inches in diameter. Extended drought can cause bare ground to increase upwards to 10-20% with bare patches reaching upwards to 6-12 inches in diameter.

5. Number of gullies and erosion associated with gullies: None

6. Extent of wind scoured, blowouts and/or depositional areas: None

7. Amount of litter movement (describe size and distance expected to travel): Minimal and short.

8. Soil surface (top few mm) resistance to erosion (stability values are averages – most sites will show a range of values): Stability class rating anticipated to be 5-6 in interspace at soil surface. Soil surface is stabilized by decomposing organic matter. Biological crusts (lichens, algae, cyanobacteria, mosses) may be present on or just below soil surface.

9. Soil surface structure and SOM (soil organic matter) content (include type and strength of structure, and A-horizon color and thickness): Average SOM is 2-4%. Soils are typically deep to moderately deep. Surface texture ranges from loam to very fine sandy loam. A-horizon ranges from 0-5 inches in depth with a dark grayish-brown color and a medium sub-angular blocky structure.

10. Effect of plant community composition (relative proportion of different functional groups) & spatial distribution on infiltration & runoff: Diverse grass, forb, shrub canopy and root structure reduces raindrop impact and slows overland flow providing increased time for infiltration to occur. Extended drought reduces short/mid bunchgrasses causing decreased infiltration and increased runoff following intense storms.

11. Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site): None

12. Functional/Structural Groups (list in order of descending dominance by above-ground production or live foliar cover (specify) using symbols: >>, >, = to indicate much greater than, greater than, and equal to; place dominants, subdominants and "others" on separate lines):

Dominants: cool season mid rhizomatous >

Sub-dominants: warm season short bunchgrass > cool season mid bunchgrass/grasslikes > shrubs >

Other: other shrubs > warm season short stoleniferous > leguminous forbs > cool season forbs > warm season forbs > warm season mid bunchgrass

13. Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence): Typically minimal. Expect slight short/mid bunchgrass mortality/decadence during and following drought.

14. Average percent litter cover (_______%) and depth (______ inches). 30-45% litter cover at 0.25 inch depth. Litter cover during and following extended drought ranges from 15-25%.

15. Expected annual production (this is TOTAL above-ground production, not just forage production): 600 lbs./ac. low precip years; 1300 lbs./ac. average precip years; 1800 lbs./ac. above average precip years. After extended drought or the first growing season following wildfire, production may be significantly reduced by 300 – 500 lbs./ac. or more.

16. Potential invasive (including noxious) species (native and non-native). List species which characterize degraded states and which, after a threshold is crossed, "can, and often do, continue to increase regardless of the management of the site and may eventually dominate the site": Invasive plants should not occur in reference plant community. Cheatgrass, Russian thistle, kochia, other non-native annuals may invade following extended drought or after fire assuming a seed source is available.

17. Perennial plant reproductive capability: The only limitations are weather-related, wildfire, natural disease, and insects that may temporarily reduce reproductive capability.

Functional/Structural Groups Sheet

State: CO **Office: ______________________** **Ecological Site: Loamy** **Site ID: R067BY002CO**

Observers: ____ **Date: ________________**

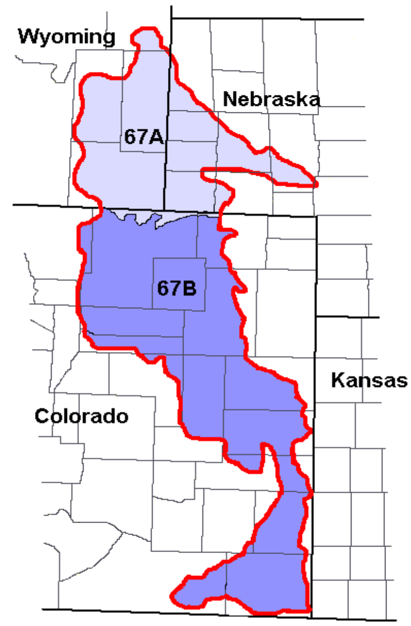
Functional/Structural Groups			**Species List for Functional/Structural Groups**
Name	Potential[1]	Actual[2]	Plant Names
Cool season mid rhizomatous	D		Western wheatgrass
Warm season short bunchgrass	S		Blue grama
Cool season mid bunchgrass/grasslike	S		Green needlegrass, bottlebrush squirreltail, Indian ricegrass, needleandthread, sun sedge, needleleaf sedge
Shrubs	S		Fourwing saltbush, winterfat
Other shrubs	M		Rabbitbrush, broom snakeweed, fringed sagebrush, cactus, small soapweed
Warm season short stoleniferous	M		Buffalograss
Leguminous forbs	M		American vetch, purple prairie clover, scurfpea, locoweeds, crazyweeds
Cool season forbs	M		Scarlet globemallow, penstemon
Warm season forbs	M		Dotted gayfeather, ironplant goldenweed, prairie coneflower
Warm season mid bunchgrass	M		Sand dropseed
Noxious Weeds			
Invasive Plants			
Biological Crust[3]	T		

Indicate whether each "structural/functional group" is a Dominant (D) (roughly 40-100 % composition), **a Sub-dominant (S)** (roughly 10-40% composition) **a Minor Component (M)** (roughly 2-5% composition), or a Trace Component **(T)** (<2% composition) based on weight or cover composition in the area of interest (e.g., "Actual[2]" column) relative to the "Potential[2] " column derived from information found in the ecological site/description and/or at the ecological reference area.

Biological Crust[3] dominance is evaluated solely on **cover** not composition by weight.

United States Department of Agriculture
Natural Resources Conservation Service

Ecological Site Description



Site Type: Rangeland

Site Name: Sandy

Site ID: R067BY024CO

Major Land Resource Area: 67B – Central High Plains, Southern Part

Physiographic Features
This site occurs on level to hilly uplands and plains.

Landform: hill, plain **Aspect:** N/A

	Minimum	Maximum
Elevation (feet):	3800	5600
Slope (percent):	0	9
Water Table Depth (inches):	60	60
Flooding:		
Frequency:	None	None
Duration:	None	None
Ponding:		
Depth (inches):	None	None
Frequency:	None	None
Duration:	None	None
Runoff Class:	very low	medium

Climatic Features
The mean average annual precipitation varies from 12 to 16 inches per year depending on location and ranges from less than 8 inches to over 20 inches per year. Approximately 75 percent of the annual precipitation occurs during the growing season from mid-April to late-September. Snowfall can vary greatly from year to year but averages 35 to 45 inches per year. Winds are estimated to average about 9 miles per hour annually, ranging from 10 miles per hour during the spring to 9 miles per hour during late summer. Daytime winds are generally stronger than nighttime and occasional strong storms may bring periods of high winds with gusts to more than 90 miles per hour.

The average length of the growing season is 142 days, but varies from 129 to 154 days. The average date of first frost in the fall is September 28 and the last frost in the spring is about May 9. July is the hottest month and December and January are the coldest. It is not uncommon for the temperature to exceed 100 degrees F during the summer. Summer humidity is low and evaporation is high. The winters are characterized with frequent northerly winds, producing severe cold with temperatures dropping to -35 degrees F or lower.

Plant Communities

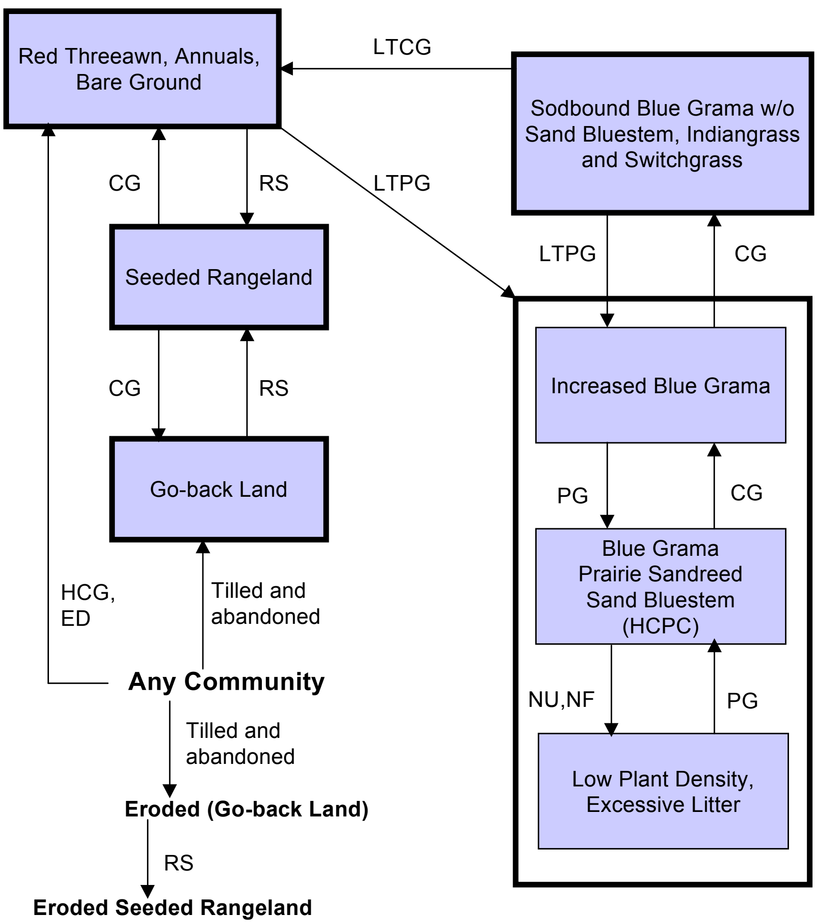
Ecological Dynamics of the Site:

Continuous grazing without adequate recovery opportunities following each grazing event during the growing season will cause blue grama to increase and eventually form a sodbound condition. Major warm season grasses such as sand bluestem, yellow Indiangrass and switchgrass will decrease in frequency and production. Key forbs and shrubs such as American vetch, purple prairie clover and western sandcherry will decrease also. Red threeawn, annuals and bare ground will increase with long term continuous grazing, heavy continuous grazing or excessive defoliation. Years of non-use (rest) or lack of fire will cause litter to accumulate and reduce plant density.

The historic climax plant community (description follows the plant community diagram) has been determined by study of rangeland relic areas, areas protected from excessive disturbance, seasonal use pastures, short durationl/time controlled grazing and historical accounts.

The following diagram illustrates the common plant communities that can occur on the site and the transition pathways (arrows) among communities. Bold lines surrounding each plant community or communities represent ecological thresholds. The ecological processes are discussed in more detail in the plant community descriptions following the diagram.

Plant Communities and Transitional Pathways



CG - continuous grazing without adequate recovery opportunity, **ED** - excessive defoliation, **HCG** - heavy continuous grazing, **HCPC** - Historic Climax Plant Community, **LTCG** - long term continuous grazing (>25 yrs), **LTPG** - long term prescribed grazing (>40 yrs), **PG** - prescribed grazing with adequate recovery period, **NF** - no fire, **NU** - non-use, **RS** - range seeding

Plant Community Composition and Group Annual Production

COMMON/GROUP NAME	SCIENTIFIC NAME	SYMBOL	Blue Grama, Prairie Sandreed, Sand Bluestem (HCPC) Group	lbs./acre	% Comp
GRASSES & GRASS-LIKES			*1*	*1155 - 1403*	*70 - 85*
blue grama	Bouteloua gracilis	BOGR2	1	330 - 495	20 - 30
prairie sandreed	Calamovilfa longifolia	CALO	1	330 - 495	20 - 30
sand bluestem	Andropogon hallii	ANHA	1	83 - 248	5 - 15
needleandthread	Hesperostipa comata ssp. comata	HECOC8	1	83 - 165	5 - 10
switchgrass	Panicum virgatum	PAVI2	1	83 - 165	5 - 10
western wheatgrass	Pascopyrum smithii	PASM	1	17 - 116	1 - 7
Indiangrass	Sorghastrum nutans	SONU2	1	17 - 83	1 - 5
little bluestem	Schizachyrium scoparium	SCSC	1	17 - 83	1 - 5
sideoats grama	Bouteloua curtipendula	BOCU	1	17 - 83	1 - 5
thickspike wheatgrass	Elymus elymoides ssp. elymoides	ELELE	1	0 - 83	0 - 5
prairie junegrass	Koeleria macrantha	KOMA	1	17 - 50	1 - 3
sand dropseed	Sporobolus cryptandrus	SPCR	1	17 - 50	1 - 3
Indian ricegrass	Achnatherum hymenoides	ACHY	1	17 - 33	1 - 2
red threeawn	Aristida purpurea var. longiseta	ARPUL	1	0 - 17	0 - 1
sand paspalum	Paspalum setaceum	PASE5	1	0 - 17	0 - 1
sun sedge	Carex inops ssp. heliophila	CAINH2	1	17 - 83	1 - 5
other native grasses		2GP	1	0 - 83	0 - 5
FORBS			*2*	*165 - 248*	*10 - 15*
American vetch	Vicia americana	VIAM	2	17 - 33	1 - 2
dotted gayfeather	Liatris punctata	LIPU	2	17 - 33	1 - 2
narrowleaf penstemon	Penstemon angustifolius	PEAN4	2	17 - 33	1 - 2
pacific peavine	Lathyrus polymorphus	LAPO2	2	17 - 33	1 - 2
prairie spiderwort	Tradescantia occidentalis	TROC	2	17 - 33	1 - 2
purple prairie clover	Dalea purpurea var. purpurea	DAPUP	2	17 - 33	1 - 2
scarlet globemallow	Sphaeralcea coccinea	SPCO	2	17 - 33	1 - 2
upright prairie coneflower	Ratibida columnifera	RACO3	2	17 - 33	1 - 2
cutleaf evening-primrose	Oenothera coronopifolia	OECO2	2	0 - 17	0 - 1
hairy goldaster	Heterotheca villosa	HEVI4	2	0 - 17	0 - 1
heath aster	Symphyotrichum ericoides	SYERE	2	0 - 17	0 - 1
Louisiana sagewort	Artemisia ludoviciana	ARLU	2	0 - 17	0 - 1
nuttails evolvulus	Evolvulus nuttallianus	EVNU	2	0 - 17	0 - 1
rush skeletonplant	Lygodesmia juncea	LYJU	2	0 - 17	0 - 1
silverleaf scurfpea	Pediomelum argophyllum	PEAR6	2	0 - 17	0 - 1
slimflower scurfpea	Psoralidium tenuiflorum	PSTE5	2	0 - 17	0 - 1
stickleaf mentzelia	Mentzelia decapetala	MEDE2	2	0 - 17	0 - 1
Texas croton	Croton texensis	CRTE4	2	0 - 17	0 - 1
western ragweed	Ambrosia psilostachya	AMPS	2	0 - 17	0 - 1
winged buckwheat	Eriogonum alatum	ERAL4	2	0 - 17	0 - 1
woolly locoweed	Astragalus mollissimus	ASMO7	2	0 - 17	0 - 1
wormwood	Artemisia dracunculus	ARDR4	2	0 - 17	0 - 1
other native forbs		2FP	2	33 - 83	2 - 5
SHRUBS			*3*	*83 - 248*	*5 - 15*
western sandcherry	Prunus pumila var. besseyi	PRPUB	3	50 - 83	3 - 5
fourwing saltbush	Atriplex canescens	ATCA2	3	17 - 50	1 - 3
spreading buckwheat	Eriogonum effusum	EREF	3	17 - 33	1 - 2
sand sagebrush	Artemisia filifolia	ARFI2	3	0 - 33	0 - 2
broom snakeweed	Gutierrezia sarothrae	GUSA2	3	0 - 17	0 - 1
fringed sagebrush	Artemisia frigida	ARFR4	3	0 - 17	0 - 1
plains pricklypear	Opuntia polyacantha	OPPO	3	0 - 17	0 - 1
purple pincushion	Escobaria vivipara var. vivipara	ESVIV	3	0 - 17	0 - 1
small soapweed	Yucca glauca	YUGL	3	0 - 17	0 - 1
other native shrubs		2SHRUB	3	17 - 83	1 - 5

Annual Production lbs./acre	LOW - RV* - HIGH
GRASSES & GRASS-LIKES	600 - 1300 - 1690
FORBS	150 - 200 - 255
SHRUBS	50 - 150 - 255
TREES	
TOTAL	800 - 1650 - 2200

This list of plants and their relative proportions are based on near normal years. Fluctuations in species composition and relative production may change from year to year dependent upon precipitation or other climatic factors. *RV - Representative Value.

Plant Community Narratives

Following are the narratives for each of the described plant communities. These plant communities may not represent every possibility, but they probably are the most prevalent and repeatable plant communities. The plant composition table shown above has been developed from the best available knowledge at the time of this revision. As more data is collected, some of these plant communities may be revised or removed and new ones may be added. None of these plant communities should necessarily be thought of as "Desired Plant Communities". According to the USDA NRCS National Range and Pasture Handbook, Desired Plant Communities will be determined by the decision makers and will meet minimum quality criteria established by the NRCS. The main purpose for including any description of a plant community here is to capture the current knowledge and experience at the time of this revision.

Blue Grama, Prairie Sandreed, Sand Bluestem Plant Community

This is the interpretive plant community and is considered to be the Historic Climax Plant Community (HCPC). This plant community evolved with grazing by large herbivores, is well suited for grazing by domestic livestock, and can be found on areas that are properly managed with grazing that allows adequate recovery periods following each grazing occurrence during the growing season.

The potential vegetation is about 70-85% grasses and grass-like plants, 10-15% forbs and 5-15% woody plants. The dominant tall warm season grasses are prairie sandreed, sand bluestem and switchgrass. Blue grama dominates the understory. Important cool season grasses and grass-likes are needleandthread and sun sedge. Key forbs and shrubs are American vetch, pacific peavine, purple prairie clover, western sandcherry and leadplant.

This plant community is well adapted to the Northern Great Plains climatic conditions and is relatively resistant to many disturbances except prolonged continuous grazing, sodbusting, urban and other development. The diversity in plant species allows for high drought tolerance. Plant litter is properly distributed with very little movement off-site and natural plant mortality is very low. This is a sustainable plant community in terms of soil stability, watershed function and biologic integrity.

Production in this community can vary from 800 to 2200 pounds of air-dry vegetation per acre per year depending on weather conditions and averages 1650 pounds.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6709
Growth curve name: Warm season dominant, cool season sub-dominant; MLRA-67B; upland coarse textured soils.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	2	7	25	35	15	10	5	1	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- Continuous grazing without adequate recovery periods between grazing events will move this plant community toward the *Increased Blue grama Plant Community.*
- Non-use (rest) or lack of fire will move this plant community toward the *Low Plant Density, Excessive Litter Plant Community*.
- Prescribed grazing that allows adequate recovery opportunity following each grazing event with proper stocking will maintain the *Blue Grama, Prairie Sandreed, Sand Bluestem Plant Community (HCPC).*

Increased Blue Grama Plant Community

This plant community evolves with continuous grazing. When compared to the Historic Climax Plant Community; sand bluestem, yellow Indiangrass, prairie sandreed, switchgrass, leadplant and western sandcherry have decreased in frequency and production. Blue grama is the dominant grass species. Sand dropseed, red threeawn, hairy goldaster, croton, slimflower scurfpea, western ragweed, stickleaf, heath aster, lupine, loco, milkvetch and cactus have increased. Soils that have a sandy loam or coarser subsoil will show an increase in sand sagebrush.

Continuous spring grazing with summer deferment will reduce the cool season component (needleandthread, western wheatgrass, sun sedge) of this plant community and increase the warm season component. Continuous summer grazing with spring deferment will reduce the warm season component (sand bluestem, yellow Indiangrass, prairie sandreed, switchgrass) of this plant community and increase the cool season component.

The risk of losing key tall warm season grasses, important forbs and shrubs is a major concern. Prescribed grazing with adequate recovery periods between grazing events will enable the land user to maintain the vegetation or move it toward the HCPC. Continuous grazing will take this plant community past an ecological/economic threshold resulting in costly revegetation practices or require many years of prescribed grazing to reverse the process.

Blue grama is increasing at the expense of the tall grasses and deep-rooted shrubs. Water cycle, nutrient cycle and energy flow are becoming impaired do to a shift in root structure and species composition. Less litter is being produced. This is an early stage of desertification.

Production in this community can vary from 400 to 1200 pounds of air-dry vegetation per acre per year depending on weather conditions and averages 900 pounds.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6710
Growth curve name: Warm season dominant; MLRA-67B; upland coarse textured soils.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	0	5	20	40	20	10	5	0	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- Continuous grazing without adequate recovery periods between grazing events will move this plant community across an ecological threshold toward the *Sodbound Blue Grama without Sand Bluestem, Yellow Indiangrass and Switchgrass Plant Community.*
- Prescribed grazing that allows adequate recovery periods following grazing occurrences and proper stocking can bring this plant community back to the *Blue Grama, Prairie Sandreed, Sand Bluestem Plant Community (HCPC).*

Low Plant Density, Excessive Litter Plant Community

This plant community occurs when grazing is removed for long periods of time in the absence of fire. Most of the species occurring in the HCPC are present in this plant community but are reduced in abundance and production. Much of the nutrients are tied up in excessive litter. The semiarid environment and the absence of animal traffic to break down litter slow nutrient recycling. Aboveground litter also limits sunlight from reaching plant crowns. Many plants, especially bunchgrasses die off. Thick litter and absence of grazing or fire reduce seed germination and establishment.

This plant community is at risk of losing many key species and if left ungrazed or ungrazed without fire can go to a vegetative state resembling the *Red Threeawn, Annuals, Bare Ground Plant Community*. This plant community will change rapidly if plant manipulation is allowed to occur (grazing by domestic livestock or possibly fire).

In advanced stages, plant mortality can increase and erosion potential increases as bare areas increase.

Production can vary from 300 to 1500 pounds of air-dry vegetation per acre per year depending on weather conditions and the plants that are present.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6711
Growth curve name: Warm season dominant, cool season sub-dominant, excess litter; MLRA-67B; upland coarse texture soil.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	2	8	20	35	17	10	5	3	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- Prescribed grazing that allows for adequate recovery periods following each grazing event and proper stocking will shift this plant community back to the *Blue Grama, Prairie Sandreed, Sand Bluestem Plant Community (HCPC).*

Sodbound Blue Grama without Sand Bluestem, Indiangrass and Switchgrass Plant Community

This plant community evolves with longer term continuous grazing caused by lack of adequate recovery periods between grazing events. Sodbound blue grama dominates this plant community. Large amounts of sand dropseed and red threeawn are common. Louisiana sage, lupine, stickleaf, croton, hairy goldaster, loco, wormwood, fringed sage and soapweed have increased. Sand sagebrush may increase on sandy loam or coarser subsoils. Sand bluestem, yellow Indiangrass, switchgrass, leadplant, western sandcherry and fourwing saltbush have been removed. Prairie sandreed and needleandthread may persist in remnant amounts protected by remaining shrubs. Western wheatgrass may be found in small depressions. This plant community is present on most of the Sandy ecological site in the Central High Plains today.

A significant amount of production and diversity has been lost when compared to the HCPC. The soil is stable at this stage however, the nutrient cycle, water cycle, community dynamics and energy flow are all impaired do to the substantial increase of blue grama and loss of tall warm season grasses, nitrogen fixing legumes and shrubs. Desertification is advanced.

Production varies from 200 to 900 pounds of air-dry vegetation per acre per year depending on weather and averages 700 pounds.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6710
Growth curve name: Warm season dominant; MLRA-67B; upland coarse textured soils.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	0	5	20	40	20	10	5	0	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- Long term continuous grazing without adequate recovery periods between grazing events will move this plant community to the *Threeawn, Annuals and Bare Ground Plant Community*. This transition may take greater than 25 years to accomplish.
- Long term prescribed grazing with adequate recovery periods between grazing events and proper stocking will be needed to bring this plant community back to the *Increased Blue Grama Plant Community* and eventually to the *HCPC* assuming an adequate seed/vegetative source is available. This process may take greater than 40 years to accomplish.

Red Threeawn, Annuals, Bare Ground Plant Community

This plant community can develop by long term continuous grazing, heavy continuous grazing and/or occupation by prairie dogs. Red threeawn is the dominant species. Sand dropseed may also be present in varying amounts. A number of annual plants such as Russian thistle, kochia and cheatgrass will increase or invade. Field bindweed is often present on prairie dog towns.

Litter levels are extremely low. The nutrient cycle, water cycle, and energy flow are greatly reduced. Erosion is occurring. Pedestalling is evident. Organic matter/carbon reserves are greatly reduced. Desertification is obvious.

Production can vary from 50 to 400 pounds of air-dry vegetation per acre per year depending on weather conditions and the plants that are present.

The following is an estimated growth curve of this plant community expected during a normal year. Vegetative growth begins earlier in the southern reaches (Baca, Bent, Kiowa, Las Animas and Prowers counties) of MLRA-67B. Vegetative growth will typically be suppressed during the months of June through August in these counties due to higher evapotranspiration rates.

Growth curve number: CO6710
Growth curve name: Warm season dominant; MLRA-67B; upland coarse textured soils.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	0	0	5	20	40	20	10	5	0	0	0

(monthly percentages of total annual growth)

Transitions or pathways leading to other plant communities are as follows:

- Long term prescribed grazing that allows for adequate recovery periods between each grazing event and proper stocking will be needed to bring this state back to the *Blue Grama, Prairie Sandreed, Sand Bluestem (HCPC)* or associated successional plant community stages assuming an adequate seed/vegetative source is available. Expect this transition to take greater than 40 years to accomplish.
- Range seeding can be used to create *Seeded Rangeland.* Revegetation practices would be very costly.

Go-back Land

Go-back land is created when the soil is tilled or farmed (sodbusted) and abandoned. All of the native plants are destroyed, soil organic mater is reduced, soil structure is changed and a plowpan or compacted layer is formed. Residual synthetic chemicals often remain from past farming operations and erosion processes may be active.

Go-back land evolves through several plant communities beginning with an early annual plant community, which initiates the revegetation process. Plants such as Russian thistle, kochia and other annuals begin to establish. These plants give some protection from erosion and start to build minor levels of soil organic matter. This early annual plant community lasts for two to several years. Red threeawn, sand dropseed and several other early perennials can dominate the plant community for five to eight years or more. Eventually other native species become reestablished.

Transitions or pathways leading to other plant communities are as follows:

- Range seeding followed with prescribed grazing can be used to convert *Go-back Land* to *Seeded Rangeland.*

Go-back Land (eroded)

Eroded go-back land is created where tillage or farming and severe erosion has occurred. If the parent material that the original soil developed from is lost, then another ecosite will evolve. If the same parent material is present, then re-seeding or the slow process of developing soil and vegetation will start by similar processes as shown in the non-eroded *Go-back Land* above. This is a very slow process (100 years or more).

Seeded Rangeland

This plant community can vary considerable depending on how eroded the soil was, the species seeded, the stand that was established, how long ago the stand was established and the management of the stand since establishment. Prescribed grazing that allows adequate recovery periods following each grazing event will help maintain this plant community and eventually move it towards the HCPC.

Transitions or pathways leading to other plant communities are as follows:

- Continuous grazing without adequate recovery periods following each grazing event will move this plant community to the *Threeawn, Annuals, Bare Ground Plant Community* or to a plant community resembling *Go-back Land.*

Ecological Site Interpretations

Animal Community – Wildlife Interpretations

Blue Grama, Prairie Sandreed, Sand Bluestem Plant Community (HCPC)

The structural diversity in the plant community found on the HCPC is attractive to a number of wildlife species. Common bird species expected on the HCPC include Cassin's and Brewer's sparrow, chestnut collared longspur, lark bunting, western meadowlark, and ferruginous and Swainson's hawks. The combination of mid-tall grasses and shrubs provides habitat for greater and lesser prairie chicken in the eastern parts of this site. Scaled quail may also use this community.
White-tailed and black-tailed jackrabbit, badger, pronghorn, coyote, swift fox, plains pocket gopher, long-tailed weasel, and several species of mice are mammals that commonly use this plant community. Reptiles using this community include western rattlesnake, bullsnake, plains garter snake western hognose snake, racer, western box turtle, and six-lined racerunner.

Increased Blue Grama Plant Community

All HCPC species are expected in this plant community, however, the loss of some of the vegetative structural diversity in this plant community make it less attractive to many HCPC species.

Low Plant Density, Excessive Litter and Sodbound Blue Grama Plant Communities

As these communities develop into an open landscape the wildlife species will shift from the HCPC species toward the typical shortgrass prairie species such as horned lark, killdeer, long-billed curlew, McCown's longspur, and ferruginous hawk. In addition, mountain plover, black-tailed prairie dog, and burrowing owl might use these communities where slopes are less than 5%.

Red Threeawn and Go-back Land Plant Communities

Mountain plover, black-tailed prairie dog, and burrowing owl are expected on these communities where slopes are less than 5%.

Seeded Rangeland

The wildlife species expected on seeded rangeland would be those listed for the plant community the seeding most resembles.

Other Potential Species

The plains spadefoot is the only common species of frog or toad inhabiting grasslands in Eastern Colorado. This species requires water for breeding. Tiger salamanders may be found on grassland sites, but require a water body for breeding. Either of these species may be found in any plant community if seasonal water requirements are met. Mule and white-tailed deer may use this ecological site for feeding, however the shrub cover is too low to provide escape or hiding cover. On ecological site locations near riparian areas, deer will use the vegetation for feeding. Big brown bats will use any plant community on this ecological site if a building site is in the area. The gray wolf, black-footed ferret, and wild bison used this ecological site in historic times. The wolf and ferret are thought to be extirpated from Eastern Colorado. Bison are currently found only as domestic livestock.

Ecological Reference Sheet

MLRA: 67B **Ecological Site:** Sandy

Date: 01/11/05 **Author(s)/participant(s):** Harvey Sprock, Dan Nosal

Contact for lead author: ____

This *must* be verified based on soils and climate (see Ecological Site Description). Current plant community *cannot* be used to identify the ecological site.

Composition (indicators 10 and 12) based on: X Annual Production, __Cover Produced During Current Year __Biomass

Indicators. For each indicator, describe the potential for the site. Where possible, (1) use numbers, (2) include expected range of values for above- and below-average years and natural disturbance regimes for **each** community within the reference state, when appropriate & (3) cite data. Continue descriptions on separate sheet.
1. Number and extent of rills: None
2. Presence of water flow patterns: Typically none to slight. If present, are broken, irregular in appearance or discontinuous with numerous debris dams or vegetative barriers.
3. Number and height of erosional pedestals or terracettes: Pedestalled plants caused by wind or water erosion would be minor.
4. Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are *not* bare ground): 3% or less bare ground, with bare patches ranging from 3-5 inches in diameter. Prolonged drought or wildfire events will cause bare ground to increase upwards to 5-10% with bare patches ranging from 8-12 inches in diameter.
5. Number of gullies and erosion associated with gullies: None.
6. Extent of wind scoured, blowouts and/or depositional areas: A minor amount of wind scouring may occur on naturally disturbed areas. Fire or extended drought can exacerbate the appearance. Typically, wind scouring should be insignificant.
7. Amount of litter movement (describe size and distance expected to travel): Litter should be uniformly distributed with little movement. On steep slopes or knolls, litter may move from a few inches to 1-2 feet depending on intensity of wind/rainfall event.
8. Soil surface (top few mm) resistance to erosion (stability values are averages – most sites will show a range of values): Stability class rating anticipated to be 3-5 in the interspaces at soil surface.
9. Soil surface structure and SOM (soil organic matter) content (include type and strength of structure, and A-horizon color and thickness): SOM ranges from 2-4%. A-horizon ranges from 0-6 inches. Soils are deep, dark brown, weak fine granular structure.
10. Effect of plant community composition (relative proportion of different functional groups) & spatial distribution on infiltration & runoff: Diverse grass, forb, shrub canopy and root structure reduces raindrop impact and slows overland flow providing increased time for infiltration to occur. Extended drought and/or wildfire may reduce canopy cover and litter amounts resulting in decreased infiltration and increased runoff on steeper slopes.
11. Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site): None
12. Functional/Structural Groups (list in order of descending dominance by above-ground production or live foliar cover (specify) using symbols: >>, >, = to indicate much greater than, greater than, and equal to; place dominants, subdominants and "others" on separate lines): **Dominants**: warm season tall rhizomatous > **Sub-dominants**: warm season short bunchgrass = warm season tall bunchgrass > cool season grasses/grasslikes > shrubs > warm season mid bunchgrass > **Other**: leguminous forbs > warm season forbs > cool season forbs
13. Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence): Minimal.
14. Average percent litter cover (_______%) and depth (______ inches). 35-60% litter cover at 0.25-0.50 inch depth. Litter cover during and following drought can range from 20-30% and 5-15% following wildfire.
15. Expected annual production (this is TOTAL above-ground production, not just forage production): 800 lbs./ac. low precip years; 1650 lbs./ac. average precip years; 2200 lbs./ac. high precip years. After extended drought or the first growing season following wildfire, production may be significantly reduced by 300 – 650 lbs./ac. or more.
16. Potential invasive (including noxious) species (native and non-native). List species which characterize degraded states and which, after a threshold is crossed, "can, and often do, continue to increase regardless of the management of the site and may eventually dominate the site": Invasive plants should not occur in reference plant community. Following fire or extended drought, cheatgrass, Russian thistle, kochia may invade assuming a seed source is available.
17. Perennial plant reproductive capability: The only limitations are weather-related, wildfire, natural disease, and insects that may temporarily reduce reproductive capability.

Functional/Structural Groups Sheet

State: CO **Office:** ______________________ **Ecological Site: Sandy** **Site ID: R067BY024CO**

Observers: ____ **Date:** _______________

Functional/Structural Groups			Species List for Functional/Structural Groups
Name	Potential[1]	Actual[2]	Plant Names
Warm season tall rhizomatous grass	D		Prairie sandreed
Warm season short bunchgrass	S		Blue grama
Warm season tall bunchgrass	S		Sand bluestem, switchgrass, Indiangrass
Cool season grasses/grasslike	S		Needleandthread, western wheatgrass, Indian ricegrass, sun sedge, prairie junegrass
Shrubs	S		Western sandcherry, fourwing saltbush, spreading buckwheat
Warm season mid bunchgrass	S		Little bluestem, sideoats grama, sand dropseed
Leguminous forbs	M		American vetch, Pacific peavine, purple prairie clover, scurfpeas, milkvetches
Warm season forbs	M		Dotted gayfeather, Louisiana sagewort, prairie coneflower, western ragweed
Cool season forbs	M		Penstemons, spiderwort, scarlet globemallow
Noxious Weeds			
Invasive Plants			
Biological Crust[3]	T		

Indicate whether each "structural/functional group" is a Dominant (D) (roughly 40-100 % composition), **a Sub-dominant (S)** (roughly 10-40% composition) **a Minor Component (M)** (roughly 2-5% composition), or a Trace Component **(T)** (<2% composition) based on weight or cover composition in the area of interest (e.g., "Actual[2]" column) relative to the "Potential[2] " column derived from information found in the ecological site/description and/or at the ecological reference area.

Biological Crust[3] dominance is evaluated solely on **cover** not composition by weight.