By Gary Frasier

Frasier's Philosophy

Rangelands are physical features of our natural resources that most of us can identify when we see them. At the same time "rangelands" is one of the most difficult features to describe so all will have a common understanding of what we mean. It is very difficult to come to a common terminology that all can subscribe to. There have been many hours of discussion devoted to this topic within the Society for Range Management as well as outside the Society. The problem becomes more complex when we consider rangelands from other parts of the world with different cultures and lifestyles.

In this issue of ***Rangelands***, we are presenting an International theme of rangelands from around the world, both in picture context as well as the more familiar articles. Several of the articles describe parts of the world I did not know existed. You will find there is an underlying message in the articles indicating that in many areas the land resource has been overused and abused in the past, but that there are now major efforts to return the land to a sustainable condition. In many respects we are at the dawn of solving the problems of rangeland management, especially in countries outside the United States. Our job as range management professionals returning the land to a functioning entity is a long way from ending.

Some of the themes for upcoming issues of ***Rangelands*** are "Improvements," "Working Rangeland Landscapes," and "Youth." We hope you will find them of interest. ◆

COMING IN THE APRIL ISSUE OF *RANGELANDS*

Mobile Solar Water Pumping
National Animal Identification
Applying GPS to Rangeland Management
Rapid Assessment Methodology
Skid Sprayer for Prescribed Burning
Low Moisture Mineral Blocks
King Ranch Symposium on Ranch Management

- Strategies for Profitability
- Branded Customer Service
- Educational Objectives
- Management of Wildlife Resources
- Cattle Production Systems
- Natural Resource Perspectives
- Strategic Management Tool
- Quality of Life

Accounting for the World's Rangelands

By H. Gyde Lund

How much rangeland do we have? Globally we do not know. I suspect the same can be said nationally. If we do not know what we have, how can we monitor it and develop a strategy for management? Existing statistics and definitions for rangelands or grasslands vary widely. In addition, definitions of various land classes such as rangeland and forest overlap. Not only is the definition important for accounting purposes, how one classifies lands could dictate who will administer the lands and how they will be managed.

To help resolve the problem, I offer a definition for rangelands that one can use to objectively inventory and report on rangelands at the national and international level. The intended audience is anyone who has to account for and report on the area of rangelands.

Why Are Rangelands Important?

Rangelands (including grasslands, shrublands, and tundra) are found throughout the world from the outback of Australia, to the muskegs and tundra of the Arctic, to the savannahs of Africa, to the cerrados of Brazil, to the plains of Mongolia, and to the sagebrush lands of the United States. As any range manager knows, rangelands are of key importance globally, nationally, and locally, both in terms of extent and socio-economic impact.

Properly managed rangelands can provide food security and poverty alleviation to millions of people. Rangelands are the main feed resource for traditional livestock rearing systems in many parts of the world. They provide about 70 percent of the feed for domestic ruminants.[1] Rangelands are of great economic and social importance, because they offer a livelihood to millions of people. Traditional animal production provides people in developing countries with food (milk, meat, and blood), manure (for fuel and fertilizer), wool, hides, draft power, transportation, added security, and the possibility to accumulate capital. Livestock are also important in association with arable agriculture, because livestock provide the power for cultivation and manure for increased fertility. Livestock also consume crop residues, which often have no or little other value, except that straw can be used as roofing material or made into baskets.[2]

In addition, rangelands are vital for the ecological, environmental, and economic functions they provide. The multiple uses of rangelands, as with forests, are of great ecological significance because both vegetation types protect often-fragile soil profiles, store carbon, provide habitat for wild fauna and flora, and act as catchments or watersheds for large river systems.

Environmentally, rangelands provide biological diversity and ecological functions. They provide local, regional, and global values and regulatory and buffering services (for instance, corals reefs in the Caribbean are declining due to desertification in the Sahel;[3] deforestation of the cerrados in Brazil affects the water balance in the whole of Amazon as well as the regional climate, etc.; all of these have major long-term impacts).

Economically, forests and rangelands provide us with essential goods and services. Both vegetation types contain medicinal plants, timber, germplasm for new and wild relatives of existing crop and pasture plants, and recreational opportunities. Furthermore, rangelands provide designated reserves.[2]

The economic importance of rangelands varies significantly according to the socio-economic system in which they are embedded. In developed economies, such as Australia and

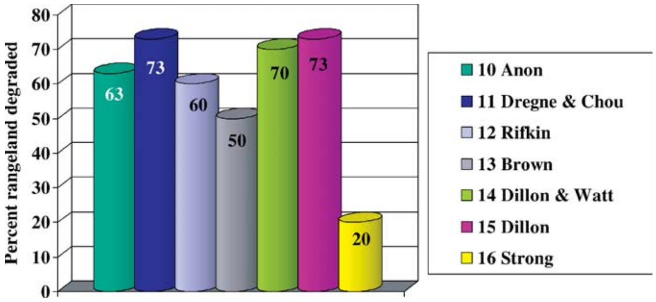

Figure 1. Recent estimates of percent of world's rangelands that are degraded.

Figure 3. Juniper (*Juniperus* spp.) lands in central Oregon, United States. Is this forest or rangeland? Distinguishing between the two is important for determining land management objectives and avoids double counting of lands for national and international assessments.

the United States, rangelands are essentially marginal terrain suitable for low-intensity stock rearing and hunting, according to the Food and Agriculture Organization (FAO) of the United Nations.[4] In pluralistic economies, such as Brazil, high-density vegetation such as rain forest, which is of crucial importance to hunter-gatherers and smallholder farmers, can all too easily be converted to low-fertility savannah, which is of interest to wealthy ranchers. In Africa and Central Asia, rangelands are essential to the subsistence of pastoralists, foragers, and farmers who are dependent on rainfed crops.[4,5]

What Is Happening?

Demographic pressures on rangelands are increasing. The demands put on rangelands by society are not limited to food and fiber. Rangeland management needs to meet multiple demands simultaneously, including outdoor recreation, hunting, water supply, and conservation.[6]

Threats to rangelands include climate change, overuse, and land conversion. Desertification is a global issue and can now be seen on every continent.[7] However, perceptions of the condition of rangeland vary in accordance with the statistics used to evaluate it. Estimates of degraded rangeland vary from 680 million ha[8] to 3.3 billion ha.[9] The amount of the world's rangeland that one considers to be degraded ranges from 20% to 73% (Fig. 1).

How Much Rangeland Is There?

Rangelands are one of the Earth's major ecosystems. However, estimates of the amount of the Earth's land surface covered by rangelands vary from 18% to 80% (Fig. 2). The variation is due to differences in bases (Earth surface, land surface, ice-free land surface, etc.), sources (ground surveys and inventories, remote sensing, climatic or soils maps, etc.), and the definitions used. The various percentages might be based upon the estimate of the Earth's total surface area, land area, or ice-free land area. Often authors do not provide a definition, state the foundation upon which they base the estimates, or give the source. Lastly, there is no international organization responsible for the assessment and reporting on the world's rangelands as there is for the periodic global forest assessments by FAO. As a result we really do not know how much rangeland we have at the global level.

If we wish to account for lands at the national and international level, definitions of various land classes should be mutually exclusive. Therefore to avoid double-counting, we should not consider the definition of "rangeland" without considering the definition of "forestland" because of potential for overlap (Fig. 3).

Figure 4 shows estimates of the world's forestland. Note there is less variation in estimate of land cover for the forest sector than there is for rangeland. The reason is simple—almost all the estimates come from FAO's Global Forest Resource Assessment (FRA). In turn, data from the FRA often come from national inventories of forestland harmonized to

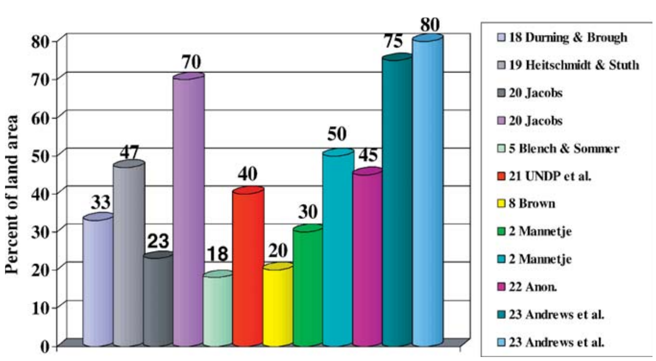

Figure 2. Recent estimates of world's rangeland (percent of total land area).[17]

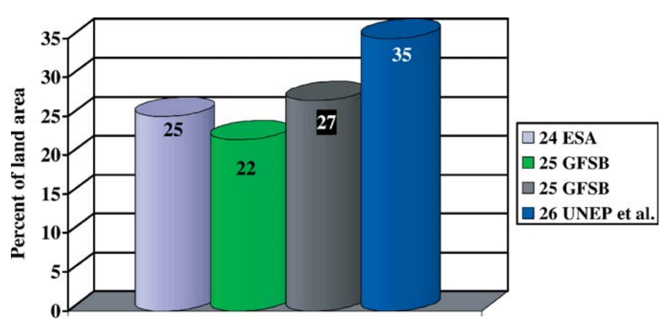

Figure 4. Recent estimates of the world's forestland (percent of total land area).[17]

Table 1. Example of different approaches for defining rangeland and forest

Approach	Rangeland[31]	Forest[32]	Comment
Cover	Lands dominated by grasses and shrubs.[33]	Land areas dominated by trees where the tree canopy covers at least 10% of the ground area.[34]	Easiest to use.
Use	Areas of land used extensively by grazing animals. Native grasses, shrubs and woody vegetation generally cover the area.[35]	All land that is capable of supporting a merchantable stand of timber and is not actively being used in a use which is incompatible with timber growing.[36]	Difficult to separate what is a forest use and what is a rangeland use.
Ecological or Potential	A kind of land on which the native vegetation, climax or natural potential, consists predominately of grasses, grasslike plants, forbs, or shrubs…[37]	Terrestrial ecosystem (biome) with enough annual precipitation (at least 76 cm or 30 inches) to support growth of various species of trees and smaller forms of vegetation.[24]	Taken literally, New York City would qualify as forest and Denver as rangeland. The potential changes over time.
Administrative or gazetted	Grassland: An administrative unit of the USDA Forest Service (more frequently "National Grassland").	An area within an administrative boundary of a forest agency, whether having trees or not.[38]	Not all lands are classed administratively.

FAO's definition of forestland, which is very objective and precise.[27] The definition is as follows:

Forest includes natural forests and forest plantations. The term is used to refer to land with a tree canopy cover of more than 10 percent and area of more than 0.5 ha. Forests are determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 m. Young stands that have not yet reached, but are expected to reach, a crown density of 10 percent and tree height of 5 m are included under forest, as are temporarily unstocked areas. The term includes forests used for purposes of production, protection, multiple use or conservation (i.e. forest in national parks, nature reserves and other protected areas), as well as forest stands on agricultural lands (e.g. windbreaks and shelterbelts of trees with a width of more than 20 m) and rubberwood plantations and cork oak stands. The term specifically excludes stands of trees established primarily for agricultural production, for example fruit tree plantations. It also excludes trees planted in agroforestry systems. (p. 137).

Unfortunately there are no objective international definitions of rangeland. By objective I mean that if two or more different people visit a piece of land, they will all classify it the same. For example FAO defines rangeland as: "*An area where wild and domestic animals graze or browse on uncultivated vegetation.*"[28] Note there are no thresholds in this definition. What is the minimum area to be considered? How much vegetation, if any, has to be present? And so on. Without thresholds, classification of which lands qualify as rangelands will vary person to person.

Similarly, the United Nations Environment Programme[9] defines rangeland as:

All territories presently used as grazing lands, which are accounted for in yearly FAOs statistics, as well as other non-agricultural, largely unoccupied, drylands which are used only occasionally by nomadic pastoralists or are presently unused at all.

As one can see, both definitions are vague. In addition, the facts that 1) there is no single organization that periodically accounts for the world's rangelands, and 2) very few nations have national rangeland inventory programs, leave any global estimates in question.

Because the area of rangeland is in question, any estimates of changes and conditions are also questionable. Holechek,[29] for example, reports a loss of some 1.2 to 1.6 million ha per year of rangeland in the western United States and the Great Plains due to conversion to other uses. On the other hand, if one assumes that FAO's land use class of permanent pasture is equivalent to rangeland, then FAO[30] reports an increase of the world's rangeland area from 3.1 billion ha in 1961 to nearly 3.5 billion ha in 2002. Despite the extent and importance of rangelands, most government and development agencies have neglected them.

How one classifies lands can affect how they are managed. For example, there is pressure throughout the world to maintain forestlands. If lands are classed as forest, environmentalists might wish to maintain tree cover. If lands are classed as rangeland, then tree cover may not be desirable and management strategies could be to eliminate the trees. Similarly, the classification of lands can affect which agencies are funded. For more forest, more money is required to protect or manage them. The same can be said about rangelands. In the United States alone, approximately 20 million ha of land

Table 2. Land uses (goods and services) provided by rangelands and forests

Goods and Services	Rangeland	Forest-lands
Biological diversity	Yes	Yes
Carbon sequestration	Yes	Yes
Ecological functions	Yes	Yes
Environmental protection	Yes	Yes
Forage/crop production	Yes	Sometimes
Recreation	Yes	Yes
Wood production	Sometimes	Yes
Poverty alleviation	Yes	Yes

are in question as to whether they are rangeland or forest.[17] This is why we need a workable definition of our land cover classes including rangelands.

So Just What Should Be Considered "Rangeland?"

Lund[31] lists over 300 published definitions of grassland, grazing land, pasture, shrubland, and rangeland. What one considers rangeland varies. To some, rangeland can be a type of land use, land cover, ecosystem, an administrative unit, or a combination of these categories. Table 1 compares different approaches for classifying rangeland and forest.

Rangeland is often defined as a land cover or land use. It is important to understand the differences between the two. **Land cover** is *the vegetational and artificial constructions covering the land surface*.[39] It is the physical characteristic of earth's surface, captured in the distribution of vegetation, water, desert, ice, and other physical features of the land, including those created solely by human activities such as mine exposures and settlement. **Land use,** on the other hand, is *the intent and management strategy placed on a land cover type*.[40] Forest, a land cover, can be used for selective logging, resource harvesting (such as rubber tapping), grazing, watershed protection, or recreation and tourism. Shifts in intent and/or management constitute land-use changes.

As stated above, when accounting for lands at the national or international levels, it is desirable that the land classes be mutually exclusive. When using land use as a classifier, the classes can overlap, as illustrated in Table 2.

To provide continuity in data collection and reporting, an objective and inventory-friendly definition should include thresholds for minimum area, percent vegetation cover, tree height (to separate rangeland from forestland), strip width, and listings of inclusions and exclusions such as is found in the FAO's definition of forest. Of the two types of definitions, it is easiest to develop an objective definition of rangeland based upon cover.

The following are some suggested guiding principles for developing an international classification system and definitions that would include rangelands for inventory and monitoring purposes. These are modified from the Vegetation Subcommittee[41] of the US Federal Geographic Data Committee (FGDC) and the FGDC Earth Cover Working Group.[42]

- The definition(s) will build upon the existing work where possible.
- The definition(s) will use common terminology (i.e., terms should be understandable and jargon will be avoided).
- The definition(s) will be applicable over extensive areas and at a range of scales.
- Application of the definition(s) will be repeatable and consistent.
- Classifications should follow established scientific procedures where appropriate.
- The definition(s) will avoid developing conflicting concepts and methods through cooperative development with the widest possible range of individuals and institutions.
- The definition(s) will be mutually exclusive and additive to 100% of the Earth's land area, as represented on aerial photographs or satellite images.
- The definition(s) will be based upon existing, not potential, situations, and, in the case of vegetation cover, based upon condition at the optimal time during the growing season where such seasons exist.
- Land use classifications and nomenclature will be excluded from earth cover classifications and nomenclature.

Hope at the International Level

Two international activities could provide an objective structure for developing a definition. These include the Millennium Ecosystem Assessment (MA) and the Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance for Land Use, Land Use Change, and Forestry (GPG-LULUCF).

The MA[43] reports on finding for 10 categories of the land and marine surface, including forest, cultivated, dryland, coastal, marine, urban, polar, inland water, island, and mountain. Although rangelands are not discussed per se, dryland systems are defined as lands where plant production is limited by water availability; the dominant human uses are large mammal herbivory, including livestock grazing and cultivation. Drylands include cultivated lands, scrublands, shrublands, grasslands, savannas, semideserts, and true deserts. Dryland systems cover about 41% of Earth's land surface and are inhabited by more than 2 billion people.

The MA reporting categories are not spatially exclusive; their areas often overlap. For example, transition zones between forest and cultivated lands are included in both the forest system and cultivated system reporting categories. Thus there could be duplicate reporting in these categories. In addition, the MA synthesized existing information from the scientific literature, datasets, and scientific models, and included knowledge held by the private sector, practitioners, local communities, and indigenous peoples. There were no new data collected.

The IPCC has developed a classification scheme for reporting on greenhouse gas emissions that could provide estimates of rangelands at the national and international level using a common definition through the GPG-LULUCF. Of the 2 international activities, the IPCC represents the best construction for developing a definition.

To comply with the GPG-LULUCF, inventory agencies at the national level need information about land area for each of 6 classes to estimate carbon stocks and emissions, and removal of greenhouse gases associated with Land Use, Land-Use Change, and Forestry activities. The classes are "forestland," "cropland," "grassland," "wetland," "settlement," and "other land" for greenhouse gas inventory reporting. Milne and Pateh[44] define these classes as follows:

Forestland—*All land with woody vegetation consistent with thresholds used to define forestland in the national greenhouse gas inventory, sub-divided into managed and unmanaged, and also by ecosystem type as specified in the IPCC Guidelines 3. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forestland category.* (p. 2.6)

Forestland is further defined by the Marrakesh Accords[45] as follows:

"Forest" is *a minimum area of land of 0.05–1.0 hectares (with tree crown cover or equivalent stocking level) of more than 10–30 per cent with trees with the potential to reach a minimum height of 2–5 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high portion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10–30 per cent or tree height of 2–5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest*. (p. 58).

Noteworthy about the Marrakesh forest definition is that there are no exclusions listed nor is there a minimum strip width threshold specified as often done in other definitions of "forest."[46] However, Section 4.1.1 of the GPG-LULUFC, Step 1.1 specifies:

In addition to the minimum area of forest, it is good practice that countries specify the minimum width that they will apply to define forest unit and units of land subject to ARD [Afforestation, Reforestation and Deforestation] *activities, as explained in Section 4.2.2.5.1*.[47]

In addition, Milne and Pateh[44] did not specify any minimum percent of cover for lands to be considered as vegetated. Given that the Marrakesh Accords has a minimum of 10–30 percent for forest, we can assume this threshold would apply to the other vegetation types.

- **Cropland—***Arable and tillage land, and agro-forestry systems where vegetation falls below the thresholds used for the forestland category, consistent with the selection of national definitions.*
- **Grassland—***This category includes rangelands and pasture land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold used in the forestland category and are not expected to exceed, without human intervention, the threshold used in the forestland category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastural systems, subdivided into managed and unmanaged consistent with national definitions.* [This would also include savannahs with tree cover less than the forest threshold.]
- **Wetland—***Land that is covered or saturated by water for all or part of the year (e.g., peatland) and that does not fall into the forestland, cropland, grassland or settlements categories. The category can be subdivided into managed and unmanaged according to national definitions. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions.*
- **Settlement—***All developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with the selection of national definitions.*
- **Other land—***Bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available.* (p. 2.6).

The following is a proposed land classification key[48] that incorporates the thresholds contained in the Marrakesh Accords and the IPCC classes. In this classification scheme "Rangeland" is synonymous with "Grassland" by default.

1. Is the land area and strip width > national threshold? (Threshold must be between 0.05 and 1.0 ha.) Yes—Go to 2. No—Classify with surrounding area.
2. Is the land covered or saturated by water for all or part of the year? Yes = Wetland. No—Go to 3.
3. Does the area have a vegetative cover (which can consist of woody, herbaceous, trees, shrubs, forbs, graminoids, mosses/lichens[49]) > national threshold? (Threshold must be between 10% and 30% during at least two months of the year.) Yes—Go to 4. No—Go to 8.
4. Does the land have tree crown cover > national threshold (threshold must be between 10% and 30%) or will it have such tree cover in the future? Yes—Go to 5. No—Go to 6.
5. Do or will the trees reach the national threshold height (threshold must be between 2 and 5 m in height in situ at maturity)? Yes = Forestland. No = Non-forestland—Go to 6.
6. Is the land used for growing crops? Yes = Cropland. No—Go to 7.
7. Is the land dominated by grasses, forbs, or shrubs? Yes = Grassland (Rangeland). No—Go to 8.

8. Is the land developed for human activity? Yes = Settlement. No = Other land.

When applying the above categories, inventory agencies are to classify land under only one category to prevent double counting. Thus the classes are considered to be mutually exclusive and all-inclusive. Application could be particularly difficult because the IPCC classes are a combination of land cover and land use classes but it will be up to a nation to decide what goes where and when.

Based upon the above key, one could further refine a definition of grassland or rangeland for national and international accounting purposes as *dry lands having at least ten percent vegetative cover at least two months of the year and less than ten percent tree cover and that are not used for growing crops.* A workable definition of Rangelands definition based upon the IPCC categories is as follows:

Rangeland (including grasslands, shrublands, savannas, etc.): *Any dry land at least _ ha in size and _ m in width having at least _ percent vegetation cover at least _ months of the year and less than _ percent tree cover and that are not used for growing crops. A **tree** is any woody perennial at least _ m tall.*

The international community should determine the thresholds, or one might default to the thresholds already established that FAO uses for its periodic Global Forest Assessments: 0.5 ha for size, 20 m for width, and 10% cover of woody perennials at least 5 m tall.[27] After plugging in the FAO thresholds, the definition becomes:

Rangeland (including grasslands, shrublands, savannas, etc.): *Any dry land at least 0.5 ha in size and 20 m in width having at least 10 percent vegetation cover at least 2 months of the year* [49] *and less than 10 percent tree cover* [27] *and that is not used for growing crops. A **tree** is any woody perennial at least 5 m tall.*

A question arises if this level of specificity is needed. The answer is "Yes" if we ever hope to have reliable estimates of our land cover. Although this definition might not be acceptable by all, it does offer an opportunity for obtaining consistent and repeatable estimates of rangeland area at the national and international level.

Conclusions

Rangelands are important to us all for the goods and services they provide. Consequently, we need to be concerned about the extent and condition of these lands. However, there are no verifiable estimates of the world's rangeland areas. This is due in part to the lack of an objective definition of rangelands and the lack of national and international organizations that actually inventory and monitor rangelands. The definitional and accounting part could be solved by the recent issuance and national use of the Good Practice Guidance for Land Use, Land Use Change, and Forestry (GPG-LULUCF) from the IPCC. National implementation of the GPG-LULUCF should increase the local attention given to rangelands—politically, financially, and institutionally.

Additionally, on November 28, 2006, FAO announced that it is taking a new step forward and monitoring the management, uses, and users of all natural resources and their trends using an integrated approach. FAO is simultaneously monitoring all aspects of natural resources be it agriculture, forestry, fisheries, livestock, or wildlife, to build knowledge about the real environmental and socio-economic situations on the ground, making information closer to reality and relevant to policy makers.[50]

To obtain reliable estimates of rangeland and its changes, the various resource agencies and societies, especially the range management community, should promote an international definition followed by objective inventories. Without an objective definition and inventory, we will never know how much rangeland we have. If we don't know what we have, how can we adequately plan for and mange our rangeland resources?

It is hoped that this article will generate interest in the national and international accounting not only for rangelands but also for all lands. If all else fails, I encourage those who report area statistics to state both the definition they use and the source of their data.

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Natural Resource Management on the Other Side of the World: The Nagorno Karabakh Republic

By Steven H. Sharrow

Nestled on the slopes and in the valleys of the southern Caucasus Mountains in Central Asia, the Nagorno Karabakh Republic (NKR) could well have been the model for James Hilton's Shangri-La in his novel "Lost Horizon." Like Shangri-La, the steep mountains that provide its basic character have also served to isolate it from the outside world. Uplift of the Caucasus Mountains began approximately 5 million years ago as the Arabian Plate collided with the Eurasian Plate.[1] Mountain building continues today as the Arabian Plate moves NNE at about 28 mm per year. The resulting mountains are relatively young and steep. Slopes commonly exceed 100%. Earthquakes, such as the devastating 6.9-magnitude trembler of 1988 centered over a thrust fault near Spitak, Armenia, are characteristic of the region's active mountain uplift.

Figure 1. Territory controlled by the Nagorno Karabakh Republic and the traditional boarders of the Karabakh Autonomous Region. (Source: Wikipedia, http://en.wikipedia.org/wiki/Image:Az-qa-kaart-en.PNG).

Table 1. Rare and endangered predators still found in the southern Caucasus Mountains

Common name	Scientific name
Brown bear	*Ursus arctos*
Caucasus panther	*Panthera pardus ciscaucasica*
Golden eagle	*Aquila chrysaetos*
Grey wolf	*Canis lupis*
Lynx	*Lynix lynix*

The highest point in Karabakh is mount Gomshasar at 3,700 m. The Karabakh range also includes 4 other peaks over 2,400 m in elevation. With the Black Sea to the west and the Caspian Sea to the east, the Caucasus Mountains have long blocked movement of humans as well as plants and animals within this natural corridor between Europe and Asia (Fig. 1). The mixing of Mediterranean, Asian, and European species within relatively isolated mountain valleys has made the Caucasus region one of the world centers of biodiversity with over 6,300 plant species,[2] 1,600 of which are found nowhere else in the world (are endemic). This places the Caucasus among the richest floristic regions in the temperate zone.[3] Fauna of the Caucasus is equally diverse with 152 species of mammals (32 endemic), 389 species of birds (3 endemic), 79 reptile species (21 endemic), 13 amphibian species, and over 14,000 species of invertebrates.[4] The mountain forests provide refuge to predators that are becoming scarce elsewhere in Central Asia and Europe, such as the gray wolf, lynx, golden

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Figure 2. Former grape vineyards on upper slopes of the Caspian Plain south of Mardakert, NKR. Natural vegetation is sagebrush-steppe.

eagle, and the increasingly rare Caucasus leopard (Table 1). People in NKR are very environmentally aware and highly value their clean mountain environment. This region is a locus of long life where people often live to be over 100 years old. Low environmental pollution undoubtedly contributes to this longevity.

Lying between 39° and 40° north latitude, NKR has a relatively mild subtropical climate. Rainfall is fairly evenly distributed across the year with 28% of total annual precipitation occurring in fall (September–November), 12% in winter (December–February), 32% in spring (March–May), and 28% in early summer (June–August). Summer thunderstorms frequently bring damaging hail storms, especially in the foothills and mountains of the Karabakh range. Winter temperatures in lower elevations seldom remain below freezing, and people are able to grow subtropical fruits such as citrus, pomegranates, and figs in their home gardens.

Unfortunately, rising from the ashes of the former Soviet Union has proven to be a daunting challenge for this small democratic nation. The region that now includes NKR and Azerbaijan was acquired by czarist Russia from the Persian Empire by the treaty of Gulistan in 1813. Following the Bolshevik Revolution of 1914–1917, peace negotiations to end World War I, and the Bolshevik invasion of Azerbaijan and Armenia in 1920, Karabakh was eventually incorporated as an ethnic Armenian Autonomous Region within the predominantly Turkish Soviet Socialist Republic of Azerbaijan, where it remained until the breakup of the Soviet empire in 1991. Deep-seated ethnic tensions between ethnic Armenians and the Turkish majority population in Azerbaijan flared up in 1988. The resulting violent civil unrest contributed materially to the collapse of the Soviet Union. Karabakh declared its independence from Azerbaijan in 1991. The 4 years of civil war that followed was finally halted by a cease-fire in 1994. To date, the political issues that spawned the war have not been resolved, so no peace treaty has been signed, and no foreign government other than Armenia has diplomatic or trade relations with NKR. Lack of formal international recognition extends to establishing the territorial boarders of the nation. The NKR claims a central homeland of approximately 5,000 km^2 in the mountains and foothills of the Karabakh range, a small portion of which is held militarily by Azerbaijan. In addition, NKR controls another 12,000 km^2 of "occupied land" in the mountains between NKR and Armenia and in the sloping plains above the Caspian Sea. Lack of foreign trade relations has only added to NKR's natural geographic isolation. Physical access to NKR is presently limited to a single winding mountain "road of life" linking Goris, Armenia, to Stepanakert, NKR's capital. There are no operational civilian airports in NKR. The 300-km drive from the nearest airport in Yerevan, Armenia, to Stepanakert takes 5–6 hours. The nearest ocean access is through Armenia to the Mediterranean by way of the Black Sea ports of Georgia or to the Indian Ocean through Iranian ports on the Persian Gulf.

Land reform was initiated quickly after independence. The government recognizes 3 types of land: government land, village land, and private land. Private lands were issued to each person residing within NKR. Each person received 6,000 m^2 of land, making the average family farm about 3 ha in size. Villages often received 1,000–3,000 ha of land based on their size and traditional land use. This land may be rented for individual use under leases ranging from 1 to 25 years. All other lands belong to the government and may be used if appropriate under government land use policies. Most agricultural equipment was lost during the war for independence. That remaining was transferred to private operators that currently do custom operations for farmers for a set fee per hectare treated. Farm equipment is old and tired, and custom charges to farmers are relatively high compared to the value of crops obtained. This appears to be as much a problem of low crop yields as it is one of low prices received for crops.

There has been a long human presence in Karabakh. It is a country of small villages, many of which were founded prior

Table 2. Common plants of the foothill grassland zone

Common name	Scientific name
Annual ryegrass	*Lolium rigidum*
Black-wood	*Cotoneaster racemiflora*
Buckthorn	*Rhamnus* spp.
Bulbous bluegrass	*Poa bulbosa*
Fescue	*Festuca* spp.
Hawthorn	*Crataegus* spp.
Junegrass	*Koeleria* spp.
Needlegrass	*Stipa* spp.
Wheatgrass	*Agropyron* spp.
Sagebrush	*Artemisia* spp.

Figure 3. Mesic mixed shrub-steppe in foothills near Hardrut, NKR.

Table 3. Common plants of the lower mountain forest zone	
Common name	**Scientific name**
Ash	*Fraxinus* spp.
Beech	*Fagus* spp.
Birch	*Betula* spp.
Cherry	*Prunus* spp.
Elm	*Ulmus* spp.
Hornbean	*Carpinus* spp.
Linden	*Tilia* spp.
Maple	*Acer* spp.
Oak	*Quercus* spp.
Poplar	*Populus* spp.
Walnut	*Jugulans* spp.

to the 13th century. Although most villages have fewer than 500 people, their high number have supported a considerable population of rural farmers. Approximately 70% of NKR's 140,000 current inhabitants are rural farmers. Karabakh was a significant commercial contributor of wheat, grapes, and animal products to the Soviet central economy. Most land suitable for farming has been plowed, and areas suitable for grazing have been grazed or hayed. Therefore, the vegetation largely reflects this past use. It is difficult to find unimpacted reference areas to judge what the "potential natural community" might be without human interference. Therefore, observations of present vegetation plus plant community descriptions of similar sites in the Caucasus region[3,5] are used to broadly define 3 agroclimatic zones: foothill grassland, lower mountain mixed hardwood forest, and mountain subalpine grassland.

The foothill grasslands once occupied the generally eastern facing foothills and lower slopes of the mountains at about 300–600 m elevation (Fig. 2; Table 2). Annual precipitation is approximately 250–400 mm. Shrubs were an important component of these communities. Cool-season grasses, such as bulbous bluegrass, annual ryegrass, perennial fescues, needlegrass, junegrass, and wheatgrass, occurred with several types of woody and herbaceous sagebrush in the more xeric areas and with shrubs such as buckthorn, hawthorn, and black-wood in the more mesic areas (Fig. 3). This is the major dryland cereal zone of Karabakh. It is currently used to grow winter wheat. Potential wheat yields range from 6,000 kg/ha on the most productive lower slopes to 2,500 kg/ha on the upper slopes. However, current yields are well below these levels because of declining use of fertilizer and lack of improved seed varieties. Average wheat yields in NKR are currently about 1,900 kg/ha.[6,7] During Soviet times, the Transcaucasus Canal brought water from the Tartar River to irrigate 14,000 ha of wine grapes in the foothill zone near Mardakert. Closure of a section of the canal where it crosses Azerbaijan has killed most of these vineyards. They have now been converted to rain-fed wheat fields. Fruits such as grapes pomegranates, figs, pears, apricots, and peaches are currently grown in small orchards where irrigation water is available.

Figure 4. Old wheat fields interspersed with midelevation mixed hardwood forest in northeastern NKR.

The lower mountain zone is generally found at 600–1,100 m elevation and receives approximately 400–600 mm annual precipitation (Fig. 4; Table 3). Hills are covered with mixed hardwood forests of oak, beech, wild cherry, hornbean, maple, elm, and linden, with poplar, ash, birch, and walnut in moister areas. Broad areas of forest still exist on steep slopes. Moderate slopes have often been cleared for use as crop or hay fields, forming large openings in the forest. Cereals such as oats, wheat, and barley were grown dryland, and corn for livestock feed was grown with irrigation during Soviet times. Most of this cropland is now used to grow winter wheat or left unplanted to serve as go-back pasture. Winter wheat yields are low (1,000–2,000 kg/ha), and agricultural equipment is not reliably available to plant and harvest crops. Oats and spring barley are no longer grown, and large areas of former cropland have been returned to early successional pasture because tractors and harvesters are not reliably available.

Table 4. Common plants of the subalpine zone

Common name	Scientific name
Bentgrass	*Agrostis capillaris*
Bluegrass	*Poa nemoralis*
Bogsedge	*Kobresia* spp.
Clover	*Trifolium* spp.
Dandelion	*Taraxacum stevenii*
False brome	*Brachypodium silvaticum*
Junegrass	*Koeleria* spp.
Lady's-mantle	*Alchemilla caucasica*
Mountain brome	*Bromus* spp.
Orchard grass	*Dactylis glomerata*
Reed grass	*Calamagrostis arundinacea*
Sedge	*Carex* spp.
Sheep fescue	*Festuca ovina*
Speedwell	*Veronica gentianoides*
Sweet clover	*Melilotis* spp.
Vetch	*Vicia* spp.
Yarrow	*Achillea* spp.

Forests occupy about 36% of NKR. They are used to graze livestock, especially pigs. Little forest floor vegetation or tree reproduction may be present because of foraging by livestock as well as dense overhead tree canopies. Fuel wood is a major source of heat for rural homes. Firewood cutting is allowed in forests, but the high permit fee charged per cubic meter of fuel wood taken limits domestic wood use. Unauthorized cutting of large trees was discouraged by forest use zoning during Soviet times[3] and is currently forbidden by a NKR law signed in 2000. Forests often contain large commercially valuable trees. Armenia is currently liquidating its inventory of large hardwood trees for sale to Europe. This process has been greatly hampered in NKR by lack of market access. However, there is concern that "high grading" the most valuable large trees may spread into NKR forests.[8] For example, a news story in NKR[9] exposed logging of large old trees that recently occurred under the guise of "salvage logging" to remove diseased trees. The concern is not about deforestation because only large trees of valuable species, such as linden, oak, and walnut, are being cut. The problem is with reduced "quality" of forests as the large trees that give the forest its characteristic structure are removed. There are no forest tree nurseries in NKR, so replanting is not practiced. Inventory of present forest resources as well as more effective regulation of forest practices are needed to preserve NKR's forest heritage.

The subalpine zone generally is found above 1,100 m elevation. Average annual precipitation is 600–800 mm. Vegetation is predominantly cool-season short and midgrasses with a significant component of perennial forbs and native legumes (Table 4). Orchard grass, junegrass, bentgrass, reed grass, clovers, bluegrass, vetch, yarrow, false brome, and sweet clover are typical lower-elevation plants (below 2,400 m) within the zone. Sedges, sheep fescue, mountain brome, bogsedge, speedwell, lady's-mantle, and dandelion are common in the higher portions of the zone. Grazing and haying are the most common agricultural uses of this zone (Fig. 5). However, some limited potato production occurs in the lower elevations on deeper soils. Large white mushrooms are collected during spring from subalpine grassland and sold from small stands along roadsides.

There is a small deposit of gold and some other commercially useful minerals (marble and limestone), but NKR's main economic assets are hydropower and agriculture. The steep mountains support streams that have significant potential for generating electricity. Currently, NKR produces sufficient electricity to meet its own needs and exports power to Armenia. All villages have electricity that provides their lighting and heating needs. Agriculture has long been the economic lifeblood of Karabakh. Unfortunately, the region has gone from being a significant exporter of agricultural produce during Soviet times to importing 60% of its food today.

Rural farmers in NKR have traditionally practiced subsistence agriculture. During Soviet times, rural families had gardens and household livestock for their own use while working in the commercial communes. Production bonuses for agricultural workers were often paid in kind. For example, a worker in a wheat-growing commune may get a bonus of 1,000 kg of wheat. When the local economy collapsed during the end of Soviet rule, people just shifted their emphasis entirely to subsistence agricultural practices with surpluses sold through informal markets. Rural families currently grow their own wheat; make their own bread; keep cows to produce cheese, yogurt, and other dairy products; have a household garden/orchard for fruits and vegetables; make their own wine, brandy, and vodka; and harvest wild foods such as walnuts, berries, and mushrooms. Excess production is bartered with neighbors or sold to merchants from Step-

Figure 5. Subalpine grassland in the Karabakh Mountains, NKR.

anakert or Armenia who visit the villages. Village life has a rather medieval quality. Forage producing lands occupy 57% of NKR. There are approximately 14,000 pigs, 39,000 cattle, and 40,000 sheep and goats in NKR.[7] Villages near forests send a herd of pigs out to forage each morning, while a separate herd of cattle or a mixed herd of sheep/goats is herded out to graze open uncropped land. Herds are mixed sex, and males are not castrated. Bulls and boars are left intact so that they will be more aggressive in defending the herd against attack by wolves. One hill village visited lost 60 pigs last year to wolves that came into the village at night and took pigs out of people's fenced yards! Little hay or grain is fed to livestock, so reproductive rates of cattle and sheep are relatively low (often below 50% calving rate for cows and below 100% lambing rate for sheep). The little hay that is cut tends to be of low quality because it is often harvested late by hand and transported and stored loose. Sheep and goats consume about 20% of all forage in NKR, while cattle consume about 80% of the forage used for livestock production. Although cattle are found both in the mountains and in the plains, sheep and goats tend to be more concentrated in the mountains, where their shorter lactation period and shorter reproductive cycle make them more able to deal with high seasonal variability in forage quantity and quality. Sheep are primarily the fat-tailed type preferred as meat animals in Iran, North Africa, and the Middle East region. Exports of live sheep to these areas may be a viable and lucrative future market opportunity. Both sheep and goats are often kept as small household livestock that provide rural farmers with milk and meat for their own use. They are also important sources of hair for textiles and carpet making. The Caucasus region, along with nearby Iran, are well respected traditional carpet making areas.

Because of its political isolation, NKR receives little foreign aid or economic assistance from the international community. Money for economic development and construction of basic infrastructure comes from private charities such as Catholic Relief Services and the Hayastan All-Armenia Fund. The Armenia Fund has been actively building roads, schools, clinics, hospitals, water pipelines, and other basic infrastructure in NRK for many years. An ambitious 5-year project of economic development through agricultural modernization was added to the portfolio of infrastructure projects in 2006. Bread is the basis for rural diets. Karabakh wheat is in demand in Armenia because its high gluten content makes it desirable for bread production. Current wheat production is well below that needed to supply both domestic and export markets. The development strategy is to initially focus on supporting and improving cereal production by importing new modern tractors, harvesters, and field implements so that land can remain in production. Access to fertilizers, improved seeds, and, to a lesser extent, agricultural chemicals, together with improved farming practices, should increase cereal yields. Modern equipment to cut and bail hay is also being imported. This is meant to be the first stage in a successional process moving up the value-added ladder from basic commodities such as wheat and corn to processed products such as processed meats, dairy products, dried fruits, and jams and jellies. Prices for meat are relatively high, and there is considerable potential to increase meat production and rural household income by improved pasture and livestock husbandry without saturating local markets.[6] A few hill farmers have begun to increase hog production as a way of marketing excess grain. It is hoped that using grain to support animal production will become more common as wheat yields increase and other grains more suitable for animal production, such as oats, corn, and barley, are again grown. Once sufficient excess animal products are consistently available, processing businesses can follow.

The opportunity to finish forage-raised livestock on grain may place additional stress on NKR's forest and pasture resources by encouraging expansion of livestock populations. Currently, local graziers do not perceive overuse of pastures and forests as being a problem despite some evidence to the contrary. The land tenure situation in NKR is very amenable to allocating forage resources at the village level. In addition, some of the lower-producing croplands may be more economically used as improved pastures. Although planting agronomic pasture is rare in Karabakh, their use along with cereal grains for more intensive livestock production may be more profitable than wheat production. This opens up possibilities to reduce pressure on grazing lands surrounding villages.

Karabakhes realize that their quality of life is tied to the health of their farms, forests, and pastures. While much work remains to be done, there is every reason to be optimistic that a reasonable balance between economic rejuvenation and environmental quality will be achieved so that Nagorno Karabakh truly becomes a Shangri-La.

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Veld Condition Trend of Grazing Areas

Why poor livestock production in the tropics?

By C. T. Gadzirayi, E. Mutandwa, and J. F. Mupangwa

Grazing Condition in Marginal Areas

In sub-Saharan Africa, poverty is literally endemic and seems to be an inextricable part of the lives of the majority of people in this region. Recent estimates indicate that the gap between the rich and poor countries has increased over the last few years. This scenario has been further complicated by the HIV/AIDS pandemic.[1] However, agriculture still represents an option that is touted to have the potential to revitalize the livelihoods of the rural poor and the general populace.

Like most developing nations, Zimbabwe's agriculture is a key component of economic growth.[2] Field crops such as cotton, tobacco, maize, wheat, and livestock production dominate the sector. The importance of the livestock subsector is underscored by contract supply of beef under the European Union and African, Caribbean, and Pacific trade arrangements. Recent changes in agriculture have ushered in small farmers who now dominate the livestock production landscape in Zimbabwe.

The basis of cattle production in Zimbabwe is mainly natural grazing from the veld or range. Cattle production is heavily dependent on the nature, conditions, and quality of the grazing land. However, veld deterioration resulting from mismanagement is becoming more apparent, particularly in the communal areas of Zimbabwe. Despite the important role that cattle play in the livelihoods of smallholder farmers (draft power, milk, meat, hides, aesthetic values, and form of wealth), communal farmers fail to increase calving rate and herd sizes because of deteriorated grazing land.

Figure 1. Wedza communal and commercial lands in Zimbabwe.

Overstocking further exacerbates the situation in communal areas. Stocking rates used to be as high as 15 times the recommended level of 1 Livestock Unit (500 kg) to 3 ha grazing area.[3] Although the national herd has significantly declined, pockets of overstocking still exist, particularly in low rainfall areas such as Masvingo Province where rates of about 80% above normal were recorded.[4]

Because of the extensive variations in veld conditions across the communal areas of Zimbabwe, this research was focused

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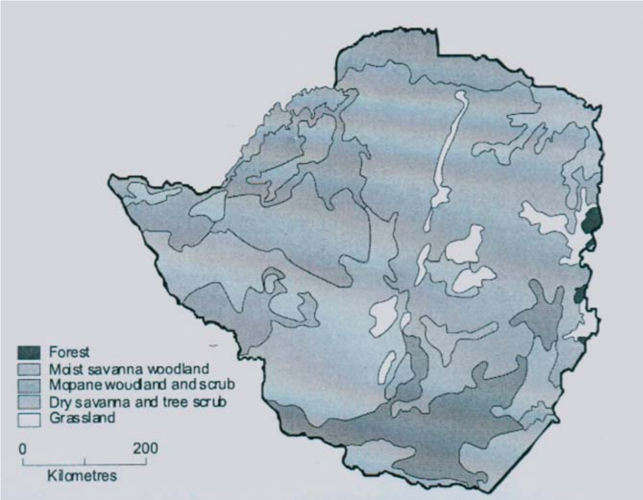

Figure 2. Vegetation zones in Zimbabwe.

on Wedza communal lands as a case study. The Wedza communal area is located in natural region I1b (Fig. 1), and the vegetation of this area is mainly savanna woodland with the miombo tree species dominating (Fig. 2). Thatching grass is the dominant grass species. While it may be acceptable that it is the responsibility of the local community to ensure a well-managed veld, it seems little attention has been paid to ways of improving veld condition in Zimbabwe. There is also a relative dearth of information on studies focusing on continuous assessment of the condition of grazing land within the context of the land and agrarian reforms in the country and sub-Saharan Africa in general.

Effects of Veld Mismanagement

Although smallholder livestock agriculture is vital to the lives of the rural poor, a nexus of social, economic, and environmental factors affect it. The declining quality of the veld in communal areas has serious ramifications at both the micro- and macrolevels. At the microlevel, this implies loss of cattle value and ultimately compromising the household economy. At the macrolevel, this means reduced consumer welfare due to rising prices as a result of dwindling supply. It also means a loss of foreign currency that could be earned through export of "Genetically Modified Organism-free" cattle products. Ecologically, there will be loss of plant biodiversity, loss of topsoil, and siltation of rivers and dams. A well-managed veld could potentially reverse the above effects. There is need to assess the quality of grazing land as well as exploring options that can be used to promote sustainable livestock production.

Why Veld Assessment?

The main objective of this study was to assess the condition of grazing land in communal lands of Zimbabwe and adjacent protected commercial areas (formerly called European Land in Rhodesia).

The specific objectives of the study were to:

- Describe the grass species distribution found in selected grazing areas and explain the veld condition.
- Determine the degree of veld deterioration in communal grazing land measured against benchmark sites in protected commercial areas.
- Identify constraints to sustainable management of communal grazing lands.
- Develop options that can be used to sustain good quality grazing lands.

Issues Underpinning Grazing Management

The quality of grazing land is affected by social (human), physical, and natural factors. Social factors that affect quality include activities such as deforestation and stream bank cultivation. These activities reduce soil cover, hence the area under grazing land. Physical and natural factors such as rainfall patterns and ambient temperatures affect the types of plant species that can potentially be found in an area. Economic factors such as the returns to farm investments may also have an implication on the exploitation of natural resources. If the returns to farming are relatively lower than nonagricultural activities, households may engage in activities such as gold panning or deforestation (selling of firewood), which results in overextraction of resources. There is a positive relationship between poverty and land degradation.[5] In addition, if the community members do not have access to appropriate training in management of grazing land and use of resources this may lead to reduced quality of grazing land in the long term.

Assessing Veld Condition

In assessing the veld condition, one of the following criteria based on floristic composition may be used:

- The state of the vegetation with respect to its ecological status.
- The proportion of plants, which decrease, increase or invade under grazing.
- The forage production of a site.

Ecological Status

Ecological conditional classes are as mentioned in Table 1.

Forage Production

Current forage production was compared with what is considered to be produced under the best possible management (Table 2).

Table 1. Ecological status

State	Classification
Excellent	76—100% of climax species
Good	50—75% of climax species
Fair	25—49 of climax species
Poor to very poor	0—24% of climax species

Table 2. Forage production classifications	
Class	**Percentage**
Excel-lent	75—100% of possible forage production
Good	50—74% of possible forage production
Fair	25—49% of possible forage production
Poor	Less than 25%

Practical Assessment of Veld Condition

In carrying out the project, both qualitative and quantitative methods of assessing veld condition were used. A condition score sheet adapted from Rattray[6] was used since it has stood the test of time in tropical grasslands. In using the qualitative system of veld assessment, 5 paired sites were chosen from commercial and communal farming areas. The sites that were located in commercial farming areas were referred to as the benchmark sites because they were in good condition. The

INSTRUMENT 1
VELD CONDITION SCORE SHEET

Farm:.. Farmer:..
Conservation Area:..................................... Date of Survey:............................
Paddock No..
....
....

Criteria	Excellent 10-9	Good 8-7	Fair 6-5	Poor 4-3	Very poor 2-1
Grass species composition					
Basal cover					
Forage production					
Litter and plant residue					
Soil compaction and erosion					
Veld-Final rating					
Grass Species composition					

BASAL COVER..
....
FORAGE PRODUCTION AND PLANT VIGOUR
SEEDLINGS..
AGE DISTRIBUTION OF GRASSES...
....
Dead or dying tufts..
Est. carrying capacity.............................Est. potential c.c.............................
LITTER. Type and quantity..
SOIL COMPACTION AND EROSION
Surface capping...
Litter fans...
Sheet erosion...
Erosion pedestals and pavements...
TERMITE ACTIVITY..
PHYSIOGNOMIC TYPE..
Dominant trees...
....
Bush encroachment...
....

Figure 3. Instrument 1: Veld Condition Score sheet.[7]

veld in communal areas within the same climatic zone, soil type, and same position on slope and aspect was rated against such benchmark sites. Selection of benchmark sites was subjective. It involved the selection of sites that were stable with a lot of decreaser grass species, particularly thatching grass species. Adjacent sites contained desirable grass species, mainly decreasers. Sites that were in poor condition were selected within a distance of 100 m from benchmarks. Sites for assessment were selected away from roads, fences, and water points in order to reduce the incidence of assessing veld that is not representative of the area due to disturbance.

Veld Condition Scoring Sheets

Veld condition score sheets were used for the overall veld assessment (Fig. 3). Aspects measured included ground cover.

The proportion of plants that decrease, increase, or invade under grazing pressure was used to show variability in the veld condition between commercial and communal grazing lands.

Five paired sites that were 50 m × 50 m were selected. Within each site, species composition and ground cover were recorded at 200 selected positions using the line-transect and step-point methods, respectively.

Semistructured interviews were conducted with farmers and local leadership in communal areas to elicit their thoughts with regards to sustainable grazing options for them.

Results were analyzed using 2-way analysis of variance (ANOVA), chi-square, and *t* tests.

Findings

Score Sheet Recordings

The assessment of veld condition using score sheets (Instrument 1) showed that the condition of the veld in commercial areas was generally good (Fig. 4) with some excellent sites. Veld condition in communal land was fair to poor among the assessed sites (Fig. 5). This might explain why the condition of animals in communal areas is relatively poor.

Figure 4. Commercial grazing land.

Species Composition

For the proportion of decreasers, increasers, invaders, and weeds for the adjacent sites, there was a statistically significant difference between communal and commercial areas at the 10% level. A greater proportion of decreasers were observed in commercial sites and this might be responsible for the better beef production in commercial areas where a high proportion of decreaser species exist.

Ground Cover

The percentage ground cover obtained using line-transect and step-point methods for commercial and communal areas showed that commercial land has better ground cover as opposed to communal grazing land. Perhaps this is why soil erosion is easily observable in the communal areas of Wedza and most communal lands since ground cover helps to reduce the effects of raindrop erosion.

What Farmers Have to Say

Interviews with communal farmers using semistructured meetings revealed that:

- They were in favor of controlled grazing through the use of paddocks.
- They were against destocking expressing that their cattle were a source of wealth to be bequeathed to children.
- They also insisted on using their own bulls for honoring their ancestors (traditional rituals).

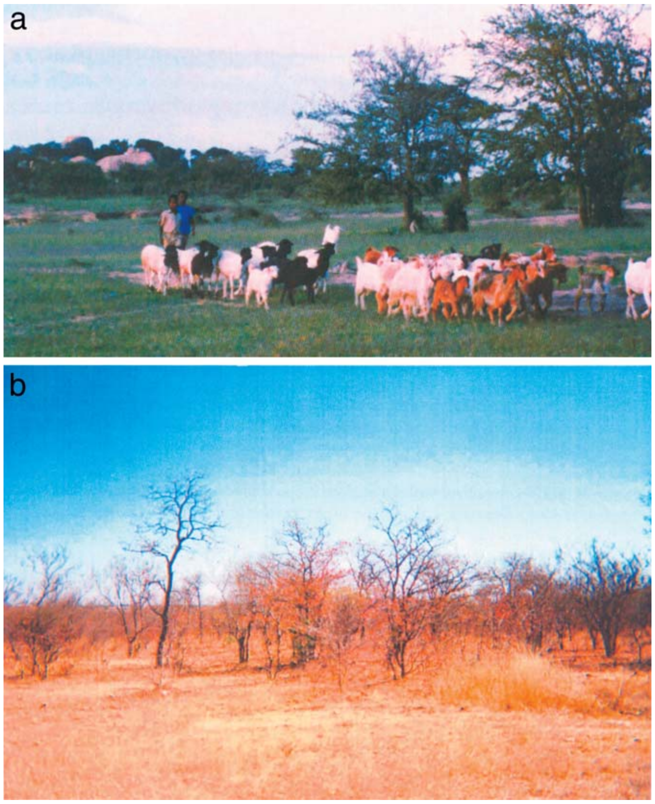

Figure 5. Communal grazing land toward end of wet season (a). Communal grazing land during the dry season (b).

Interviews with the government extension staff showed that grazing schemes should be introduced in communal areas, farmers should practice pen fattening to reduce grazing pressure, they should establish legumes on contour ridges to improve winter grazing, and they should ask trained staff for help.

Conclusions

Veld condition in protected commercial areas is better than that in unprotected communal areas. Less vegetation is found in the communal areas because grass mismanagement through overstocking has led to much vegetation loss. Loss in vegetation results in animals walking long distances in search of pastures and more energy used in obtaining feed. This is an important factor leading to reduced productivity.

The following systems of reclaiming veld in a deteriorated state can be applied to most tropical grasslands under open grazing systems:

- Seasonal resting 2-paddock system per herd.
- Destocking and supplementation with plant residue.
- Pen fattening animals and planting legumes on contour ridges to improve grazing in winter.
- Constant appraisal of the veld to establish the trend.

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Holistic Environmental Management in a Communal Grazing Scheme

From isolation to consolidation

By C. T. Gadzirayi, E. Mutandwa, and J. F. Mupangwa

About the Grazing Area

The Chikukwa communal area is located on the southeastern border of Zimbabwe with Mozambique and on the northern end of the Chimanimani range of mountains. The communal area has approximately 700 households, deriving livelihoods from diverse agricultural activities practiced on deep, mainly clay, soils. The area is found in agro-ecological region 1, receiving between 1,200 mm and 1,500 mm of rainfall per annum. Temperatures are relatively low, ranging from 15°–25°C. It is one of the prime agricultural zones of Zimbabwe, but under siege from environmental degradation as a result of soil erosion, steep slopes, and inappropriate farming practices. The vegetation is characterized by open grasslands and scattered woodlands of various indigenous and exotic species.

The Chikukwa people were allocated Jantia Farm in 2003 by the government as a grazing area for their cattle. This was done to solve grazing problems emanating from a shortage of grazing land. Jantia farm is 1,120 ha in extent, much of which is hilly and broken hills with a number of streams starting from the hills. Over 100 ha are for homesteads and cropping, leaving 881 ha of grazing land. Jantia can hold between 300–400 livestock units (LU). One livestock unit is equivalent to 500 kg live weight. The Chikukwa grazing committee planned 6 paddocks in Jantia farm ranging from 88–194 ha. Each paddock has one or more water points for cattle.

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Why a Holistic Grazing Scheme?

- Encourage sustainable agricultural practices.
- Improve animal condition and livestock growth rates.
- Reduce straying of animals and thefts.
- Increase labor availability for agricultural and other social activities.
- Have an adequate supply of meat and milk.
- Promote the economic and social interests of members.
- Investment in social skills through community exchange of information.

The Grazing Scheme Planning Process

Community members were the hub in planning the grazing scheme with the assistance of government extension services and other stakeholders. A participatory mapping exercise of the Jantia grazing scheme was carried out. All participants took part in the Jantia grazing map, identifying and filling in all features such as rivers, wells, and springs. They considered the topography, vegetation density, veld types, and the availability and distribution of water. The carrying capacity of Jantia is set at 200 LU. The stocking rate is set at 1 LU per 5 ha of grazing area.

Consultations with various stakeholders were done and revealed the following:

- The concept of a planned grazing scheme was well received by all stakeholders.

- The Chikukwa people agreed that only those settled on the scheme could graze their livestock instead of having all neighboring households grazing their livestock which could result in overgrazing.
- In order for the scheme to be viable, there is a need to set up a training fund for the community for initial and continuous training on livestock management and business principles in livestock production.
- A constitution for the grazing scheme bylaws and management plan for the grazing scheme was drawn up.
- The stakeholders agreed that the scheme should also have other functions in the future, such as honey production and goat production among other things.

Grazing Management System

A rotational grazing system was agreed upon as a management system to follow. Participants demonstrated their understanding of the rotational grazing system by drawing grazing management charts, a paddock management record, varying the period of stay, and calculating the rest period of each paddock. The grazing periods are varied depending on size of paddock, veld type, and season of the year. The recommended period of grazing in any one paddock is 5–7 days during early summer. As grass growth improves and sufficient quantity of forage become available the grazing period is increased to 14–21 days from late summer to the dry season.[1] However, varying the time of grazing in any one paddock is flexible, being guided by common sense, experience, and close observation of the condition of the veld.[2]

Implementation of Grazing Scheme

Grazing Committees

Six grazing committees were established for the Jantia grazing scheme. These are executive, veld management, animal health, finance, security, and disciplinary. Each committee is characterized by a chairman and vice-chairman, secretary, treasurer, and committee members. This arrangement is depicted below. The committees work together by holding monthly meetings and consult with other stakeholders on issues pertaining to the grazing scheme. Members of the respective committees are selected through a voting process at Annual General Meetings. A member serves up to 2 terms of 2 years per term.

Functions of the Management Committees

Executive Committee

Coordinates the activities of the 5 subcommittees in consultation with the local leadership.

Veld Management Committee

This committee is involved in the implementation of the grazing scheme that includes fencing and fence repairs, grazing management system implementation, and control of the number of animals coming into scheme. The committee is also responsible for organizing and mobilizing the community to plant pastures, to fortify the veld, and to carry out repair work on the fences.

Security Committee

This committee looks at the condition of the fences and this is usually done once a week. They also monitor unauthorized hunting, cutting down of trees, and apprehend offenders. The committee is also responsible for the employment of 2 security guards who check on the security of livestock and equipment in the grazing scheme. The security guards are to report all cases of theft to the Chief, Headman, Kraal head, and the police.

Animal Health Committee

This committee has been entrusted to maintain the dip tank, assist the dip attendant in dipping of cattle, check and treat sick animals, and also purchase drugs and chemicals with the money collected from members of the scheme. It is also responsible for ensuring that 5 households per time collect animals for dipping and change cattle from paddock to another paddock.

Finance Committee

The Finance committee is responsible for collecting monies from members. They are also involved in the payment of casual labor, who works on the scheme, and other running costs affecting the operations of the grazing scheme. The committee was tasked to open a bank account with 3 signatories where all funds received will be deposited.

Disciplinary Committee

This committee is involved in assessing the gravity of cases brought by the security committee. There are some cases on which they can pass judgment and others that are referred to the chief or the police.

Membership

Members of the community who joined the scheme paid an initial subscription fee irrespective of whether one owns livestock or not. The money is used to hire contract labor for maintenance of the fences in the scheme. The current membership of the scheme is 84 with 63 of them owning cattle.

Table 1. Number of cattle owners by village

Name of village	Number of cattle owners
Jantia	27
Kwaedza	21
Mabasa	12
Mukwee	3
Total	63

The breakdown by village and number of cattle owned is shown in Table 1. Currently there are about 331 cattle in the scheme with stockholders owning between 2 and 24 animals per household. The breakdown of animals in Jantia grazing scheme is shown in Table 2.

Fencing

The implementation process started in 2004 with the fencing materials being provided by key stakeholders. Labor to construct the perimeter fence was provided by members of the grazing scheme. So far the community has fenced 8 km of the perimeter and 4 km of internal fence with 11.8 km of the perimeter and 13.69 km of internal still to be fenced.

Members also fenced off some springs that are within the grazing area to protect water works from pollution. Livestock corridors have been fenced from the villages into the grazing scheme.

Figure 1. Veld in fair to good condition.

Veld Condition

The grass species diversity indicates a greater proportion of the desirable rangeland grasses which should be maintained. The forage production, ground cover, and plant density are good which help to reduce the erosivity of runoff water. There is no noticeable incidence of soil erosion or capping. Very isolated cases of termites were observed because of relatively low temperatures and a high water table. The veld was assessed to be in a fair to good condition (Fig. 1).

Cattle Condition

The cattle grazing in the scheme were in good body condition. The major disease incidences according to the grazing committee members are sweating sickness, red water, diarrhea, and black leg. Farmers use both traditional and conventional medicine in treating some of the diseases. The grazing scheme has a functional plunge dip system jointly managed by the veterinary department and the animal health committee. One of the members in the veld management committee has 27 years of experience as a stockman and assists his colleagues in disease control and calving problems. According to the experiences of the grazing committee, the scheme experiences low reproductive rates of about 40%, high preweaning mortality, and low growth rates of 3–4 years to maturity. The low reproductive rates are associated with poor-quality bulls available in the area, low-quality nutrition of animals during the dry season, and diseases, especially tick-borne.[3] Generally there are few goats in the area, which are grazed by tethering.

Benefits of Grazing Scheme to the Community

Social

The social benefits include reduced conflicts among community members and within families, and reduced crop destruction by straying animals, resulting in less stock theft. There is also enhanced social cohesion as families now spend quality time together and the community is involved in all stages of project planning and management.

Economic

Maize crop yields have since increased from an average of 1 to 3 tons per ha due to more labor being available for agricultural activities. Improved cattle conditions are due to quality veld condition and have resulted in increased milk and manure output. On average, milk production was about 400 ml per day/cow and is now 1,000 ml per day/cow. Farmers are now resorting to the use of organic manure as opposed to inorganic fertilizers, which are expensive and unavailable.

Table 2. Classes of livestock in Jantia grazing scheme

Livestock class	Number	Estimated LU equivalent	LU	Percentage of total (%)
Oxen	95	0.6	57	28
Bulls	36	0.6	21.6	11
Cows	96	0.5	48	29
Calves	45	0.18	8.1	14
Heifers	59	0.36	21.24	18
Total	331		155.94	100

There is also early tillage of land that boosts crop output. The restriction of cattle in the grazing scheme has also resulted in fewer cattle injuries. There is now improved cattle management through the establishment of the animal health committee that promotes early detection of diseases and control, leading to reduced cattle losses. The community has started a bee production project within the grazing scheme. This gives a positive spillover effect through cross-pollination into nearby fields, and also honey sold locally raises incomes for participant households.

Environmental

There is improved conservation of trees and other forms of biodiversity through the monitoring and implementation of agreed upon bylaws by the veld management and the security committees. There is less soil erosion as noted from increased ground cover and improved water conservation of some springs that are now protected to conserve water. In addition, there is reduced siltation of rivers, wells, and other water points. The aesthetic value of the land has thus improved due to the good veld management.

Institutional

The support of the traditional leaders and the police to the scheme is through the enforcement of bylaws. There has been enhanced collaboration between the Chikukwa community and local nongovernmental organizations (NGOs). Collaboration has been achieved through facilitating the planning of the grazing scheme, training, stakeholder consultation meetings, purchase of fencing materials for the perimeter fence, and organization and funding exchange visits. Government departments offer technical advice in the demarcation of paddocks and paddock layout plans. The veterinary department advised on the types of pastures to be planted, rehabilitation of the dip tank, training of farmers in animal health, mobilization of funds for training of farmers, and supplementation of cattle feeds with crop residues such as maize stover, beans, and pea residues.

Food Security

The community is experiencing enhanced food security through sustainable crop production and diversification, thereby reducing production risk. Farmers often experience excess production to their home needs and sell within the local community and nearby markets.

Major Lessons Learned From Jantia Holistic Grazing Scheme

- Controlled grazing schemes are more suitable for communities that have organized residential and cropping areas.
- The community in the grazing area showed willingness to contribute to building their cattle herd both in numbers and quality.
- The community demonstrated resourcefulness with minimal external assistance to improve their environment.
- The holistic grazing scheme has a coordinated community management approach to natural resources. This has helped bring about community ownership of resources.

Key recommendations made are:

- For successful implementation of a community grazing scheme there must be total involvement of the community and wide consultation of the relevant stakeholders.
- There is a need for an effective finance resource mobilization mechanism by the community, persistent focus, and commitment to the values of the grazing scheme.
- There is a need for product patenting so that the community enjoys royalties associated with their knowledge.
- There is a need for Participatory Action Research focusing on the local needs, and knowledge products should be packaged and disseminated in local languages to assist wider community acceptance.

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Nara Desert, Sindh, Pakistan: Part III: Range Types and Their Plant Resources

By Rahmatullah Qureshi and G. Raza Bhatti

Introduction

Nara Desert, the northern part of Thar Desert (Fig. 1), is characterized by high wind velocity, massive shifting and rolling sand dunes, high diurnal variation of temperature, scanty rainfall, extreme solar radiation, and high rates of evapotranspiration. It receives between 88–135 mm of rainfall every year, mostly between July and September. The sandy soils of the desert have a rapid infiltration rate of water, poor fertility, low organic matter due to hasty oxidation, and high salinity. All these conditions are very hostile for the existence of life, although large human and livestock populations inhabit the area. This desert is highly fragile with poor primary producer but large responsibility (ie, the consumers cause severe obstruction in its ecological regeneration).

The word *desert* gives the notion of a vast, lifeless, undulating area of sand. The Nara region does not concur with this popular conception. It is not a perpetual elongation of sand dunes devoid of life or vegetation. During the rainy season, it blooms with a colorful range of trees and grasses. It transforms into lush green with the slightest amount of precipitation because the soil is full of dormant seeds of various species, which germinate with little moisture.

Vegetation

The vegetation in the Nara Desert region is sparse, consisting mainly of stunted, thorny, or prickly shrubs and perennial herbs capable of drought resistance. Trees are few and scattered. The ephemerals come up during the rainy season, completing their life cycle before the advent of summer, and the bulk of the area is once more transformed into an open, sandy plain that is desolate and barren. Four types of plant groups were observed in this area and are described below on the basis of their growth and habitats performance:[1]

1. **True Xerophytes**
   - Succulence.
   - Covered with trichomes.
   - Reduce the size and length of transpiring parts (ie, leaves), leaflessness, etc. Includes *Haloxylon stocksii, Arthrocnemum indicum, Saueda fruticosa, Salsola imbricata, Aerva* spp., and *Glinus lotoides*.
2. **Semi-xerophytes**
   - Plants which grow in arid climate in the presence of sufficient amount of precipitation. Includes *Acacia nilotica, Calotropis procera, Heliotropium europium, H. currasavicum,* and *Withania somnifera*. These plants grow mostly on the periphery of the desert.
3. **Pseudo-xerophytes**
   - Ephemerals which complete their life cycle within 6–8 weeks before the advent of summer. Includes *Neurada procumbense, Mollugo* spp., *Gisekia pharancoides, Cleome brachycarpa, Boerhavia procumbense,* and grasses like *Eragrostis minor, Stipagrostis plumosa*, and *Aristida* spp.
4. **Hydrophytes**
   - Plants which live in water or in very moist habitat. Includes *Cyperus rotundus, Fimbristylis dichotoma, Phragmites karka, Saccharum bengalense*, and *Typha* spp.

Range Types and Their Plant Resources

During a survey from 1998–2001, 5 distinct range types were constructed from the Nara Desert, Pakistan, based on topographical features and plant resources.[2] In addition, a sixth

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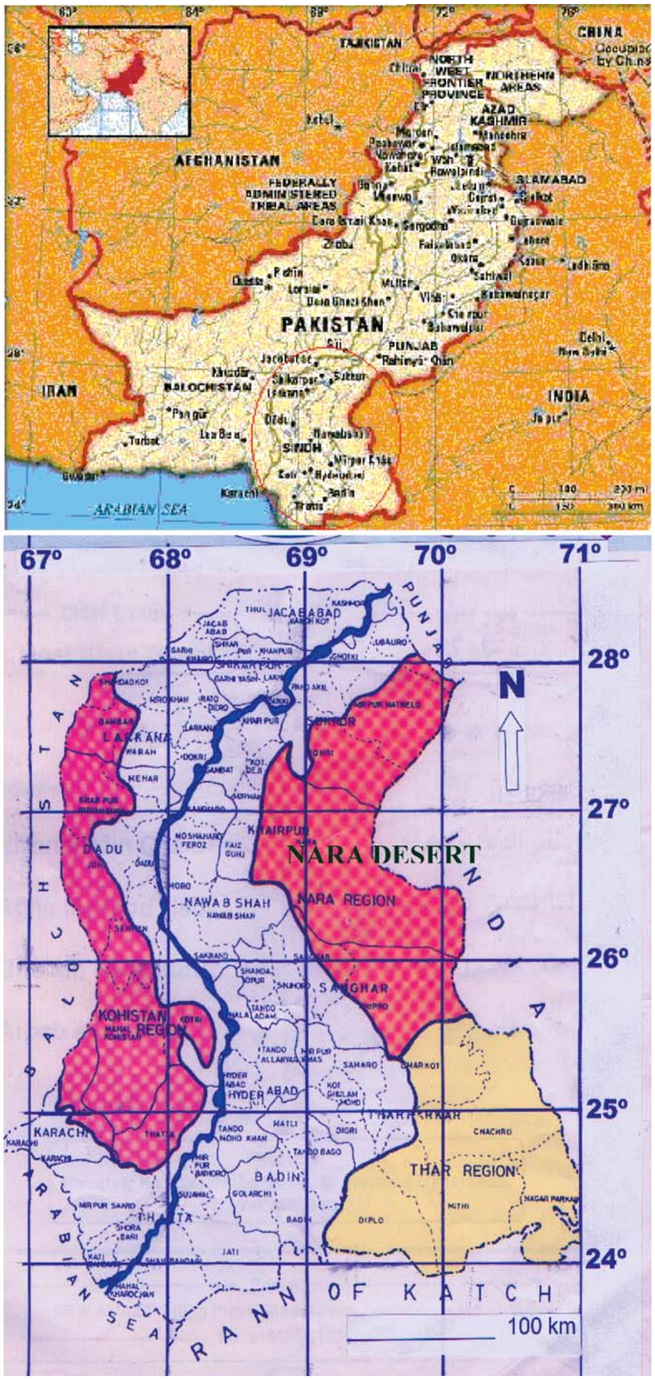

Figure 1. Map of Pakistan showing the location of the Nara Desert.

type (Hilly Tract) was also identified[1] and will be discussed in a separate paper.

A total of 145 species belonging to 101 genera and 41 families were recorded during the report period. Species composition in the different range types showed differences in species richness. The highest species richness of 72% is recorded from flat range type. Crest range possessed fewer species as compared to the rest of the range types. The vegetation over this major area is characterized by xerophytic adaptation. The most common plants in this desert are *Calligonum polygonoides* (Phog), *Aerva javanica* (Booh), *Dipterygium glaucum* (Phair), *Crotalaria burhia* (Chagg), *Prosopis cineraria* (Kandi), *Tamarix aphylla* (Lao), *Capparis decidua* (Kirar), *Salvadora oleoides* (Jaar), *Leptadenia pyrotechnica* (Khipp), *Aristida* spp. (Lumb Gaah), *Limeum indicum* (Dhoor Chhapri), and *Stipagrostis plumosa* (Lumb Gaah) growing in crest, slope and flat range types. Saline/sodic land and wetland ranges possess halophytic and hydrophytic characteristic features.

A view of crest range showing sparse vegetation.

Crest Range

Sand dunes comprise the main characteristic features of the study area. Topography of this range varies from undulating to moderately steep with elevation from 70–120 m. These sand dunes are very excessively drained. Most of the area is barren and only 18 plant species (12% of the total flora of the Nara Desert) are recorded from this range type. These plants can be regarded as sand-loving and have specialized adaptation for survival on sand dunes. The composition of the plant community of this range includes *Calligonum polygonoides*, *Aerva javanica*, *Dipterygium glaucum*, *Limeum indicum, Indigofera argentea, Tribulus longipetalus, Aristida adscensionis, A. funiculata, Panicum turgidum, Lasiurus sindicus, Stipagrostis plumosa, Cyperus arenarius*, and *C. conglomeratus*.

Slope range showing mixed vegetation of trees and shrubs.

Flat habitat showing thick pockets of trees of *Tamarix aphylla* and *Prosopis cineraria*.

Saline sodic land range showing stunted vegetation.

Slopes/Swale/Flank Range

This range type supports plant species similar to those supported by the crest range. A total of 32 species (22% of the total flora of the Nara Desert) were recorded from this range, including a few trees like *Prosopis cineraria, Tamarix aphylla, Salvadora oleoides*, and *Capparis decidua*. The common plants that form the typical vegetation type of this range type are *Calligonum polygonoides, Aerva javanica, Dipterygium glaucum, Limeum indicum, Indigofera argentea, Tribulus longipetalus, Aristida adscensionis, A. funiculata, Panicum turgidum, Lasiurus sindicus, Stipagrostis plumosa, Cyperus arenairus*, and *C. conglomeratus*.

Sandy Plains Range (Tar-Tarai/ Low-lying Flat Area)

The sandy plains range occurs in low-lying flat areas between sand dunes. This range type supports a mixed population of tall and old trees of *Prosopis cineraria, Tamarix aphylla*, and *Capparis decidua* presenting a forested look. The highest diversity of species was recorded from this range with 105 species (72% of the total flora of the Nara Desert). The most common plant species included *Aerva javanica, Aristida adscensionis, A. funiculata, Boerhavia procumbense, Calligonum polygonoides, Capparis decidua, Cassia italica, Cenchrus ciliaris, Cleome brachycarpa, C. scaposa, Corchorus depressus, Cymbopogon jawarancusa, Cynodon dactylon, Cyperus rotundus, Dactyloctenium aegyptium, Heliotropium strigosum, Limeum indicum, Polygala erioptera, Salsola imbricata, Stipagrostis plumosa, Tephrosia uniflora, Tribulus longipetalus,* and *Zaleya pentandra*. Trees are very commonly observed in this range forming a mini-forest. These include *Prosopis cineraria, Tamarix aphylla, Capparis decidua*, and *Salvadora oleoides*.

Saline/Sodic Land (Kharror)

This range is found between interdunal areas of the desert. It was formed by evaporation of saltwater in the lakes leaving behind high residual salt concentrations. These salty lands, locally called *Kharror,* occupy the edges of saline lakes. A total of 24 plant species (17% of the total flora of the Nara Desert) are recorded from this range. The most common plants of this range are *Tamarix indica, Saccharum spontaneum*, *Salsola imbricata*, *Pluchea lanceolata*, *Prosopis cineraria*, *Limeum indicum*, *Aeluropus lagopoides, Desmostachya bipinnata*, and *Alhagi maurorum*.

Lake/Wetland Range

Seepage has created wetlands on both banks of the Nara Canal. The extent of the wetland (locally called *Dhand*) solely depends upon the water availability in the Nara Canal.[3] Nearly 40 lakes are observed in the study area. There were 17 species (12% of the total flora of the Nara Desert) growing in this range type. The edges of lakes are dominated by undestroyed plant communities consisting of common species in this range like *Saccharum bengalense, S. spontaneum*, and *Tamarix passernioides*. *Aeluropus lagopoides, Cynodon dactylon, Desmostachya bipinnata*, and *Phragmites karka* are also common species in this range. These plants typify emergent vegetation, which has its roots in soil covered or saturated with water and its leaves held above water.

Conclusion

Dune lands and slopes are dominated by the tussock grasses *Panicum turgidum* and *Lasiurus sindicus*. These species were

Wetland range having halophytic vegetation.

grazed by flocks of goats, cows, and camels at medium to high rates of utilization in the early wet, late wet, or dry seasons. Effects of grazing on species composition were greatest in the early wet season. Therefore, the range types of the Nara Desert are under immense pressure and need conservation. Moreover, range management programs should be launched to maintain the continuity of plant and human life.

Plants are the only source enriching the rangeland in the shape of pasture. Besides supplying food for livestock, there are other uses of plants, including turf, fuel, human nutrition, and medicine.[1] The genetic diversity of range and forage grasses, legumes, and other forbs needs to be preserved. These plants are capable of triumphing over restrictions to their growth and development, producing high-quality forage, and serving a variety of conservation and other uses. Therefore, managed livestock grazing is very essential for the sustainable use of rangeland and pasture resources.

Authors are Seed Certification Officer for the Federal Seed Certification & Registration Department, Government of Pakistan Rahim Yar Khan, Punjab, Pakistan, deserttaxonomist@yahoo.com (Qureshi); and Professor, Shah Abdul Latif University, Khairpur, Sindh, Pakistan (Bhatti). At the time of research, the senior author was a Research Associate in the Department of Botany, Shah Abdul Latif University, Khairpur, Pakistan. *This work was carried out under the research project entitled "Floristic Study of Arid Zone (Desert-Nara Region), Sindh, Pakistan" S-SALU/ENVR (45) sponsored by Pakistan Science Foundation, Islamabad, which is thankfully acknowledged.*

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Nara Desert, Pakistan: Part IV: Destruction of Natural Habitats and Its Impact on Plant Diversity

By Rahmatullah Qureshi and G. Raza Bhatti

Introduction

The climate of Pakistan is arid subtropical with vast semi-arid to arid tracts of land spread over 68 million ha (72% of its land mass) receiving 250 mm of annual rainfall. Provinces comprising Pakistan include Punjab (119,310 km^2), Sindh (134,897 km^2), and Baluchistan (149,467 km^2). The Nara Desert is located in Sindh Province between latitudes 26°–28° N and longitude 68°–70° E (see p. 27, Fig. 1, in Bhatti, et al.[1]). In spite of its low productivity, this desert supports fairly high human and livestock populations (1.05 million and 1.25 million, respectively).[2] The escalating occurrence of prolonged drought, desertification, deforestation, and soil erosion is causing serious trouble. Any further deterioration in the existing status will bring about adverse changes with calamitous consequences.

Since local pastoralists depend solely on livestock for their livelihood, there is a tendency to only increase the livestock population. However, increases in the livestock population occur at the expense of a fragile ecosystem. The overexploitation of vegetation by grazing, browsing, and chopping of trees and shrubs for fuel purposes has resulted in environmental degradation which threatens the natural resource base of this region.

This area is a hot, sandy desert. The mean minimum and maximum temperatures are 20°C and 45°C, respectively. During the summer, the temperature reaches up to 51°C with very low humidity. Aridity is the most distinctive feature of the Nara Desert, with wet and dry years occurring in clusters.[3] Annual rainfall ranges from 88–135 mm and is mostly received during the monsoon season (mid-July to the

Grazing in desert by goat and sheep.

Chopping of *Prosopis cineraria* for timber purposes.

This article has been peer reviewed.

Coal formation from *Prosopis cineraria* in Nara Desert.

Gas processing plant in Nara Desert, Pakistan.

Campsite of gas exploratory agency in Nara Desert.

end of August). Consequently, there is a scarcity of water in the Nara Desert for most of the season. Groundwater resources are limited and are met at a depth of 50–300 feet from surface. The only source of water for human beings and livestock is from dugout/natural ponds that capture and store rainwater during the monsoon season. The livelihood of people is largely dependent on their livestock (ie, sheep, goats, and camels). Nomadic shepherds, with their herds, migrate from their *Goth* (villages) towards the grazing grounds and establish *Wandh* (temporary huts).[4] *Tarrs* (where wells are situated) occur in permanent settlements, whereas *Wandhs* are established near the *Tarai* (low-lying areas where water can be stored after rainfall). There are also *Tobas/Tankas* (man-made tanks that store rainwater) in *Taries*. The scarcity of water compels dwellers to migrate their animals towards the periphery of the desert where water is available.

Natural Resources and Degradation of Vegetation/Loss of Habitats

Inhospitable intrinsic factors such as inconsistent and erratic rainfall, low humidity, and extreme temperatures leave vegetation susceptible to degradation by human activities. Increasing livestock density and degradation of vegetation/habitats for fuel and other purposes are the major factors causing regular decreases in vegetation cover and ultimately generating endless desertification.

Necessities of Local Inhabitants

Of the 160 species of vascular plants that have been recorded in the Nara Desert, 148 species have been used for various multifarious purposes by local inhabitants of the area.[5] Major uses include folk medicine (86 species), fuel wood (31 species), forage (148 species), food (1 species), vegetables (8 species), wild fruits (8 species), flavoring (1 species), tea (1 species), roof thatching (6 species), agricultural implements (2 species), timber/furniture (4 species), matrices (2 species), ropes (4 species), baskets (3 species), chairs (1 species), brooms (1 species), toothbrushes (4 species), clothes washing (3 species), leather tanning (1 species), detergent (1 species), fencing/hedge (8 species), shade (9 species), ornamental/recreational (7 species), soil binder (20 species), windbreaker (7 species), and poisonous (5 species). However, indiscriminate use of important plants has affected the natural process of regeneration of these species and is ultimately degrading the environment.

Gas Exploratory Activities

As in other parts of the world, the task of finding fuels for human consumption has been taken up by exploration and production (E & P) companies in the Nara Desert. For a decade, these E & P companies have been studying the subsurface geology of the area to predict the absence or presence of oil and gas. If a potential hydrocarbon-bearing structure is identified in the area, then it is further explored by means of drilling exploratory wells. Four multinational oil and gas E & P companies are operating in the Nara Desert, including Mari Gas and Petronas Carigali Pakistan in the Ghotki District area, Miano and Sawan gas fields of Österreichische Mineral Ölverwaltung AG Pakistan in the Sukkur and Khairpur Districts, and Kadanwari field of the London and Scottish Marine Oil Company Pakistan in the Khairpur District.

The energy sector plays a key role in the economy of Pakistan. The cost of importing crude oil and petroleum products reached $3 billion in 2000.[6] To reduce this loss of foreign exchange, the government is committed to maximum replacement of imported furnace and diesel oils with indigenous natural gas. Natural gas accounts for 40.5% of the total energy supply in Pakistan. The country had an estimated balance of recoverable reserves of 25 trillion cubic feet as of June 2000. Gas consumption in the year 1999–2000 was 1,958 million cubic feet per day (mmcfd), 12.41% higher than the previous year. Gas supplies in the same year have been estimated to be 2,169 mmcfd, only 9.8% higher than the previous year. The expected average growth rate of gas demand in this sector is 10.3% per annum. This increasing gas demand is believed to surpass the growth rate of gas supplies. The country's natural gas reserves are expected to reach a critical stage by the year 2007 or 2008, and natural gas imports will become inevitable unless new recoverable reserves are identified in the country.

Depletion of vegetation cover for camping purposes by gas exploratory agency.

However, activities by E & P companies have resulted in destruction of natural habitats through clearing of vegetation. Because of the high probability of finding gas reserves in these areas (Ghotki, Sukkur, and Khairpur Districts) these companies have planned to expand their exploration. For this purpose, they are going to be involved in various activities such as seismic surveying, well drilling, and installation of pipelines for gas supply. Relevant activities include the clearing of 3-m–wide seismic lines for the operation of vibroseis, preparation of campsites, road travel on access tracks, and clearing of land for preparation of new access tracks. Such activities can have two types of impacts on habitat and wildlife within the operation areas. The first may be the destruction of habitats due to clearing of land and vegetation, and the second is sensory disturbance to wild species (animals/birds) due to the physical presence of people, vehicles, and equipment.

Arab Activities for Taloor Hunting

United Arab Emirates Arabs (Shaikhs) come annually during the winter season for game hunting (Taloor) in the deserts of Sindh (Nara and Thar) and Cholistan in Punjab. Recently, the representative office of Shaikhs in Pakistan has developed a network of thoroughfares in various directions in the Nara Desert to facilitate hunting access. As many as 800 km (unofficial statement) of motorized tracks have been developed in the Nara Desert using heavy machinery for hunting leisure. As a result, hundreds of plant species within the desert habitat (herbs, shrubs, and mature trees) that were once present have been uprooted. Since wildlife is very much associated with the vegetation, the destruction of vegetation in this area has resulted in the extinction of some forms of life in the project area. In addition, vegetation provides a green security carpet that plays a very important role in protecting against soil erosion by acting as soil binders. The major concern is that no mitigation measures for plant and animal life were taken into consideration before launching tracks. A single blast in the shape of a bulldozer's blade has decimated hundreds of years of vegetation succession in the Nara Desert habitat.

Motorized tracks formation by Arabs (Shaikhs).

Camping of Arabs (Shaikhs) for hunting purposes in Nara Desert, Sindh.

Conclusion and Recommendations

All above discussed human activities coupled with high wind velocity have destroyed centuries of vegetation succession and exacerbated the aridity and desertification of the Nara

Desert. If these activities continue without taking immediate action to minimize their impact, the Nara Desert will remain at risk of further degradation, placing the livelihood of local inhabitants and the environment in serious jeopardy.

The following recommendations have been made to mitigate degradation of the desert area:

- The conservation of species, especially those growing on the windward side of sand dunes, is essential because they provide protection against wind erosion.
- The lopping/chopping of mature/immature trees like *Prosopis cineraria*, *Tamarix aphylla*, and *Salvadora oleoides* growing in low-lying areas (valleys) should be avoided because they provide excellent shade to flocks of animals in scorching summer.
- Overexploitation of trees, shrubs, and forbs for domestic use has resulted in the degradation of the natural environment, which is not only providing vegetation cover but is also maintaining the natural habitat for wildlife such as mammals, birds, and lizards. The vegetation is also one of the major factors responsible for lowering the temperature in the desert area.

Authors are Seed Certification Officer for the Federal Seed Certification & Registration Department, Government of Pakistan Rahim Yar Khan, Punjab, Pakistan, deserttaxonomist@yahoo.com (Qureshi); and Professor, Shah Abdul Latif University, Khairpur, Sindh, Pakistan (Bhatti). At the time of research, the senior author was a Research Associate in the Department of Botany, Shah Abdul Latif University, Khairpur, Pakistan. *Pakistan Science Foundation Islamabad provided funds to carry out this research under the research project entitled "Floristic Study of Arid Zone (Desert-Nara Region), Sindh, Pakistan" S-SALU/ENVR (45,) which is thankfully acknowledged.*

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6. Economic survey. 2000. Government of Pakistan, Economic Adviser's Wing, Finance Division, Islamabad, xxiv.

RANGELANDS AROUND THE WORLD

Located at the "Top End" of Australia's Northern Territory. Grass termite mounds are a common site on these rangelands. Area is typically grazed by cattle on large stations.
Winter 2005

Located at Wharnui on the Northeastern coastal area of the South Island in New Zealand. Native bush had been cleared and converted to exotic cool season grasses and legumes. Areas intensively managed to produce sheep and beef.
Spring 2004

Located in Telemark province of South Central Norway. Alpine areas traditional grazed by sheep and goats. Further to the North areas grazed by reindeer.
Summer 2004

Photo Essay by Wade Anderson

Skane province in Southern Sweden along the southwest coast. These areas are unsuitable for cultivation and have remained grasslands typically grazed by beef cattle

Nanuya Lai lai Island in theYasawa Island Group, Fiji. Notice burn marks on the palm trees. Areas burned to keep areas clear and to graze or cultivate for food in local villages.

"Parque Nacional los Cardones" near the village of Cachi within the Salta Province, Argentina. The "candelabra" cactus known as "cardones" grows up to 4 meters tall. Area is high desert of over 3000 meters in elevation with harsh temperature extremes.

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Essays of a Peripheral Mind

Art and Science

By K. M. Havstad

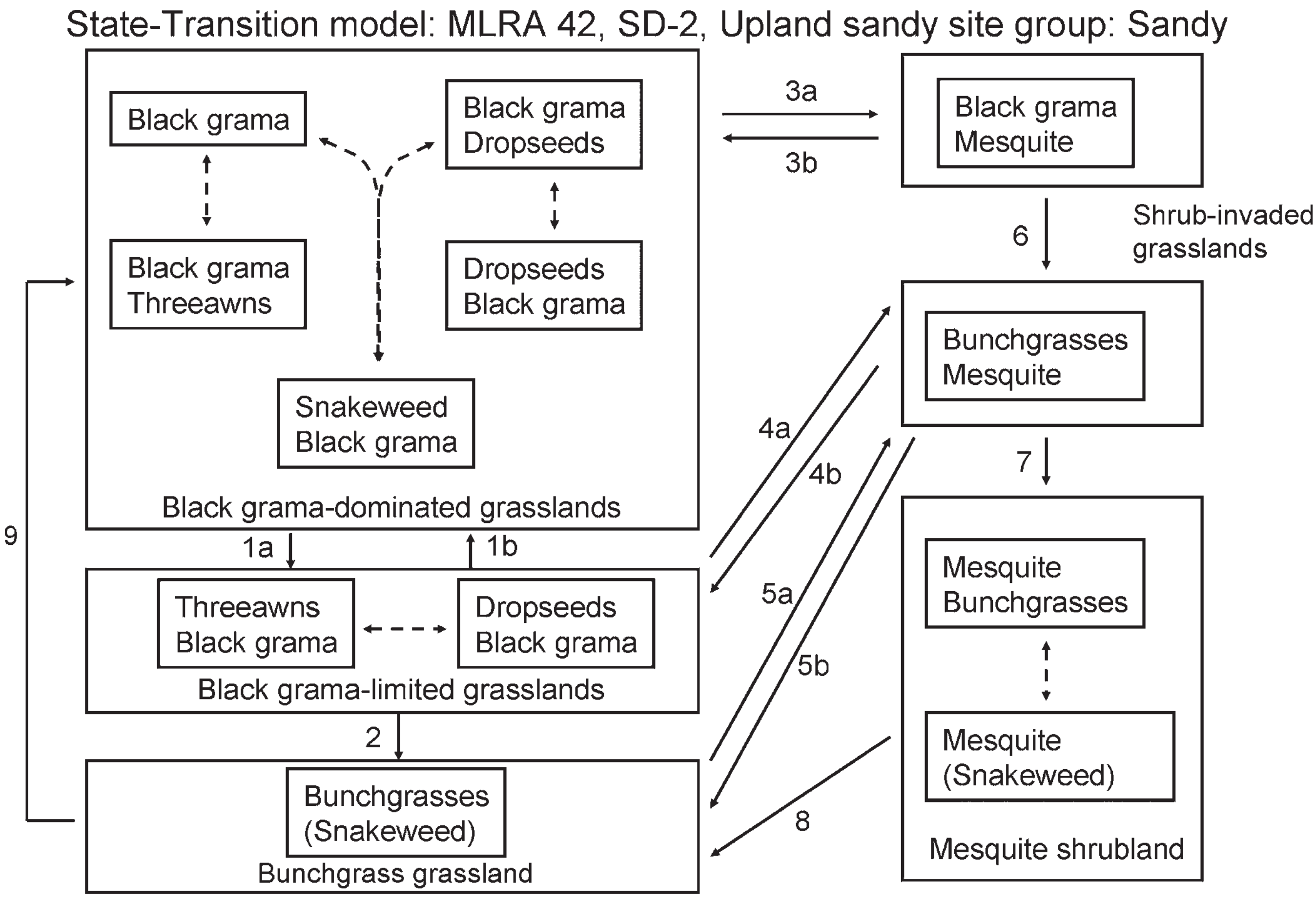
This is an essay about 2 illustrations. They are remarkably similar, though they have remarkable differences. Both are artistic, yet both are based in science. Both convey powerful ideas, and both justify thoughtful study. For each, a passing glance would not do justice. Both have tremendous utility in explaining human interactions with our environments. Both are intensely creative and may raise more questions in their interpretations than they answer. Both are reflections of our world. Both are useful in our pursuits.

Despite these similarities, the differences are equally striking. The first of these illustrations, in its original form, is nearly priceless (estimates of its value at auction approach $100 million if it was even available) and would require a trip to the Art Institute of Chicago to view it as painted. It is the product of one mind. Its linkage to rangelands would seem remote, but its core concepts are easily communicated. The second illustration is freely available in its present form on the Internet. It is a work in progress and the product of many minds. Its linkages to rangelands are obvious, but its nuances are not easily grasped.

The first illustration is *Nighthawks*, a painting by Edward Hopper, one of the great American painters of the 20th century (Figure 1). Painted in 1942, *Nighthawks* is maybe Hopper's most celebrated piece and familiar to most college graduates with an elective in Art Appreciation 101. Although my favorite Hopper painting is one of his last works, *People in the Sun* (1960), which distinctly captures my profession and the people I work with, *Nighthawks* is also an insightful, many-layered work of art. At first glance it portrays a view

Figure 1. Edward Hopper, American, 1882–1967, Nighthawks, 1942, Oil on canvas, 84.1 × 152.4 cm, Friends of American Art Collection, 1942.51 The Art Institute of Chicago. Photography © The Art Institute of Chicago.

of urban life as America emerged from the Depression and into the throes of World War II. The diner scene is instantly recognizable. Yet a deeper biological expression of human nature is readily evident. The seated adults are obviously presented as birds of prey perched above a single object of prey in white. The males are drab and similar in appearance, while the lone female is brightly colored. The single male perched to the left seems to be more interested in the female of his species than in the prey. All these humans are drawn to light from their dark cave like dwellings apparent in the fringes of the piece. Hopper communicates other ideas about human nature, such as our extraction from our more wild origins into artificial dwellings and our inherent gregariousness but also



1a. Climate change and/or overgrazing, moderate soil degradation. 1b. Restoration of soil fertility (if climate not involved).
2. Extinction of black grama, severe soil degradation. 3a. Introduction of mesquite sees, reduced grass competition, lack of fire.
3b. Shrub removal, restoration of fuel loads and fire. 4a, 5a. Mesquite invasion. 4b, 5b. Shrub removal, restoration of fuel loads and fire.
6a. Black grama extinction due to mesquite competition and grazing. 6b. Shrub control with black grama restoration.
7. Continued grass loss (e.g., overgrazing), inter-shrub erosion, soil fertility loss, high soil temperatures, small mammal herbivory.
8. Dune destruction, mesquite removal, soil stabilization, nutrient addition, seeding during wet periods.
9. Reseeding, replanting with restoration of soil fertility.

Figure 2. State and transition model taken from the Natural Resource Conservation Service's Ecological Site Description for a Sandy Upland site in Major Land Resource Area (MLRA) 42, Southern Desert (SD) region 2 viewable at http://esis.sc.egov.usda.gov/esis_report/fsReport.aspx?id=R042XB012NM&rptLevel=all.

our continued independent, almost lonely nature. All these artistically expressed ideas are rooted in principles of human biology or Hopper's interpretations of human biology and enrich my perceptions of our interactions with our environment. One of the attributes of Hopper's art is its ability to accommodate personal (okay, amateur) interpretations.

It was over 30 years ago that I first heard the profession of range management defined as both art and science. This statement was presented in an introductory range class at a university and was something I gave little thought to at the time. It seemed to be an expression that captured the idea that the science wasn't perfect and that rangelands were so heterogeneous that it took creativity to apply any management principle or practice. Or it was a statement that justified a general approach of trial and error. It was a license to guess. Although many currently accessible glossaries with definitions of rangeland management no longer include the "art and science" reference, the description is still prevalent in commonly referenced textbooks. In addition, current definitions may lack this "art and science" term yet still refer to a human element and that management implies choices and interpretations. Art is, by definition, a human contrivance. As I've thought more recently about the current technologies emerging from our profession—and, specifically, ecological site descriptions, their utilities, their limitations, and their creation—I admit that everything we do is an interpretation of our views on nature. Our applications of principles require an artistic view of the scientific basis beneath those principles. I see it as the visual power of a *Nighthawks* needing to be merged with the inferences drawn from our recorded observations.

This brings us to the second illustration. This is a description of vegetation dynamics, a state and transition (S&T) model, characteristic of sandy soils in the 8–12-inch precipitation zone of the desert region of southern New Mexico (Fig. 2). Illustrations such as this one are embedded in ecological site descriptions now being revised by rangeland professionals working with users, including ranchers, as well as the science community and other interested parties. They represent a core technology within the profession. They reflect much of the science that has occurred on rangelands throughout the world over the past century. Illustrations such as Figure 2 convey many of our basic principles of both ecology and management. Yet, like *Nighthawks*, this illustration is definitely art.

It is a contrivance. It is an interpretation or, in fact, a compilation of many interpretations. As an image, it serves to communicate ideas about rangelands, how they vary through time, how they respond to management, their resilience, and their resistance. It is modern art as a record of our observations.

Is Figure 2 too complex for use in rangeland management? I think not. It can be reduced to a fairly simple layer that illustrates different possible plant communities. Further complexity can be added by the viewer depending on interest or purpose. And it can create further questions for study or be refined at a later date with new information. In this fashion, the S&T model is like a more classic work of art such as *Nighthawks*. It can be viewed simply as a wonderful presentation of something from our past, or it can be studied for more nuanced and intricate patterns of nature viewed today or of what is possible in the future. Two key points about Figure 2 are that 1) it does represent both the art and science of our profession and that 2) it is a better illustration than we have had before. Some may prefer the earlier illustrations of rangelands that we have used in the past. I find them less interesting, less insightful, and less open to new information. They are less art and less science than what is available to us today. Our professional advancements are really about updating our slivered substitutions of science for art. There has always been an appreciation for both.

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Thad Box

Sin Fronteras

Trinidad Vasquez was born to Mexican ranch hands on a cold, remote Wyoming ranch during the winter of 1926. When he was 6 months old, his father was killed by a horse. His mother took him to her native Chihuahua. There he grew up, finished high school, met his bride on the plaza. His 10 children were baptized in the village church. He was a cultural Mexican, an American birth citizen who knew no English. He lived on the south side of poverty.

Trinidad found a job in New Mexico. One by one he brought his family north. They didn't swim the Rio Grande. They followed a ranch road west of Juarez and entered the United States through a livestock fence. He was the only American citizen.

I hired Trinidad to help me rehabilitate an old adobe house. We became friends—just two old codgers rebuilding a house that was twice our age. We shared common values, but spoke different languages. He spoke Spanish, I English. We understood one another without speaking a word.

He could do anything. He took pride in his work. He did more than was expected. One Friday we drank cerveza and rested. I said I could rent a backhoe for $50 to fill the 100-foot-long ditch that we couldn't reach with the farm tractor.

He said he would fill that ditch for 50 bucks. Next Saturday at daybreak he was hard at it with pick, shovel, and wheelbarrow. Just before sundown he finished. I gave him 3 $20 bills. I refused the change. Sunday he was back grubbing out a stump that wasn't part of our deal. You couldn't get ahead of Trinidad.

He was in considerable demand as a farrier. Many weekends he took his tools and went to some ranch to shoe horses. He was welcome on both sides of the border. He had a broken nose and a big scar on his forehead from early encounters with ranch horses.

One morning Trinidad's daughter-in-law came to tell me he had been killed in an automobile accident. I drove to the crash site. His car had been towed away. His old felt hat lay in a pool of blood surrounded by road trash in the ditch.

Trinidad's father died violently while working for a Wyoming rancher. Trinidad died violently where his sweat and blood were part of the land. He left a wife, 8 children, and about 30 grandchildren. His grandchildren are American citizens born here. Several children are in various stages of becoming US citizens. The rest are Mexicans.

This issue of *Rangelands* is devoted to the international aspects of our profession. The ecological and economic potential of rangelands cannot be contained within national boundaries. Nor can the contribution of range people be measured by their chance arrival in a particular economic or social setting. We all belong to the land.

In my last column I wrote about being influenced by hungry children in Somalia. When I returned to Texas, my Dad, a product of the Texas Hill Country, asked what Somalis were like. I told him they spoke a different language, had black skin, and worshiped God differently than he did, but he had more in common with them than with white businessmen in New York.

My last PhD graduate was Somali. Ali Ahmed Elmi could have had a good job in the United States. He opted to return to his war-torn country. He and his family helped establish, and now live in, the new country of Somaliland, an independent breakaway nation north of Somalia. Though not recognized by many nations, this new democracy is a shining example of independent pastoralists.

Our role, as land care professionals, is to assure sustainability of rangelands. This means keeping options open for future generations whether they live on Texas grasslands, sagebrush foothills in Nevada, mulga shrublands of Australia, thorn tree savannahs of Africa, or cold deserts in Iceland. The climate, vegetation, and people are different in each of these, but the universal need is to pass viable communities on to the next generation.

We develop science to assure sustainability with many varied demands on the land. This means our science must be based on principles—understanding why rather than how. Certainly we need to know how to grow better calves, how to keep recreational vehicles from causing erosion, or how to get rainfall into soil to grow more grass. But to achieve sustainable rangelands these how-to tasks have to be done as subheadings in the larger framework of getting what people want without violating the ecological limits of carrying capacity.

What people want from rangelands varies between rich and poor countries. Gary Frasier wrote in the October issue of *Rangelands* that he didn't agree with the widespread belief that recreation is the main use of rangelands in America. Rangelands are multiple use lands. Our culture determines the priority of uses. In rich countries such as the United States, Canada, and Australia, our food comes via a global market. Recreation, open space, watershed, ecological services, waste disposal, and aesthetic values are rapidly becoming more important than the traditional use of providing forage for livestock or wildlife.

In poor countries, products from the land are more important than ecological or recreational services. Many people in Africa and Asia still depend directly on the land for food. Cattle, sheep, goats, and camels keep people alive. Rangeland products such as charcoal, fiber, and gum are important trade goods. Gum arabic from *Acacia senegal* trees is a common thickener of foods in rich countries. It is one of the most important export products from many African ranges. A US claim that much of its trade is financed by Osama bin Laden has not stopped export of gum arabic. American companies just call it "gum acacia" on our food labels.

Development of a multicultural cadre of range managers who can apply science in very different cultures and environments is perhaps our profession's greatest contribution. American range schools have produced thousands of graduates from every corner of the globe.

I have worked in or visited over 30 countries, some on every continent. Everywhere there are range management graduates from our schools. Although many SRM members working in a number of universities produced those graduates, 2 stalwarts stand out in my mind for their work with international students: Rex Peiper and Phil Ogden.

I've been told Rex produced over 125 international graduate students at New Mexico State University. I don't know how many students Phil turned out at the University of Arizona. But the joke was that you could always locate him, night or day, by the crowd of foreign students surrounding him. Others may have equally valid heroes for spreading rangeland messages internationally, but I have yet to visit a country where I didn't meet a disciple of Phil or Rex.

Our TV screens are filled with genocide and the suffering of the people of Darfur. One of my first graduate students, El Rasheed Abdul Magid, did his master's thesis on the rangelands of that battered province.

On my living room wall is an ostrich feather fan and a giraffe tail wand, symbols of power for a queen and a chief. These were given to Jenny and me by Rasheed after he became head administrator of rangelands in Sudan.

Rasheed died from tropical diseases about 2 decades ago. The rangelands he studied as a student and administered as a government official are now killing fields burned, overgrazed, overcut. Human capital has been wasted. The land, abused though it is, remains.

I don't know when the killing will stop, or when those of us in rich countries will direct our attention and our wealth to Darfur. I don't know who remains in Sudan from the hundreds of students Rasheed sent overseas to study, or what schools they graduated from. But through them—through us—Rasheed lives and his besieged Darfur will rise again some day.

Our individual contribution can be as earthy as shoeing a horse on a border ranch. Or as basic as developing ecological principles at a land grant university. Or as practical as making a range management plan. Or as complex as finding the place of gum arabic in the global economy. Taken together, our actions collectively make us a people without borders—sin fronteras.

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Jeff Mosley

Browsing the Literature

This section reviews new publications available about the art and science of rangeland management. Personal copies of these publications can be obtained by contacting the respective publishers or senior authors (addresses shown in parentheses). Suggestions are welcomed and encouraged for items to include in future issues of *Browsing the Literature*. Contact Jeff Mosley, jmosley@montana.edu.

Animal Ecology

Are livestock weight gains affected by black-tailed prairie dogs? J. D. Derner, J. K. Detling, and M. F. Antolin. 2006. *Frontiers in Ecology and the Environment* 4:459–464. (USDA-ARS, High Plains Grasslands Research Station, 8404 Hildreth Rd., Cheyenne, WY 82009). When 20% of the pasture was occupied by prairie dogs, steer weight gains were reduced 5.5%, whereas when 60% of the pasture was occupied, steer weight gains were reduced 13.9%.

Behavioral responses of bison and elk in Yellowstone to snowmobiles and snow coaches. J. J. Borkowski, P. J. White, R. A. Garrott, T. Davis, A. R. Hardy, and D. J. Reinhart. 2006. *Ecological Applications* 16:1911–1925. (Dept. of Mathematical Sci., Montana State Univ., Bozeman, MT 59717). Found no evidence that winter recreation via snowmobiles or snow coaches during the past 35 years has affected elk or bison populations in Yellowstone National Park.

Grazing Management

Browsing of western snowberry by goats and sheep. A. J. Smart, J. Daniel, K. Bruns, and J. Held. 2006. *Sheep and Goat Research Journal* 21:1–5. (Dept. of Animal and Range Sci., South Dakota State Univ., Brookings, SD 57007). Concluded that goat browsing in late June is a viable alternative to herbicides for controlling western snowberry in tallgrass prairie.

Prairiegrass-brassica hybrid swards for autumn dry matter production. D. P. Belesky, J. P. S. Neel, and J. M. Ruckle. 2006. *Agronomy Journal* 98:1227–1235. (USDA-ARS, Appalachian Farming Systems Research Center, 1224 Airport Rd., Beaver, WV 25813). Improved prairiegrass (*Bromus catharticus*) and a brassica hybrid seeded together can provide suitable fall pasture in the eastern United States.

Pyrrolizidine alkaloids in *Senecio madagascariensis* from Australia and Hawaii and assessment of possible livestock poisoning. D. R. Gardner, M. S. Thorne, R. J. Molyneux, J. A. Pfister, and A. A. Seawright. 2006. *Biochemical Systematics and Ecology* 34:736–744. (USDA-ARS, Poisonous Plant Research Lab, 1150 East 1400 North, Logan, UT 84341). The alkaloid content of this *Senecio* species makes it a significant risk to livestock when grazing heavy infestations on the Hawaiian Islands.

Seasonal changes in dry matter partitioning, yield, and crude protein of intermediate wheatgrass and smooth bromegrass. A. J. Smart, W. H. Schacht, J. D. Volesky, and L. E.

Moser. 2006. *Agronomy Journal* 98:986–991. (Dept. of Animal and Range Sci., South Dakota State Univ., Brookings, SD 57007). In Nebraska, plant growth and nutritive value of intermediate wheatgrass and smooth brome followed a similar pattern, but intermediate wheatgrass tended to be 1 to 2 weeks behind smooth brome.

Hydrology/Riparian

Riparian ecohydrology: Regulation of water flux from the ground to the atmosphere in the Middle Rio Grande, New Mexico. J. R. Cleverly, C. N. Dahm, J. R. Thibault, D. E. McDonnell, and J. E. A. Coonrod. 2006. *Hydrological Processes* 20:3207–3225. (Dept. of Biology, Univ. of New Mexico, Albuquerque, NM 87131). Both salt cedar and native cottonwood trees transpire large quantities of water when conditions are favorable. In the Middle Rio Grande, salt cedar prefers sites where summer flooding and cold air drainage occurs, whereas cottonwood prefers areas with groundwater within 6.5 feet of the surface.

River channel dynamics following extirpation of wolves in northwestern Yellowstone National Park, USA. R. L. Beschta and W. J. Ripple. 2006. *Earth Surface Processes and Landforms* 31:1525–1539. (College of Forestry, Oregon State Univ., Corvallis, OR 97331). Excessive elk grazing and browsing of streamside vegetation in winter–spring decreased willow cover and caused stream channels to become wider and more incised.

Shrubs, streamflow, and the paradox of scale. B. P. Wilcox, M. K. Owens, W. A. Dugas, D. N. Ueckert, and C. R. Hart. 2006. *Hydrological Processes* 20:3245–3259. (Dept. of Rangeland Ecology and Management, Texas A&M Univ., College Station, TX 77845). Authors conclude that significant increases in water yield are much more likely to result from reducing salt cedar in riparian areas than from reducing Ashe juniper or mesquite trees on upland sites.

Springs on rangelands: Runoff dynamics and influence of woody plant cover. Y. Huang, B. P. Wilcox, L. Stern, and H. Perotto-Baldivieso. 2006. *Hydrological Processes* 20:3277–3288. (Dept. of Rangeland Ecology and Management, Texas A&M Univ., College Station, TX 77843). In central Texas, removal of Ashe juniper increased streamflow from a spring.

Management Planning

Collaborative governance for sustainable water resources management: The experience of the Inter-municipal Initiative for the Integrated Management of the Ayuquilla River Basin, Mexico. S. G. Montero, E. S. Castellon, L. M. M. Rivera, S. G. Ruvalcaba, and J. J. Llamas. 2006. *Environment and Urbanization* 18:297–313. (Manantlan Biodiversidad Occidente AC, Tenacatita 134, Autlan de Navarro 48900, Jalisco, Mexico). Describes a successful collaboration among 10 municipalities to reduce river pollution and promote more sustainable management of natural resources within and across their administrative boundaries.

Plant Ecology

A lack of evidence for an ecological role of the putative allelochemical (+/−)-catechin in spotted knapweed invasion success. A. C. Blair, S. J. Nissen, G. R. Brunk, and R. A. Hufbauer. 2006. *Journal of Chemical Ecology* 32:2327–2331. (Dept. of Bioagricultural Sci. and Pest Management, Colorado State Univ., Fort Collins, CO 80523). Results shed increasing doubt on whether the (+/−) catechin in spotted knapweed is allelopathic under field conditions.

Plant-soil feedbacks contribute to the persistence of *Bromus inermis* in tallgrass prairie. M. A. Vinton and E. M. Goergen. 2006. *Ecosystems* 9:967–976. (Dept. of Biology, Creighton Univ., Omaha, NE 68178). Decreased amounts of plant litter and lower levels of soil nitrogen may help native tallgrass prairie grasses to compete better with smooth brome.

Population and clonal level responses of a perennial grass following fire in the northern Chihuahuan Desert. P. B. Drewa, D. P. C. Peters, and K. M. Havstad. 2006. *Oecologia* 150:29–39. (Dept. of Biology, Case Western Reserve Univ., Cleveland, OH 44106). Even after 2 growing seasons of recovery, black grama canopy cover was reduced 42% by a June headfire. Small plants were harmed more than larger plants. Black grama response to fire was unaffected by cattle grazing.

The influence of aridity and fire on Holocene Prairie communities in the eastern Prairie Peninsula. D. M. Nelson, F. S. Hu, E. C. Grimm, B. B. Curry, and J. E. Slate. 2006. *Ecology* 87:2523–2536. (Ecology and Evolutionary Biology, Univ. of Illinois, 505 South Goodwin Ave., Urbana, IL 61801). The prehistorical species composition of tallgrass prairie varied with climatic fluctuations. Fire-sensitive tree species declined and herbaceous prairie plants increased during drier climatic periods.

Twentieth century forest-grassland ecotone shift in Montana under differing livestock grazing pressure. T. T. Sankey, C. Montagne, L. Graumlich, R. Lawrence, and J. Nielsen. 2006. *Forest Ecology and Management* 234:282–292. (Campus Box 8130, Idaho State Univ., Pocatello, ID 83209). Levels of cattle grazing intensity during the past 60 years did not influence encroachment of aspen or Douglas-fir into southwestern Montana grasslands.

Xeric limestone prairies of eastern United States: Review and synthesis. P. J. Lawless, J. M. Baskin, and C. C. Baskin. 2006. *Botanical Review* 72:235–272. (Dept. of Biology, Univ. of Kentucky, Lexington, KY 40506). Discusses the flora, soils, and plant successional dynamics of eastern US prairies that occur on shallow, rocky limestone soils.

Rehabilitation/Restoration

Assessing grassland restoration success: Relative roles of seed additions and native ungulate activities. L. M. Martin and B. J. Wilsey. 2006. *Journal of Applied Ecology* 43:1098–1109. (Dept. of Biology, Univ. of Nebraska, 6001 Dodge St., Omaha, NE 68182). Seedling emergence of rare forbs and grasses increased in tallgrass prairie when broadcast seeding was followed by bison and elk grazing.

Should heterogeneity be the basis for conservation? Grassland bird response to fire and grazing. S. D. Fuhlendorf, W. C. Harrell, D. M. Engle, R. G. Hamilton, C. A. Davis, and D. M. Leslie, Jr. 2006. *Ecological Applications* 16:1706–1716. (Dept. of Plant and Soil Sci., Oklahoma State Univ., Stillwater, OK 74078). Prescribed burning and grazing were combined to create heterogeneous habitat that increased the diversity of tallgrass prairie birds.

TIPS for fighting weeds on small acreages in Montana. D. Martin, project coordinator. 2006. (Conservation Districts Bureau, Montana Dept. of Natural Resources and Conservation, PO Box 201601, Helena, MT 59620-1601). This 56-page color glossy bulletin was written for small-acreage landowners who may be unfamiliar with weed management principles and techniques.

Socioeconomics

Ideology and scientific credibility: Environmental policy in the American Pacific Northwest. B. S. Steel, D. Lach, and V. A. Satyal. 2006. *Public Understanding of Science* 15:481–495. (Dept. of Political Sci., Oregon State Univ., Corvallis, OR 97331). When participating in environmental policy discussions, conservatives are less likely to view science and scientists as objective than are liberals.

The values and vulnerabilities of metaphors within the environmental sciences. M. S. Carolan. 2006. *Society and Natural Resources* 19:921–930. (Dept. of Sociology, Colorado State Univ., Fort Collins, CO 80523). A random sample of articles from 3 refereed environmental science journals (*Society and Natural Resources*, *Conservation Biology*, and *Ecology*) revealed that all 3 journals used metaphors equally to make value statements about how nature should be. This article suggests alternative language for authors to use when discussing scientific findings related to environmental issues.

Soils

Storage and dynamics of carbon and nitrogen in soil physical fractions following woody plant invasion of grassland. J. D. Liao, T. W. Boutton, and J. D. Jastrow. 2006. *Soil Biology and Biochemistry* 38:3184–3196. (T. Boutton, Dept. of Rangeland Ecology and Management, Texas A&M Univ., College Station, TX 77843). In the Rio Grande Plains of Texas, soil carbon and nitrogen were 100%–500% less in remnant grasslands than where trees and shrubs have invaded during the past 130 years.

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HIGHLIGHTS

Rangeland Ecology & Management, January 2007

Integrated Ecological and Economic Analysis of Ranch Management Systems: An Example from South Central Florida

Hilary M. Swain, Patrick J. Bohlen, Kenneth L. Campbell, Laurent O. Lollis, and Alan D. Steinman

Developing sustainable cattle ranches requires integrated research that examines relationships among ecological and economic factors. We established an interdisciplinary experiment to examine the effects of cattle stocking density and pasture type on water quality, ecological factors, production and economics in ranchlands of south Florida. Lowering cattle stocking density had no effect on water quality, but decreased production and economic returns significantly. Management practices targeted at specific environmental factors on ranches need to consider economic impacts and the broader ecosystem implications of such practices.

Integrating Ranch Forage Production, Cattle Performance, and Economics in Ranch Management Systems for Southern Florida

J. D. Arthington, F. M. Roka, J. J. Mullahey, S. W. Coleman, R. M. Muchovej, L. O. Lollis, and D. Hitchcock

Developing sustainable cattle ranches requires integrated research that examines relationships among ecological and economic factors. The removal of cattle from grazing landscapes or decreasing stocking density is being investigated as one option to improve the quality of surface water. The objective of this study was to determine the effects of stocking rate on cow-calf performance, forage availability and quality, and ranch economic performance. Forage yield, utilization, and quality were not significantly affected by stocking rate. Production (kg weaned calves · ha^{-1}) was increased for high compared with medium and low stocking rates. Ranch revenues decreased one-for-one as stocking rates decreased.

Soil Phosphorus, Cattle Stocking Rates, and Water Quality in Subtropical Pastures in Florida, USA

John C. Capece, Kenneth L. Campbell, Patrick J. Bohlen, Donald A. Graetz, and Kenneth M. Portier

A large-scale research project, consisting of 8 improved summer and 8 semi-improved winter pastures, was established to investigate the influence of stocking rate on nutrient loads in surface runoff. Cattle stocking density did not influence nutrient loads, suggesting no benefit from reduced stocking density. Phosphorus loads were much greater from improved pastures than from semi-native pastures, indicating that the legacy of past fertilizer use could limit the ability of current best management practices to reduce phosphorus runoff. Reducing the overall volume of surface discharges would be a more effective strategy to reduce nonpoint runoff of P from cattle pastures in this region.

Effects of Cattle Stocking Rates on Nematode Communities in South Florida

Robert McSorley and George W. Tanner

Microscopic soil organisms such as nematodes are critical in maintaining healthy soils, but management practices can unintentionally disrupt these organisms. Nematode populations were monitored for several years in soils of subtropical Florida pastures that were subjected to different levels of cattle grazing. Cattle densities of up to twice those typically used in south Florida did not affect the kinds and numbers of nematodes present. Therefore managers could alter cattle densities without unintended impacts on nematodes involved in soil health and nutrient cycling.

Potential Outcomes and Consequence of a Proposed Grazing Permit Buyout Program

Mark S. Steinbach and Jack Ward Thomas

Public land grazing policies in the United States are under scrutiny for a variety of reasons, including impacts on ecosystem health and the relatively low cost of grazing permits. In response, legislation was introduced to purchase grazing permits from BLM and USFS permit holders. We assessed this potential policy change using a mixed-model research design, incorporating quantitative survey data and qualitative interview data to evaluate the impacts in the Rocky Mountain region. We described likely participation rates among permittees and uncovered potential impacts of the program.

This research was crucial for policy makers to make a better informed decision on a possible course of action regarding this legislation.

Utilizing Remote Sensing and GIS to Detect Prairie Dog Colonies

Timothy J. Assal and Jeffrey A. Lockwood

A large-scale monitoring effort of black-tailed prairie dog habitat is needed to assist scientists in determining the current extent and condition of the species. We mapped the locations of colonies in northeastern Wyoming, US, using three remote sensing methods: "raw" satellite imagery, "enhanced" satellite imagery (integrated with GIS data), and aerial reconnaissance (observations from a small plane). The enhanced satellite imagery provided the highest level of overall accuracy. Although it might not be adequate for all management considerations, these data can provide a coarse filter to identify large areas of contiguous habitat as well as habitat for other species.

Evaluation of Low-Moisture Blocks and Conventional Dry Mixes for Supplementing Minerals and Modifying Cattle Grazing Patterns

Derek W. Bailey and G. Robert Welling

During autumn and winter, rangeland cattle often require supplemental minerals, which can be self-fed in conventional dry mixes or in low-moisture blocks. Cattle visits to conventional dry mix feeders and low-moisture block supplements were evaluated using global positioning system tracking collars in moderate and high terrain and when cattle grazed rangeland or when they were fed hay. Cattle used low-moisture blocks more consistently than conventional dry mixes, especially when placed in high terrain away from water. Low-moisture blocks should be considered as a method to provide supplemental minerals to cattle if grazing distribution is a concern.

Diet Composition of Cattle Grazing Sandhills Range During Spring

Jerry D. Volesky, Walter H. Schacht, Patrick E. Reece, and Timothy J. Vaughn

Knowledge of the botanical composition and nutritive value of forage selected by cattle is critical for management decisions associated with supplementation programs, calving or weaning dates, and allocation of forage to different herbivores including wildlife. We conducted a study to determine diet composition of cattle when grazing upland Sandhills range during spring. Cows exhibited preference for current-year growth of cool-season graminoid species and were able to select diets that would meet nutrient requirements. However, grazing strategies would need to account for the limited availability of current-year growth, particularly April, to ensure cattle are meeting their nutrient needs.

Livestock Forage Conditioning Among Six Northern Great Basin Grasses

Dave Ganskopp, Lisa Aguilera, and Marty Vavra

Studies of Anderson and Scherzinger's forage conditioning hypothesis have generated mixed results. We researched late summer/early fall forage quality of 6 grasses grazed at vegetative, boot, and anthesis phenologies as well as ungrazed controls. Results suggested: 1) late season forage quality can be elevated by grazing but standing crop is reduced from 34 to 100%; 2) species responses varied with bluebunch wheatgrass and crested wheatgrass is harder to condition than other grasses; and 3) regrowth varied between years with more regrowth in drier than in wetter growing seasons. Findings will help managers elevate late season forage quality for livestock or wildlife.

Soil Water Content Dynamics Along a Range Condition Gradient in a Shortgrass Steppe

Eduardo Medina-Roldán, J. Tulio Arredondo Moreno, Edmundo García Moya, and F. Martín Huerta Martínez

Heavy grazing can induce subtle changes in species grassland composition that eventually affect ecosystem functioning. We examined soil water dynamics along a gradient of bluegrama (*Bouteloua gracilis*) cover. Sites with the largest bluegrama cover exhibited both fastest soil water recharge and soil water utilization. This response was explained by plant-specific traits at each community such as root biomass and plant cover rather than associated soil characteristics at each site. Our results suggest that functional thresholds in healthy semiarid grasslands move within narrow ranges of bluegrama cover. Generalization of our results would allow monitoring implementation of functional thresholds in grasslands.

Influence of 90 Years of Protection From Grazing on Plant and Soil Processes in the Subalpine of the Wasatch Plateau, USA

Richard A. Gill

Human communities in the Intermountain West depend heavily on subalpine rangelands to provide water for irrigation, forage for wildlife and livestock, and potentially sequester anthropogenic carbon. I evaluated the influence of 90 years of protection from grazing on the input, output, and storage of C in subalpine rangelands. Livestock grazing had no statistically significant impacts on total soil C or particulate organic matter, although grazing did increase active soil C and decrease soil moisture. Under predicted climate scenarios, the accumulation of easily decomposable organic material could lead to these soils becoming net sources of CO_2.

Seed Shatter Dates of Antelope Bitterbrush in Oregon

G. R. Johnson and Paul C. Berrang

Proper timing of seed collection is crucial when collecting seeds of antelope bitterbrush because the harvest period for a stand is typically less than a week. Seed shatter dates were examined for 192 sites in Oregon and surrounding states to determine how latitude, longitude and elevation affected seed shatter dates. The model developed will help determine proper timing for multiple-site collections. In general, moving north 1° latitude delayed shatter date by 6.7 days and moving up 100 m in elevation delayed shatter date 3.5 days.

Monoterpene Production in Redberry Juniper Foliage Following Fire

E. S. Campbell and C. A. Taylor, Jr.

Prescribed fire is commonly used to initiate redberry juniper (*Juniperus pinchotti* Sudw.) suppression, and herbivory by goats presents a potentially effective way to prolong the treatment. This study measured the monoterpene concentration and composition from redberry juniper foliage sampled from 3 different ages of plant tissue after fires. There was a trend in changes in composition of total oil as relative concentrations of monoterpene hydrocarbons decreased and monoterpene alcohols and oxygenated monoterpenes increased. This suggests a period of vulnerability in plant biochemical defenses which has the potential to be utilized by strategic herbivory by goats for more effective juniper management.

Brangus Cow–Calf Performance Under Two Stocking Levels on Chihuahuan Desert Rangeland

Milt Thomas, Jerry Hawkes, Godfrey Khumalo, and Jerry L. Holechek

Maintaining a core herd of well-adapted cows during short term droughts is a critical part of successful cattle ranching in arid areas. We compared cow–calf productivity on 2 lightly and 2 conservatively grazed pastures over a 5-year period in the Chihuahuan Desert of south-central New Mexico. Lightly grazed pastures yielded more calf weight per unit area than conservatively grazed pastures during a drought year due to destocking of conservatively grazed pastures to avoid excessive grazing use of primary forage plants. Our results suggest light grazing is a practical approach for Chihuahuan Desert cow–calf operators to avoid herd liquidation during short term drought periods.

BOOK REVIEW

Wrangling Women: Humor and Gender in the American West. By Kristin M. McAndrews. University of Nevada Press, Reno and Las Vegas. 200 p. $34.95 ISBN 0-87417-693-2.

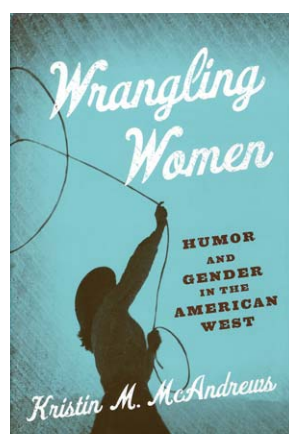
Wrangling Women describes the ways in which some women who work with horses in the Methow Valley of eastern Washington use humor in their storytelling, and what this humor reveals about issues of gender in the American West. Winthrop, Washington, a small mountain community, is a western theme town. A group of women who work as ranchers, trail guides, horse trainers, and packers find themselves in a contradictory environment where they have to preserve gender stereotypes in the tourism-based economy and still assume authority and expertise the same as their male counterparts.

McAndrews writes from her study of how these "wrangling women" accomplish this balancing act of women's subversion and manipulation of humor, language, and gender stereotypes. The author states that she "began to suspect that the reason there was so little scholarship on women's humor was that male researchers didn't understand it, or perhaps they didn't recognize it." (p. 4). McAndrews conducted interviews with Winthrop's female wranglers, collecting stories about their lives as workers and as members of the community. Professional success depends on courage, ingenuity, and a sense of humor. They also have to work within the town's Wild West image. McAndrews examines how these women use humor in their storytelling and in their work.

Several of the women interviewed by McAndrews were quite interesting. At one time Babe Montgomery ran a packhorse business in Winthrop and was caretaker at Sun Mountain Lodge. She also managed a hotel in Tacoma, Washington. She had a talent with horses, teaching her father's plow horse to do tricks when she was young. She was a jockey and a trainer of racehorses. During the summer and fall Marva Mountjoy cooks for a variety of packers. Packing into the wilderness is one of her favorite things to do. Lynn Breaky-Clark teaches half-time at a school in Twisp, Washington. In the summer she packs into the wilderness with a variety of outfitters. During the winter she cooks for sleigh rides at Sun Mountain Lodge.

The women interviewed by McAndrews demonstrate that while traditional gender stereotyping occurs, they have found nonthreatening ways to achieve professional and personal objectives in their work. *Wrangling Women* is a commentary on the way women use humor in their storytelling and in their working relationships in the American West. *Wrangling Women* is an interesting book to read.

Jan Wiedemann, College Station, TX, Texas Section Society for Range Management. ◆



Letters to the Editor

Dear Mr. Frasier (Gary),

Greetings from Olympia, Washington, in the rain belt, now turning to record snowfall for the ski resorts! I want to express my appreciation for the *Rangelands* magazine, a superior piece of literature with magnificent photography. My reason for writing you as an emeritus SRM member relates to my future subscription to *Rangelands* and membership status. I am not well, and the medical bills are being handled thanks to Federal Retirement and Medicare. I have resigned from 5 conservation organizations beginning with the Ecological Society of America. Memories flood in at this time! I reluctantly resign from our Society after reaching Emeritus status some years ago. It is a painful process but must be done to reduce stress as prescribed by an excellent internal medicine physician who has made a difference. I am limited in correction of a damaged left ventricle and the enlarged heart condition diagnosed by a cardiologist.

It's been a challenge and pleasure to serve the Society for Range Management as a former member in the Montana, New Mexico, Intermountain, and National Capitol Sections. Will continue in retirement to provide photography for monthly meetings of an SAF Chapter, as official photographer doing 3-panel displays. Hard to give up a love of photography. Believe that I remember seeing you in Boise, Idaho, at the February 2000 SRM National Convention. Dennis Phillipi and Jeff Mosley were other friends whom I met when active in the Intermountain Section in Montana. I will miss seeing them at future conventions.

Attended the University of Idaho Alumni reunion in Boise. Invited a former BIA forester from my staff at Rocky Boy's I. R. in Box Elder, Montana, who was serving as head of Fire Management for BIA in the Boise Interagency Fire Center. We enjoyed Joe and Agnes Helle's company and other former classmates. Dennis Child and Chuck Bonham, 2 good friends from National Capitol Section days (both were C.S.U. faculty), and I visited with students. I was the official photographer for the President's Breakfast at the Grove Hotel Ballroom. This honor was at the request of Dr. John Buckhouse, who was unable to attend that particular SRM Annual Convention due to family illness. While President of the Society for Range Management, John Buckhouse graciously consented in May 1997 to speak before a monthly meeting of my SW WA Chapter of the Society of American Foresters. I arranged his appearance. His topic was "Resolving Natural Resources Conflicts." I remember a great turnout of over 45 foresters, wildlife scientists, and a couple of range managers to hear John's message.

Back in February 1991, I completed my term as the Corresponding Secretary for the host National Capital Section of the SRM during the previous year. Our Host Section planning began at Reno, Nevada, during a snowstorm! After the Convention at the Marriott Hotel in Arlington, Virginia, I developed some photos for our National Headquarters staff. Some appeared in the Trailboss, I believe. Did you attend that Convention in Virginia Gary? Many photos taken on SRM Chapter field tours in the mid-80s while I was President of the Northern New Mexico Chapter are enjoyed today. We hosted the 1984 New Mexico State SRM Summer Meeting on the Jicarilla Apache Reservation in Dulce, New Mexico. On a field trip, the Conference attendees halted all vehicles to watch a mother grizzly bear and cub play on the other side of a forested ravine. Apache Mesa was the location. Today, I can enjoy subject matter in 51 albums, compiled in 5 western states, as I turn 76, and I regret very much the necessity to terminate my membership in an outstanding resources management and conservation organization internationally respected. Retirement isn't all bad, as I have resumed oil painting after a 30-year lapse. Good luck to SRM, to your staff, and to the dedicated membership practicing in all areas of range ecology and management. Will keep up correspondence with friends, as always.

Sincerely yours,

Henry W. Kipp
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