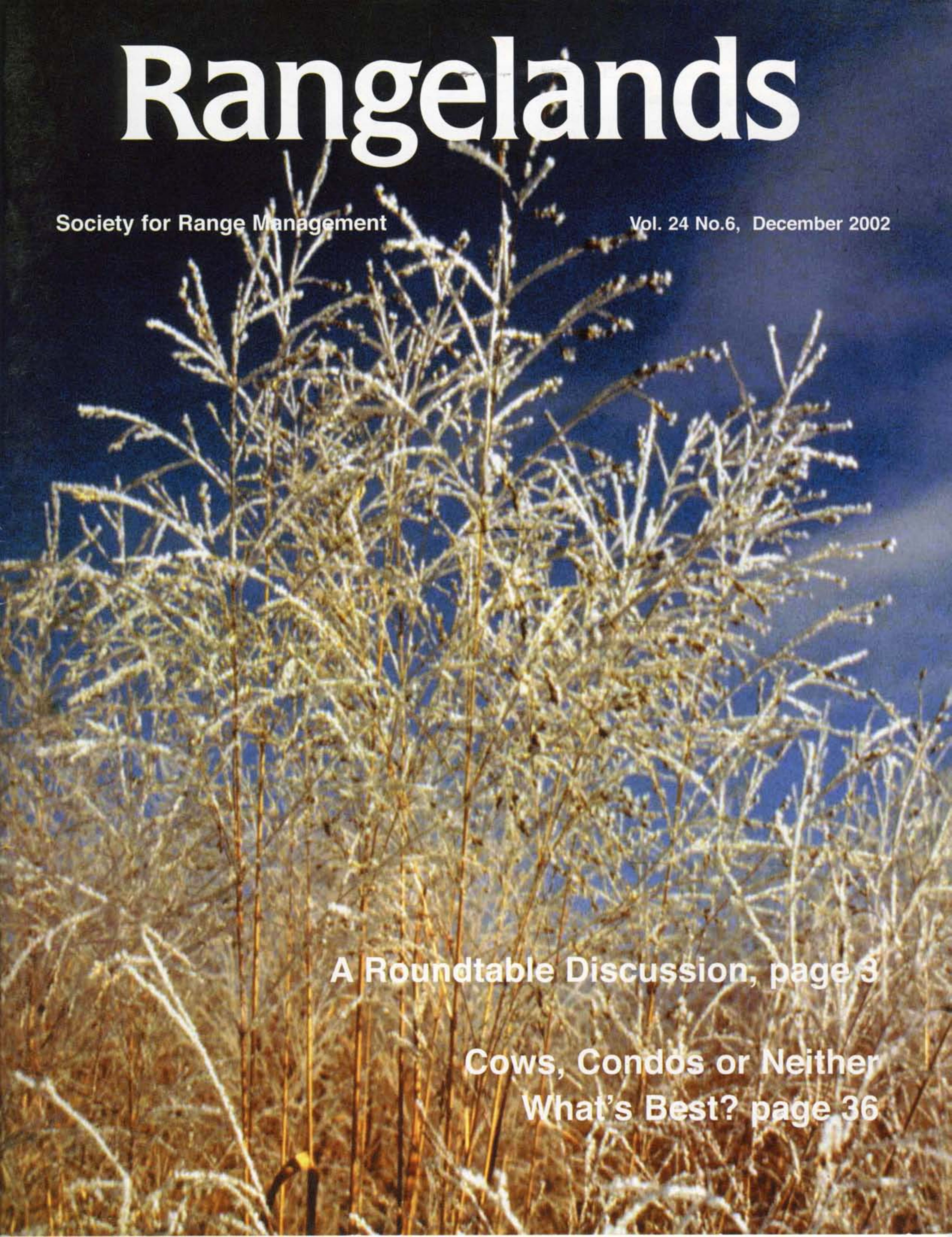
Rangelands

Society for Range Management

Vol. 24 No.6, December 2002



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Society for Range Management

The Society for Range Management

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The objectives for which the corporation is established are:

—*to properly take care of the basic rangeland resources of soil, plants and water;*

—*to develop an understanding of range ecosystems and of the principles applicable to the management of range resources;*

—*to assist all who work with range resources to keep abreast of new findings and techniques in the science and art of range management;*

—*to improve the effectiveness of range management or obtain from range resources the products and values necessary for man's welfare;*

—*to create a public appreciation of the economic and social benefits to be obtained from the range environment;*

—*to promote professional development of its members.*

Membership in the Society for Range Management is open to anyone engaged in or interested in any aspect of the study, management, or use of rangelands. Please contact the Executive Vice-President for details.

Rangelands

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Rangelands

FEATURE ARTICLES

DEPARTMENTS

COVER

About the cover: Switchgrass (front cover) and Little Bluestem (back cover) makes a picturesque winter scene. Photos were taken at the Bismarck, North Dakota Plant Materials Center (PMC) and are provided courtesy of PMC.

EVP's Comments

Reflections

The previous issue of *Rangelands*, I discussed Range Management in 2015 as it related to a document published by the National Intelligence Council. In this column, I want to reflect on the past, starting with the past year, but then stretching back even farther.

This year has been very fulfilling. A lot has happened in the arena of rangeland management. Your Society has opened an office in Washington DC in order to enable the staff and elected leadership to better inform, educate and coordinate with key agencies. In fact, I happen to be sitting in a hotel in Arlington, VA after the first day of meetings of our annual November "field trip".

While a complete trip report will be the subject of future articles, I will mention one interesting point. We met with the US Office of Personnel Management (OPM) to discuss the "GS-454" series job classification standard. We were handed a brand new, not yet released, copy of the latest revision. The title has changed from "Rangeland Management" to "Rangeland Conservation." From talking to others, it used to be "Range Conservation." While some might say that we've gone full circle, I would rather work under the principle that change is constant and we continue to tweak and define what it is that we do. We were pleased to be asked to provide an in-depth review of this latest version before final approval.

Another significant event this year was the 2002 Farm Bill. This piece of legislation includes a greater amount of funding for conservation than previous bills. In fact, it creates new challenges in implementation, and SRM has been asked to help develop solutions. We have a great opportunity to lay groundwork now, which will roll into the next Farm Bill.

But here I am, already talking about the future when I have stated that I wanted to reflect on the past. Let's go way back – say 25 years or so. Picture this—your leadership has approved a plan for a new magazine—titled "Rangelands", and staff and volunteers are busy laying out the first edition. That's right— next year we will be publishing Volume 25.

We will be celebrating this anniversary throughout the year with something special planned for each issue. We will get some interesting reflections from "old-timers", and some new ideas and thoughts on the next 25 years.

During a staff meeting in Denver a few weeks ago, we brainstormed on what we wanted to do for this celebration. As we flipped through back issues, including Volume 1, Issue 1, I was struck by the fact that many of the issues we are addressing now, were also being addressed in previous years. While that might be depressing to some, I still go back to the argument that change is constant and we continue to tweak and define what it is that we do. Dialogue continues to drive consensus. Reflection on the past continues to provide a solid base of reference for future discussions. And I am looking forward the challenges of the next year, and the 25 that follow.

Sustainable Rangelands Roundtable

Allen Torell, John Tanaka, and Mark Brunson (left to right) work on identifying indicators for the "Maintenance and enhancement of economic and social benefits to current and future generations" criterion group.

An overview of a work in progress.

By Helen Ivy Rowe, Kristie Maczko, E.T. Bartlett, John E. Mitchell

Interest in sustainable social and economic development has risen dramatically, both nationally and internationally over the past 30 years. During this time, the American public has become increasingly concerned about natural resource degradation and supported intensified environmental monitoring.

To achieve sustainable development, governments must monitor the condition of natural resources in relation to ecological, social and economic factors. In economics, overall economic well-being can be approximated using the gross domestic product (GDP), which indicates if a nation is experiencing recession or economic growth. However, no national, single measure or index for sustainability of natural resources is known to exist.

Representatives from conservation organizations, the livestock industry, local, state and federal agencies, and universities, are engaged in an ongoing program designed to identify measures of rangeland sustainability at a national scale. This group calls itself the Sustainable Rangelands Roundtable and is working to develop criteria and indicators to form a framework for national assessments of rangelands and rangeland use patterns.

"Conservation and maintenance of soil and water resources" criterion group at work during the Washington DC meeting, held May, 2002.

Ideally, the criteria and indicators will describe elements that assess trends in:

- Resource conditions
- Resource management
- Ecological variables
- Economic costs and benefits
- Social values

What Is Sustainable Development?

The term "sustainable development" was introduced in the 1980's as a modification of the concept of economic development. In 1987, sustainable development was characterized as "development which meets the needs of the present without endangering the ability of future generations to meet their own needs." (World Commission 1987).

Leaders at the 1992 United Nations Conference on Environment and Development endorsed the Rio Declaration and principles of sustainable forest management. Two years later, a working group developed criteria and indicators targeted specifically at assessing progress toward sustainable management of temperate and boreal forests. Criteria and indicators describe individual elements of natural, economic and cultural systems that need to be assessed to illuminate trends in ecological conditions, management, economic benefits and social values. Efforts of this Working Group resulted in the creation of 7 criteria and 67 indicators, endorsed by the United States and nine other countries in 1995.

Subsequently, in 1998, the USDA Forest Service initiated the Roundtable on Sustainable Forests. While focusing on forests, this Roundtable also recognized the importance of including rangelands in any national protocol for appraising our Nation's sustainability. This idea merited additional attention, and, in 1999, the Forest Service convened a meeting in Denver to consider a roundtable for sustainable rangeland management. As a result, the Sustainable Rangelands Roundtable was established in April 2001.

Ken Nelson, Stan Hamilton, Tom Roberts, and Keith Kuhlman (left to right) engage in debate concerning indicators for the "Legal, institutional and economic framework for rangeland conservation and sustainable management" criterion group.

Sustainable Rangelands Roundtable

Sustainable Rangelands Roundtable participants believe that including individuals representing many rangeland interests and emphasizing an open, inclusive process will produce more broadly acceptable criteria and indicators of rangeland sustainability. Additionally, promotion of shared leadership and group responsibility for final products will foster a sense of ownership for widely applicable criteria and indicators.

Sustainable Rangelands Roundtable launched the 2001 meetings by adopting vision and mission statements and guiding principles. Sustainable Rangelands Roundtable participants have committed to two vision statements. The first focuses upon the future of rangelands: "We envision a future in which U.S. rangelands provide a desired mix of economic, ecological and social benefits to current and future generations." The second statement regarding the work of the Roundtable asserts, "We envision a future with widely accepted criteria and indicators for monitoring and assessing the economic, social, and ecological sustainability of rangelands."

The mission statement reads, "The Roundtable will identify indicators of sustainability, based upon social, economic, and ecological factors, to provide a framework for national assessments of rangelands and rangeland use." Practices and standards that roundtable participants will follow are elaborated in the Sustainable Rangelands Roundtable guiding principles (Table 1).

Table 1. Seven Guiding Principles of the Sustainable Rangelands Roundtable.

1. Collectively, indicators should guide monitoring efforts to measure rangeland sustainability in the United States at the national scale. Where possible, indicators should guide monitoring efforts to measure rangeland sustainability at multiple scales.
2. Ensure that the indicators employ the appropriate temporal and spatial scales for assessing the criteria.
3. Collectively, criteria and indicators will address social, ecological, and economic aspects of sustainability.
4. Use a criteria and indicator framework as a common language and operational framework for defining and assessing sustainability. Begin by considering the criteria and indicator framework of the SFR.
5. Review and consider, as appropriate, other indicator initiatives.
6. There are numerous policy questions related to rangelands. We will focus on the vision-mission agreed to by the Sustainable Rangelands Roundtable.
7. The Roundtable process will feature outreach to stakeholders, open dialogue, and respect for differing opinions.
8. The Sustainable Rangelands Roundtable will be supportive of and compatible with improved on-the-ground management of rangelands.

The criteria and indicators developed by the Sustainable Rangelands Roundtable will provide a common, comprehensive framework for monitoring and assessing progress toward sustainable rangeland management. Potential ways in which monitoring sustainability indicators could improve efficiencies of federal and state land management agencies and other organizations interested in rangelands include:

- Target monitoring efforts to areas indicators identify as important.
- Provide for the development of common data collection techniques.
- Focus research by agencies, universities, and organizations on developing methodologies and protocols to measure indicators.
- Facilitate establishment of national workload and funding priorities to at-risk areas.
- Justify new funding appropriations or shifts in funding within agencies and departments.

A broadly accepted set of indicators would improve accountability for rangeland stakeholders and Congress. It would set the stage for:

- Multi-level, coordinated data reporting.
- Assessing compliance with applicable laws.
- Improving a general understanding of rangelands sustainability.

The Sustainable Rangelands Roundtable process enhances the quality of debate possible on rangeland management issues.

A set of effectively communicated criteria and indicators can potentially help educate the public about current rangeland conditions, as well as portray causal factors integral to improving and maintaining this resource. In fact, it may be possible to report on the long-term importance of rangelands to our Nation with the level of detail and consistency that has been achieved with economic indicators such as the aforementioned gross domestic product.

The Roundtable Process.

The collaborative spirit established through crafting common vision and mission statements has pervaded interactions among Sustainable Rangelands Roundtable participants during and between meetings. The Sustainable Rangelands Roundtable focuses its efforts through a series of working meetings, enhanced by formal and informal interaction between meetings, using action-oriented working groups and subject-oriented criterion groups. Participants spend meeting time developing, reviewing, and revising criteria and indicators within the five criterion groups (Table 2).

Table 2. Five criteria of the Sustainable Rangelands Roundtable.

1. Maintenance of Productive Capacity on Rangeland Ecosystems
2. Maintenance of Ecological Health and Diversity of Rangelands
3. Conservation and Maintenance of Soil and Water Resources of Rangelands
4. Maintenance and Enhancement of Multiple Economic and Social Benefits to Current and Future Generations
5. Legal, Institutional, and Economic Framework for Rangeland Conservation and Sustainable Management

As criterion groups continue to refine indicators, they review indicators across criterion groups to minimize gaps and overlaps. SRR criterion groups also meet with other roundtable criterion groups to share information and strive for consistency within the three roundtables.

As progress on developing criteria and indicators for sustainable rangelands moves forward, special projects and problems arise. To address these items, the Sustainable Rangelands Roundtable forms small working groups to perform specific tasks on behalf of the Sustainable Rangelands Roundtable, or to offer recommendations on how Sustainable Rangelands Roundtable should resolve emerging issues. Four such working groups now exist (Table 3), dealing with:

- Outreach efforts.
- Coordination with other indicator initiatives.
- Questions of spatial and temporal scale.
- Definitions.

The Sustainable Rangelands Roundtable success depends heavily on the time and effort of the participants. In addition to the 4 or 5 two-day meetings per year, participants also contribute time and effort between meetings through the Collaborative Delphi, a survey and response process, as well as through tasks assigned by working groups and criterion groups. The Sustainable Rangelands Roundtable makes an effort to expand participation and add fresh perspectives to their common understanding of rangeland sustainability by inviting representatives from local groups to each meeting.

Local interests, associations, and agencies currently represented in the Sustainable Rangelands Roundtable include: the United States Department of Agriculture – Forest Service, Natural Resources Conservation Service, Economic Research Service and Agricultural Research Service; United States Department of the Interior – Bureau of Land Management, Bureau of Indian Affairs, U.S. Fish & Wildlife Service, National Park Service, U.S. Geological Survey; Oak Ridge National Laboratory, Pacific Northwest National Laboratory, the Western States Land Commissioners Association; sixteen universities, and eighteen local, state and national organizations. The latter range from professional groups such as Society for Range Management, Society for Conservation Biology, and Ecological Society of America, to producer groups such as the National Cattlemen's Beef Association, and conservation groups including the National Wildlife Federation and the Idaho Conservation League.

The SRR recognizes that involvement of a wide variety of rangeland stakeholders will generate a more effective, broadly applicable set of indicators, as well as improve acceptance and implementation of criteria and indicators. Sustainable Rangelands Roundtable remains an

Table 3. Tasks of the Four Sustainable Rangelands Roundtable Working Groups

Working Group	Tasks
Outreach Working Group	• Involve additional organizations. • Develop effective outreach materials. • Coordinate with outreach efforts of other roundtables. • Maintain Sustainable Rangelands Roundtable momentum.
Scale Working Group	• Identify an interpretation of appropriate spatial and temporal scales. • Examine complex relationships among national, regional, and local scales to determine whether spatial aggregation is suitable and/or useful for application of indicators. • Investigate situations where indicators or their interpretation might change as scale changes and instances when the metric (measure) varies among levels of scale.
Coordination Working Group	• Avoid duplication of effort and indicator redundancy. • Enhance information sharing and cooperation with the three other roundtables, RSF, the Sustainable Minerals and Energy Roundtable (SMR), and the Sustainable Water Resources Roundtable (SWRR) as well as other indicator efforts.
Definitions Working Group	• Address the political issues involved in delineating rangeland and forestland to ensure that all vegetation communities are included in criteria and indicators efforts of the roundtables.

Facilitator Lou Romero (right) discusses sustainability processes with Phil Janik, Chief Operating Officer for the USDA-Forest Service.

open process, welcoming all individuals interested in promoting the sustainable use of our Nation's rangelands.

Timeline & Products

Sustainable Rangelands Roundtable has adhered to a schedule designed to produce an initial report about criteria and indicators for sustainable rangeland management by 2003. This document should complement a comprehensive national report, being prepared by the Forest Service, on the state of the Nation's forests. The Sustainable Rangelands Roundtable held four meetings in 2001, will have five meetings in 2002, and three sessions in 2003.

Achievement of broad acceptance and adoption of Sustainable Rangelands Roundtable criteria and indicators will require external reviews and feedback from a broad spectrum of scientists, policy makers, and interest groups. The first of these reviews occurred at the 55th SRM Annual Meeting in Kansas City, where Sustainable Rangelands Roundtable presented a symposium and distributed proceedings to inform rangeland professionals about ongoing efforts and future plans.

"Ecological health and diversity on rangelands" criterion group evaluates their list of indicators.

A similar workshop was held in August 2002 at the Ecological Society of America annual meeting in Tucson, Arizona. The second symposium targeted a narrower audience, and was designed to provide an opportunity for participating ecologists to review the ecologically-related criteria and indicators and give feedback. These focused critiques will contribute to the formal 2003 report.

Collaboration between the Sustainable Rangelands Roundtable and other groups working on indicator sets, including:

- Roundtable for Sustainable Forests
- Sustainable Minerals and Energy Roundtable,
- Heinz Working Group on grasslands/shrublands,
- The Nature Conservancy,
- EPA, and
- The President's Council on Sustainable Development

will serve to facilitate progress toward creation of a robust, useable, commonly accepted and shared set of indicators for assessing how well people, in the United States, collectively promote good stewardship and management of all their lands.

We presume that the Sustainable Rangelands Roundtable will be successful in creating a suite of criteria and indicators that will be acceptable to a broad range of agencies and organizations. However, land management agencies still will require adequate resources to support long-term monitoring programs needed to assess these indicators. Public involvement and awareness of rangeland sustainability issues will also be essential to bring about requisite changes. As Phil Janik, co-chair of the Roundtable on Sustainable Forestry, has said, "Sustainability is not a destination, but a journey; no deadlines are set, but work progresses towards a goal over time."

For additional information, see the Sustainable Rangelands Roundtable web page

http://www.cnr.colostate.edu/RES/srr/index.html,

or contact Tom Bartlett at 970-491-7256, et@cnr.colostate.edu or Helen Rowe at 970-491-3908, ivy@cnr.colostate.edu.

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Range Sites

Are they the appropriate spatial unit for measuring and managing rangelands?

By Joel R. Brown, Tony Svejcar, Mark Brunson, James Dobrowolski, Ed Fredrickson, Urs Krueter, Karen Launchbaugh, Jack Southworth and Tom Thurow

Editor's note: The following article is a synthesis of a symposium presented at the 2000 Annual Meeting of the Society for Range Management, Boise, Idaho.

Plant communities—and plant populations that comprise them—represent the fundamental spatial unit at which most information is gathered for inventory, monitoring and, ultimately, decision-making on rangelands (see SRM 1995).

Although different agencies may use different terminology, the plant community is the focal point for describing sites. Plant community concepts underlying site descriptions have been around for more than a century, but their formalization and institutionalization occurred during the late 40's and early 50's.

The range site was the on-the-ground implementation of concepts derived from Clementsian plant ecology. The plant community and the populations and processes within it were the basis for the range condition concept and its application to determine the status of rangelands.

Ultimately, the implementation of management practices was based on managing plant community processes. These ideas and protocols were the bases for rangeland inventory and management during the last half-century. Even though the theoretical basis for describing temporal dynamics has recently shifted from a climax approach to one based on non-equilibrium dynamics and range sites have become ecological sites, plant community attributes and dynamics still dictate site delineation and description.

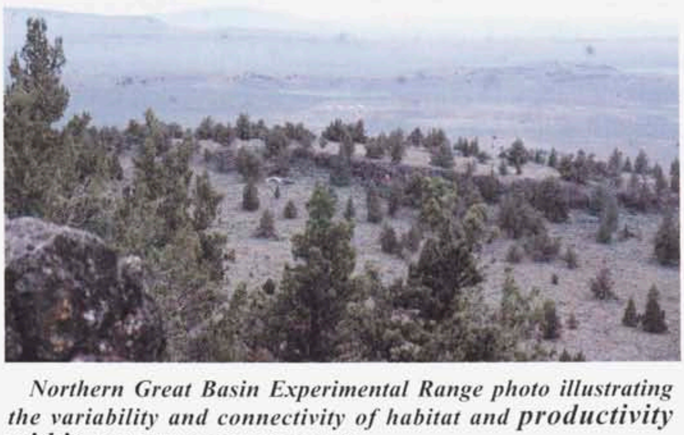
Through a half-century of research and management and an improved ability to handle large amounts of quantitative information, we have gained an increased knowledge of the importance of spatial scale in describing and managing ecological processes.

In addition, changing expectations of rangeland ecosystem services and heightened interest on the part of the general public in rangelands dictate that we rethink how we organize and disseminate information. In this article, we examine developments in several disciplines representing the most common rangeland values (grazing, watershed, wildlife, recreation) to test whether sites (representing plant community concepts) are an appropriate tool for collecting and organizing information on rangelands. Our objectives are to:

1. Review some emerging principles and applications in the spatial analysis of rangelands,
2. Illustrate how some important goods and services of rangeland ecosystems are the result of the way different organisms and processes integrate resources across a variety of spatial scales, and
3. Describe how information to make decisions and communicate the status of rangelands can be organized to better serve a variety of decision makers.

Managing Livestock

In developing grazing management plans for livestock, a critical step is to estimate carrying capacity and then set stocking rates, integrating both animal performance and vegetation management objectives. The challenge is to set the spatial scale small enough to identify areas with unique production or ecological properties and large enough for cost-effective implementation of decisions. We examine two perspectives: one in which ad-



Northern Great Basin Experimental Range photo illustrating the variability and connectivity of habitat and productivity within a single management unit.

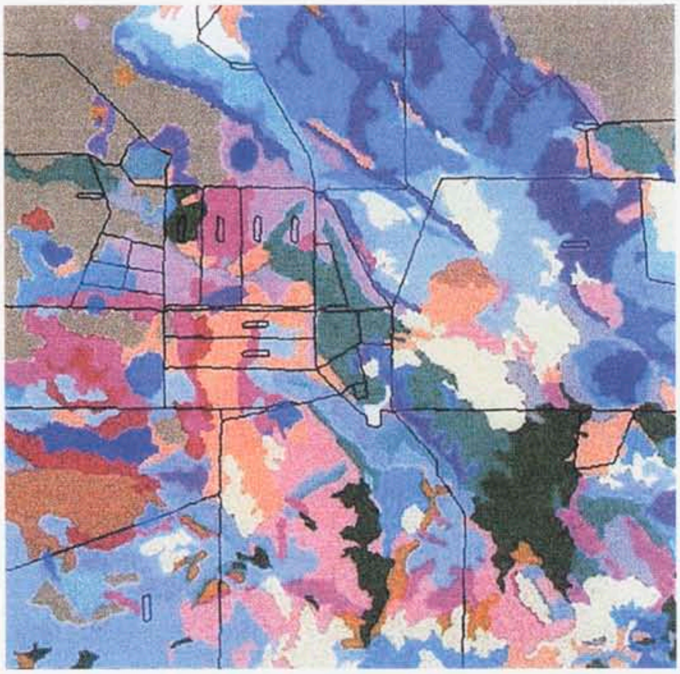


Figure 1. *Soil map units for the Northern Great Basin Experimental Range, 40 miles west of Burns Oregon. The total area is 16 000 acres. Fifty-four soil map units were identified on the range.*

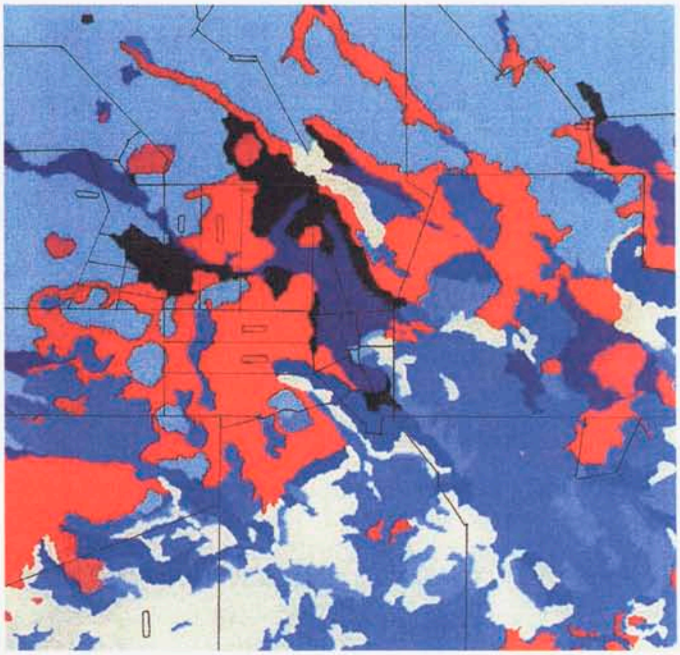


Figure 2. *The extent and distribution of range sites on the Northern Great Basin Experimental Range. Ten range sites were identified from the soils data.*

vanced analytical tools are employed in a research capacity; the other from the perspective of a practicing rancher.

On the sagebrush/bunchgrass rangeland of the 16,000 ac Northern Great Basin (NGB) Experimental Range near Burns, Oregon, a detailed soil survey was used as the basis for estimating carrying capacity by management unit (pasture) and the information managed and manipulated using Grazing Lands Application software.

Fifty-four soil map units were identified (Fig. 1) with even small (160 ac) pastures containing at least 4 to 5 soil map units. Estimating forage production for 54 different map units was unreasonably time consuming and involved much repetition, so the soil map units were aggregated into the 10 existing NRCS range sites for analysis (Fig. 2). Several pastures were dominated by one range site, but about two-thirds of the land area was a mix of sites and estimating forage production (and carrying capacity) was still too tedious, even for a research unit, considering the contribution to making critical grazing decisions.

With a combination of standing crop measurements, existing forage production data, and "expert" opinion, the ten range sites were further aggregated into four distinct forage production groups (Fig. 3). One large (~4000ac) pasture contained all four production groups, but generally one or two production groups dominated any given pasture.

This approach allows for retention of basic information (soil map units and range sites) in case it is needed in the future, while still providing reasonably scaled management delineations. With spreadsheet-type software it is easy to combine units, and if necessary, recombine according to different criteria (production, seasonality, dominant species etc) if the original decisions

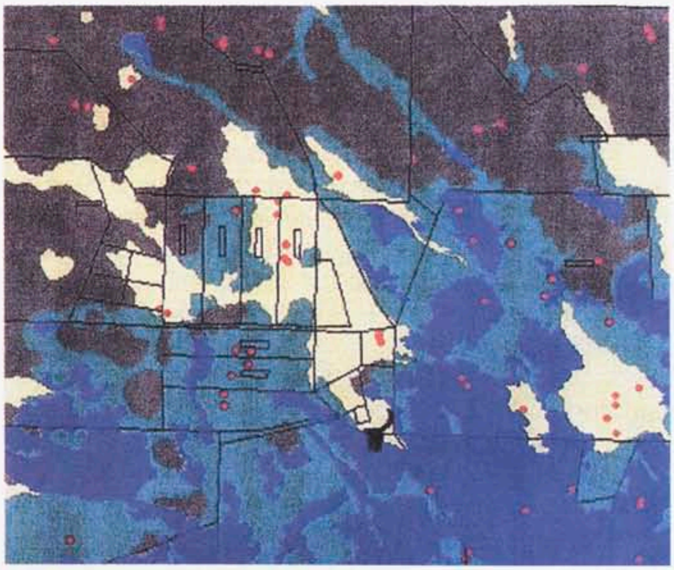


Figure 3. *Aggregation of range sites into four production groups based on current standing crop, historical data, and expert opinion.*

prove unworkable. The appropriate number of spatial units that best meets management needs will vary depending on intensity of use and land management goals.

From a rancher's perspective, does having range site information, such as productivity and species composition, improve the quality of large-scale decisions made by ranchers? In the example above, the range site information was important, but had limited value in developing a grazing management plan even when high tech tools were available.

Ranchers must make many decisions without the aid of sophisticated tools, using a qualitative, expert appraisal of the lay of the land beyond the community scale: A fence down a ridge to separate two drainages; a seeding on ground gentle enough to till; a water development located at the junction of several pastures; a riparian fence protects a river while continuing to allow a meadow to be hayed. All of these activities require a wide variety of information rather than just descriptions at one spatial scale.

Northern Great Basin Experimental Range photo illustrating the importance of spatial position on the process of shrub increase as invasive plants move from higher elevation rocky outcrops onto lowlands.

However, range site information can facilitate an understanding and be used to create a database of the capability of rangeland. As management units become increasingly smaller in response to development, a thorough description of soil/vegetation dynamics within a site in addition to a quantitative description of the relationships among sites is a critical component in making timely planning, implementation and monitoring decisions for managing domestic livestock.

Managing Watersheds

Infiltration rate, soil water storage capacity, rain use efficiency and precipitation characteristics are hydrologic attributes vital to ecosystem structure and function. Understanding how land use and management impact these attributes can be used as criteria for assessing sustainability and providing management guidance to a wide variety of land managers.

The watershed is an effective natural scale of spatial resolution for assessing progress toward both ecological and economic objectives. Drainage patterns form the framework for energy and nutrient movement within a watershed as well as providing the delivery system of materials and information into larger spatial units.

These flow patterns also provide the context for a more complete socioeconomic accounting of the serial benefits and costs of investments in rangeland management. Examples of watershed management projects from several continents illustrate how varying the spatial scale for assessing management technologies can be influenced dramatically, depending on what ecosystem service(s) are most important and who is making the decision.

For instance, examples from Niger and Honduras show that upland restoration techniques (reestablishing cover) may not be justified if the sole criterion is increased net primary productivity at the site level. However, if the criteria included enhanced hydrologic function at the watershed level, then the application of restoration technologies on upland sites that enhance infiltration rate and soil water storage become integral to project success.

Hydrologic function at the watershed level ($>10^2$ sq mi) is an emergent property and cannot be predicted using solely plant community scale information. Information at the plant community scale must be integrated using both conceptual and mathematical approaches that focus not only on the properties of individual sites, but also on how interactions between and among sites contribute to larger-scale outputs.

Distribution of public resources might also change depending on how the goals and objectives are defined and pursued. The manipulation of shrub density via chemical and mechanical techniques has long been a staple of rangeland management in the semi-arid western U.S where the majority of precipitation falls in small events. The distribution of financial and technical resources has been based on assumptions that both local site productivity and watershed scale hydrologic function would be enhanced simultaneously.

However, economic and ecological analyses suggests that increased water yield at the watershed level would be better accomplished by allocating resources preferentially to riparian sites, while efforts to enhance forage production would be achieved more efficiently by targeting resources to upland sites. Riparian sites had more influence on water delivery than did upland sites where water savings achieved through decreases in shrub density were captured on site by grasses and were not delivered to collection points.

Clearly, the objectives of managing the hydrologic cycle, whether at the watershed scale (water yield) or the community scale (forage production), may change the allocation of both public and private resources.

Managing Habitat

The attributes humans perceive and use to categorize wildlife habitat are the result of interactions that occur at spatial scales both larger and smaller than the site level. Individuals and populations contribute to site level properties, while site level outputs contribute to landscape and larger properties.

Humans selected sites as a management focus largely as a result of our body size, how we perceive and use our environment, and our capacity to organize information. Other organisms are likely to interpret the same information in vastly different ways. Swainson's hawks, for example, annually migrate from the pampas of Argentina to central and western North America. At a much different scale, meadow voles live their lives in areas defined by a measure of square feet. The characteristics that are important in their habitat selection and use may not coincide with the human-perceived concept of ecological sites.

> Changing expectations of rangeland ecosystem services and heightened interest on the part of the general public in rangelands dictate that we reevaluate how we organize and disseminate information.

The perceived boundaries of a particular site are based on an animal's integration of habitat attributes and internal driving forces. The characteristics of habitat (e.g., forage, water, or cover) are therefore completely dependent on the animal's ability to see, feel, and remember and current internal needs (e.g., hunger, thirst, predator avoidance, thermoregulation, or social interaction). Features of a particular ecological site may, never the less, have substantial impact on animal species and animal communities.

Individual animals, animal populations, or communities of interacting animal species are rarely limited to single sites. Additionally, biotic and abiotic factors affecting individual animals, populations or communities are not limited to site boundaries. For example, a loamy ecological site dominated by black grama and bush muhly in the northern Chihuahuan Desert adjacent to a housing development provides a different set of habitat constraints then a similar site adjacent to a black grama-bush muhly site with lesser degrees of human influence.

While attributes of human development provide opportunities for some species it provides barriers to others. Feral dogs and cats, roads, introduced plants, increased water availability, and increased perches for avian predators differentially affect the habitat quality for animals that inhabit adjacent lands. As a result there is a shift in the community toward species better adapted to human dominated landscapes.

Similarly, a range site adjacent to or including seasonal water will present different attributes to potential users compared to sites having the same vegetation adjacent to either perennial water or no surface water. Effective management requires concepts and techniques that take into account a species' life history, population genetics and interactions with other species in addition to site-specific information.

Making and Implementing Policy

While the debate over issues of spatial scale in range management has focused mainly on the biophysical aspects of rangelands, it can also be applied to socioeconomic questions. Because humans influence rangelands (and are influenced by them) at various spatial scales, human/rangeland interactions must be assessed and managed at multiple scales.

The smallest scales of human/rangeland interactions, those measured most appropriately at the site level, consists of actions by and/or effects upon humans acting within rangeland systems. Humans can act upon rangelands through: direct management actions intended to regulate livestock grazing, wildlife, or recreation; disturbance behaviors such as off-trail ATV riding; or land type conversions that occur as a result of direct action (new subdivisions) or inaction (failure to control weeds).

Meanwhile rangelands affect humans at these smaller scales by providing scenery, wildlife habitat, food, water, fiber, and forage. Often these interactions are reciprocal, since range management can change how rangelands affect humans; e.g., if fire management influences scenic quality or grazing practices affect fish habitat.

Interactions also occur at larger scales involving actions of humans from outside rangeland systems, whether in small rural communities or society as a whole. These actions may include: changes in range policy at local, regional, or national levels; changes in land-use allocation (e.g., local bans on motorized vehicles, eliminating grazing from a new national park); or economic forces that change the demand for rangeland outputs. Conversely, range ecosystems can affect humans outside those systems through non-anthropogenic events such as fires, floods, insect/disease infestations, weed invasions, or changes in wildlife abundance and distribution.

A good example is the Grand Staircase-Escalante National Monument, designated by President Clinton in

1996 over the protests of Utah citizens and politicians. The initial action was taken to achieve a national political advantage by wooing environmental interests outside Utah, and also to achieve conservation benefits by halting a proposed coal mine. The immediate impacts (loss of potential mining jobs, uncertainty about future grazing, expansion of the tourist economy) were almost entirely local. Paradoxically, designating a new national monument also created an instant national constituency for a hitherto unknown place, so that the scale at which humans were affected by subsequent action was greatly expanded.

The BLM recognized this, and its comprehensive planning effort involved the public at multiple scales from the smallest nearby communities to cities on both coasts. This laudable effort was expensive, and so may not be repeated in subsequent planning, leading to new discrepancies of scale. For example, backcountry recreationists from distant urban areas often say their experiences are negatively affected by livestock grazing, yet grazing decisions typically occur at local scales.

Alternatively, proposed restrictions on off-highway vehicle use were intended to protect national conservation goals but have mainly affected local users who, seeking to resolve the scale discrepancy, have turned to national advocacy groups for help, leading to intensified conflict.

We cannot eliminate scale discrepancies entirely. In the case of private lands, rights of small property holders must be respected, while on federal lands we will always have cases where national political interests override local concerns. However, we can identify means for reducing the frequency of such discrepancies.

One such improvement is to expand social and economic monitoring at appropriate scales. Monitoring must occur not only when needed to predict impacts of proposed changes in policy and management, but beforehand, if managers are to know the appropriate scales for effective public involvement or impact assessment. This does not mean decisions cannot favor interests at one scale over those at another, only that managers should know the scale of impacts so they may be adequately considered.

Working Toward A Better Future

The goal of this article is not to propose a new system of inventorying, measuring and managing rangelands, but to examine our current approaches and stimulate thinking and discussion about how we as a profession can be more effective in communicating with the public and how we can better organize our body of knowledge, ultimately leading to better decisions.

Different ecosystem services provided by rangelands such as water, recreation, habitat, open space and forage production can be analyzed using plant community scale information. However, for each rangeland value, there is convincing evidence that the accurate prediction of outputs of these important rangeland services cannot be accomplished using linear combinations of site scale information. Understanding critical relationships and interactions among natural and management stresses and disturbances can only be understood using a multi-scale approach.

Plant community scale descriptions, whether they take the form of the traditional range site or the new ecological site, will continue to be an indispensable component in the responsible analysis and management of rangelands. However, plant community scale information is inadequate if we expect to meet the needs of an ever- expanding clientele and an ever-increasing complexity of ecological, economic, social and political framework in which decisions are made.

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Acacias in the New Mexico Desert

This attractive, drought tolerant shrub offers food and habitat for wildlife, and even has medicinal uses for humans.

By Muhammad Ishaque, Reldon Beck, and Rex Pieper

Acacias, shrubs not well understood, contribute to the desert landscape in southern New Mexico by adding habitat and food for animals as well as aesthetics to those who travel these rangelands. Acacias have long been part of the arid and semiarid regions of the world and were recognized by early Native Americans as having curative and medicinal values.

The genus *Acacia* is from an old word meaning hard or sharp-pointed. This is a genus of 700 to 1200 species, depending upon the taxonomic authority. These species are dispersed throughout the tropics and to some extent into the temperate regions. The largest number of species, more than 300, are found in Australia. There are 46 species in North America. Many species are spiny, spreading shrubs or small trees with delicate, bipinnate leaves.

As a result of livestock introductions in the past centuries, the acacia populations have expanded. This expansion has not been as rapid or noticeable as that of creosotebush and mesquite in southern New Mexico, but once established the acacias appear to effectively compete with other shrub species.

Following is a general description of viscid acacia and whitethorn acacia–leguminous, native shrubs, which add to the beauty, diversity, and are important for wildlife in the Chihuahuan Desert. Stands of these two species were studied near Las Cruces, New Mexico in 1993 and in 1994, a drought year (3 inches of precipitation fell from March through September, 49% of average). Average annual rainfall for the area is 8.5 inches.

Adaptations To Arid Environment

Viscid acacia and whitethorn acacia are drought resistant shrubs found in arid areas of southern New Mexico. They can be found growing either as individuals (<1/acre) among other shrubs (Figure 1) and the many grasses and forbs in the desert, or sometimes in dense, nearly impenetrable stands (>1000/acre) on ridge tops or along arroyos (Figure 2.) Both species are cold and drought deciduous. The plants are tough and durable and can tolerate a wide range of unfavorable conditions, including heat and cold, drought, low fertility, stony and alkaline soils.

Both viscid acacia and whitethorn acacia have a deciduous growth pattern. Start of leaf growth after winter dormancy depends on timing of spring and summer rains. In some years when there is little spring rain, growth is not initiated until late June or July when the summer rains start. In other years of more normal rainfall in southern New Mexico, growth will initiate sometime in May, often weeks after mesquite starts growing. During severe droughts the acacia plants may not produce any leaves or flowers in the growing season.

Both species have an asymmetrical growth pattern in the crown. This results from the new shoot tip paling or

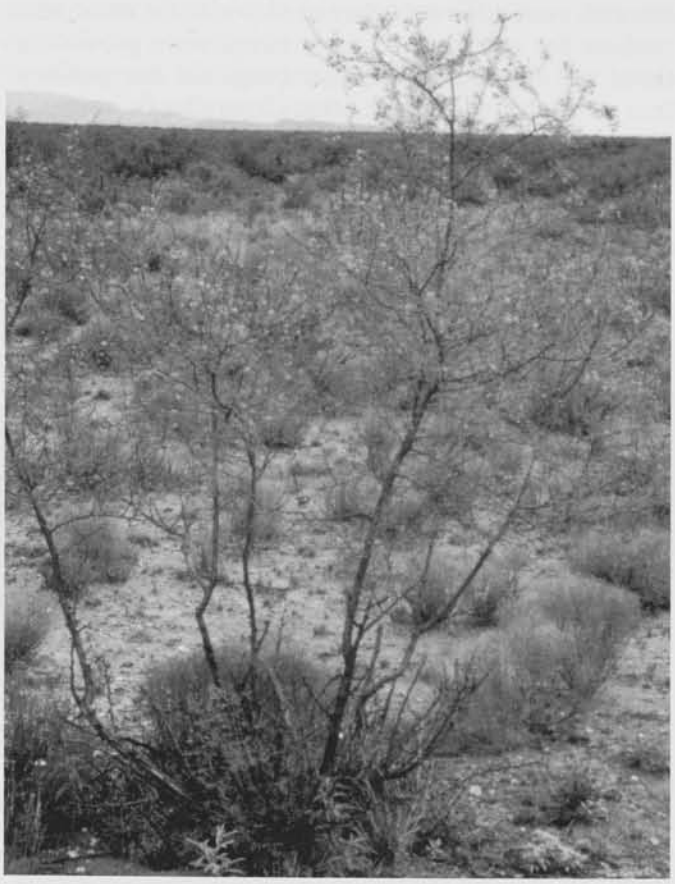

Figure 1. ***A single whitethorn acacia with flowers on a site in the Jornada Basin dominated by mesquite and snakeweed.***

Figure 2. Stand of viscid acacia growing on desert pavement below the Organ Mountains near Las Cruces, New Mexico. Note that very few other species are present in this harsh environment.

yellowing and falling off and new growth for the next year coming from auxiliary buds. Some researchers suggest that this is a mechanism shrubs utilze to reduce evaporation surface under arid conditions.

In 1993 and 1994, the time when leaf and flower growth started was different between years and between sites and even different between plants at the same site. Even on the same plant, some twigs were producing leaves and flowers while other twigs did not produce these structures until much later. Generally, flowers and leaves appear on a branch at the same time (Figure 3). At the end of the reproductive season, pod ripening also varies by several days between plants. Even on the same plant and sometimes on the same branch ripened pods as well as green immature pod were observed.

Acacias Are Attractive

Viscid acacia is an open, upright shrub (Table 1, Figure 4). The branches of the plants are usually armed with paired white spines. The skeletal, open growth habit and sparse foliage provide an untamed appearance. The leaflets are small, dense, oily green in appearance.The entire plant, including the leaves, stems and pods, are sticky from glandular secretions which appear to give it a distinct odor which is most noticeable soon after a rainfall.

Fragrant yellow clusters of flowers in a ball are sprinkled throughout the shrub from April to July. In a few cases mature pods attained lengths of 3 inches with a maximum of 10 seeds per pod. The ripened pods burst open and seed fell onto the ground around the plant. This type of seed dispersal suggests that for obtaining an accurate estimate of seed production of these species, observations of mature pods should be carried out on a daily basis during pod production.

Whitethorn acacia is an upright or spreading shrub or small tree (Table1, Figure 1). Bark of new twigs is smooth, becoming fissured and gray on older limbs and the trunk. The twigs are often armed with paired white spines. Occasionally some limbs of the plant are spineless or often an entire plant may be spineless.

Yellow-orange, fragrant balls comprised of many flowers dot the foliage. Pods are reddish-brown, curved, about

Table 1. Names, range, habitat and morphological characters of viscid and whitethorn acacias

Name	Scientific Name	Other Common Names		Range	Habitat
Viscid Acacia	*Acacia neovernicosa* Isley*	stickyleaf whitethorn Chihuahuan whitethorn		Texas to Arizona south into Mexico	Gravelly, limestone hills, 2,800-5000 ft. elevation
Growth Form	**New Bark Color**	**Leaves**	**Flowers**	**Pods**	**Spines**
Open, upright, 3-7 ft. tall, Canopy 3-10 ft.	Pink to reddish	leaf divisions 1-2 pairs, glandular, deciduous, small dense	Fragrant, yellow, many in 0.5 in. globes, April to July	medium brown, 1.5-3 in. long	paired, pinlike, white spines, 0.5 in., abundant
Name	**Scientific Name**	**Other Common Names**		**Range**	**Habitat**
Whitethorn Acacia	*Acacia constricta* Gray*	mescat acacia fragrant acacia		Texas to Arizona, northern Mexico	Washes and gravelly slopes. 2500-5000 ft. elevation
Growth Form	**New Bark Color**	**Leaves**	**Flowers**	**Pods**	**Spines**
Often tree-like, 3-10 ft. tall, canopy spread of 3-6 ft. more open	Purple gray to reddish	Leaf division of 4-7 pairs, not glandular, deciduous	Fragrant, many in yellow-orange globes, 0.5 in. diam. April to July, & late summer in some years	Reddish brown curved, 2-4 in.,	paired, pinlike, white spines, > 0.5 in. Some plants do not have any

*Allred 2000.

Figure 3. *Whitethorn acacia typically flowers shortly after leaves first appear when the late spring/summer rains start. This particular shrub does not have any spines which is not uncommon in this species.*

4 inches long and deeply constricted between the seeds. This is the characteristic that gives this acacia its species name. This species blooms between April to June, and again in late summer to mid-fall. Floral buds may appear as late as November-December, but generally temperatures are too cold to permit flower development.

Flowering in this plant is triggered by a rain of at least 0.4 inches, followed by many days with temperatures above 59 F. Only a few of the flowers in each inflorescence produce fruit. The rest which eventually fall are not wasted as they contribute to the showy display that attracts pollinators. Scientists have reported that whitethorn acacia seeds are mature when air temperatures exceed 99 F.

Seeds Need To Be Scarified

The hard pericarp which surrounds the endosperm in the seeds of these shrubs needs scarification to insure germination. In an Arizona study where germination of whitethorn acacia seeds were tested in a greenhouse, it was found that seedlings emergence was greatest from seeds sown at 0.4 to 0.8 inches depths in sandy loam soils. The optimum germination temperatures for whitethorn ranged from 79 to 88 F which resulted in seed germination by the 5^{th} day. Germination of scarified seeds exceeded 90% of those tested.

In a New Mexico trial, germination of non scarified seeds in Petri dishes was less than 11% and more than 40% for scarified seeds for both species. When scarified seeds were put into a sandy-loam desert soil, germination exceeded 50%.

Once established, water requirement varies from low to moderate. However, both species grow better in areas where rainwater periodically percolates deep into the soil, especially in areas with less than 10 inches total annual rainfall.

Many Animals Rely On Acacia

Acacias provide cover and food for many wildlife species. The browse and fruit of the acacias are rich sources of digestible protein for many herbivores. When analyzed in 1993 and 1994, whitethorn acacia had somewhat higher crude protein than the viscid acacia. Crude protein in the whitethorn acacia leaves was nearly 25% in mid summer while that of the viscid acacia was about 16%. Leaves for both species had 3-7% less crude protein at the end of the growing season than during the growing period. The green pods had nearly the same percentage crude protein as the green leaves in the respective species. Crude protein declined as the pods matured, but the mature pods still provide an important food source for many animals.

Some of the dead branches found on both the viscid and whitethorn acacia plants resulted from black-tailed jackrabbits eating the bark on the stems just above ground level. This bark is an important food-item for the jackrabbits, especially when other forage plants are scarce during drought. The bark may also be used by cotton-tail rabbits and some rodent species. Deer occasionally browse the leaves and pods. Quail eat its seeds extensively in areas where this plant species is abundant. Grasshoppers used the plant leaves, while ants ate developing seeds in the pods on the plants.

Seed beetles or bean weevils sometimes laid eggs in the pods and seed which lead to consumption of the inner parts of the seeds. These beetles (personal communication, Dr. David Richman, New Mexico State

Figure 4. *Two viscid acacia plants in spring before green-up. Due to unfavorable growing conditions on some ridgetops, the shrubs are widely spaced and only a few herbs grow here after the rains start.*

University) emerge from the stored seeds by making a hole before the start of the growing season. Caterpillars may defoliate its leaves in the spring, but new leaves develop quickly. These plants are favored by bees for making honey in the southern Trans Pecos of southern New Mexico and west Texas.

Management & Control

Both acacia species are high in cyanide forming compounds, but only a few clinical problems have been reported even though they are used for forage during drought conditions. Some death losses of livestock have been reported by animals eating acacia in most parts of their ranges. In summer the plants are rarely eaten by cattle although the pods are browsed sometimes. However, in the fall of the year when frosts occur and range grasses become less palatable, cattle may eat a considerable amount of these plants and death may result. The leaves of the plants may have high HCN content and the plant may retain their high HCN content for considerable time in the dry state.

In rangelands where either whitethorn or viscid acacia have relatively dense stands and herbaceous forage is limited, it may be important to control livestock access to those ranges. The most critical time appears to be in the early frost period in the fall. To avoid poisoning it may be necessary to remove all livestock and put them on ranges that are not infested with acacia.

On some ranges the acacias become so dense that they limit the movement of livestock and the people trying to herd the animals. On fertile soil areas, shrub control treatments may be desirable. Successful herbicide applications include treating individual plants by putting the herbicide around the base of the plant, or by large scale applications using either liquid to be applied to the foliage or dry herbicides to be incorporated through the roots. Tebuthiuron is a soil applied herbicide that has been successfully used (personal communication, Dr. Kirk McDaniel, New Mexico State University). Large scale treatments may not be practical or economical on areas of shallow soils or where there is little chance for herbaceous plants to become established.

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Acacias offer medicinal and landscape uses as well

Acacias can be used as background shrubs and are well suited for desert landscapes. They may be used in a garden where the flowers can perfume the air. They have been used for transitional or natural gardens, and also as barrier plants along arroyos banks. They've proven useful in preventing animals from grazing the area and causing erosion. They are also used for replanting disturbed desert areas or for increasing plant diversity in sparse desert areas.

The species has also been reported to be used for medicinal purposes for both humans and livestock. The leaves and pods when ground into a powder make an excellent infused tea for diarrhea and dysentery, as well as strongly astringent haemostatic and antimicrobial wash. The straight powder is widely used by Native Americans for treating sore backs and flanks of their horses. Tea made from the flowers and leaves acts as a sedative and is a good inflammatory for stomach and esophageal nauseas, vomiting, and hangovers. The pods of the plant are used for conjunctivitis. The root is thick and mucilaginous as a tea and is good for sore throats and mouth inflammations as well as dry, raspy coughing.

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Plant Succession in the Rocky Mountain Trench: Influence of Historical Factors

"Today's ecosystems are the integration of all past and present inputs and processes that have influenced them."

By Brian M. Wikeem and Timothy J. Ross

There are approximately 250,000 ha of land in the Ponderosa Pine and Interior Douglas-fir biogeoclimatic zones in the Rocky Mountain Trench and adjoining side-valleys between the U.S. border and Golden, British Columbia (BC) (Figure 1).

Figure 1. The Rocky Mountain Trench from Golden to the Tobacco Plains in southeastern British Columbia.

Under climax conditions, the Ponderosa Pine Zone is dominated by ponderosa pine with an understory of rough fescue, Idaho fescue, bluebunch wheatgrass and a variety of forbs and shrubs. In the drier parts of the Interior Douglas-fir Zone, Douglas-fir is the principal tree with an understory of bluebunch wheatgrass, rough fescue, and Richardson's needlegrass combined with forbs such as western yarrow and timber milkvetch. In wetter parts of the zone, pinegrass is the dominant grass at higher stages of succession.

These dry forests provide habitat and forage for whitetail deer, mule deer, elk, and cattle. Numerous sources of disturbance have modified both these forest types historically, which have had significant effects on plant communities and the forage resource in the Rocky Mountain Trench.

Pre-European Fire

Historically, lightning-caused fire has been prevalent in the Ponderosa Pine and Interior Douglas-fir Zones and is regarded as a natural part of the environment. Low-intensity ground fires, returning at 5–50 year intervals, maintained ponderosa pine and Douglas-fir forests in the Trench as a mosaic of grassland, open forest, and dense forest.

George Simpson of the Hudson Bay Company arrived in the Trench in the summer of 1841 and traversed the same area that David Thompson had explored about 30 years earlier. While Thompson commented on the fine timber in the area, Simpson found "the country was on fire, the sun shone like a blood red dice in the sky and every horse raised such a cloud of dust as almost to conceal itself from view". The area he described was north and south of present day Fairmont Hot Springs.

Aboriginal fires also played a role in shaping and maintaining plant communities in the Trench historically. Evidence from the Flathead region of the Pacific Northwest U.S. indicates that the introduction of horses considerably intensified native burning, especially as horse herds became larger. Although the Kootenay Indians respected fire, early narratives suggest that they deliberately set forest fires to create horse pasture.

Historical Horses

The exact date that horses arrived in the East Kootenay is unknown. Horses, however, are believed to have been

Common and Scientific Names of Plants and Animals

Grasses	
Bluebunch wheatgrass	*Agropyron spicatum*
Idaho fescue	*Festuca idahoensis*
Pinegrass	*Calamagrostis rubescens*
Prairie Junegrass	*Koeleria cristata*
Rough fescue	*Festuca scabrella*
Richardson's needlegrass	*Stipa richardsonii*
Forbs	
Timber milkvetch	*Astragalus miser*
Western yarrow	*Achillea millefolium*
Trees and Shrubs	
Bearberry	*Arctostaphyalus uva-ursa*
Douglas-fir	*Pseudotsuga menziesii*
Ponderosa pine	*Pinus ponderosa*
Animal Species	
Bison	*Bison bison*
Cattle	*Bos taurus*
Elk	*Cervus elephus*
Horse	*Equus caballus*
Mule deer	*Odocoileus hemionus*
Whitetail deer	*Odocoileus virginianus*

Plant nomenclature follows Hitchcock and Cronquist (1973).

present along the western slope of the Rocky Mountains as early as 1680 and introduced to the Flatheads and Nez Perce between 1720 and 1730.

The Kootenay Indians definitely had horses by 1792. Peter Fidler, Hudson Bay Company surveyor, met Kootenays in the foothills of Alberta in 1792 who were trading horses with the Peigan Indians of the Great Plains. Moreover, David Thompson reported seeing herds of "wild" horses, trading the Kootenay Indians for horses, eating horsemeat, and chasing feral horses throughout the Trench during his explorations from 1807 to 1811.

The size of horse populations in the Trench from 1800 to 1900 is impossible to discern. James Hector of the Palliser Expedition, however, encountered Kootenays near Columbia Lake in 1859. "They had a band of about 500 horses, many of them being beautiful animals and as wild as deer". By the 1880s, the natives around Joseph's Prairie (present day Cranbrook) had about 2,000 horses and 500 head of cattle. Additionally, an early Indian agent on the Tobacco Plains reported 5,000 horses grazing there that belonged to natives on both sides of the International Boundary Line. Although horses greatly enhanced aboriginal mobility, it is difficult to determine the extent and magnitude of ecological change attributable to horses in the Trench but historical numbers suggest they could have had an early impact.

Discovery of Gold

Gold was discovered at Wild Horse Creek near Cranbrook in 1863 and hundreds of miners headed for this new El Dorado. By 1865, between 5,000 and 8,000 men were mining in the district. Although no beef was available, about 100 sheep were imported in 1865 to feed the miners. Cattle were driven from Salt Lake City, Utah; and Lewiston, Idaho to Wild Horse Creek during 1866-1867, while other cattle were brought in from Washington State. In addition, some of the early cattle drives came from Argenta on Kootenay Lake to Windermere over the "Beef Trail" through Earl Gray Pass.

Mining interests in the Cariboo began to dwindle after 1865 and attention focused on the mines in the Kootenays. A new market for Okanagan and Similkameen beef had to be found after the collapse of the Cariboo mining boom and cattle were driven over the old Dewdney Trail to the new gold fields in the East Kootenay. In addition to cattle drives, all merchandise was packed into the area by mule and horse trains that were pastured on East Kootenay ranges during, and between, trips.

Domestic Livestock

Immigrants under the leadership of James Sinclair brought in the first cattle in the Trench from the Red River Settlement at Fort Garry in 1841. They brought horses, cattle and dogs through Sinclair Pass (present day Radium Hot Springs) descending the Cross and Kootenay rivers to Columbia Lake. A second group from Fort Garry brought cattle and horses in 1854. When they arrived at McGillivary's Portage (present day Canal Flats) they found "plenty of fine bunch grass for their stock" and encountered Kootenay Indians with whom they traded some of their cattle for horses. James Hector reported meeting Kootenays south of Columbia Lake in 1859. In addition to about 500 horses, they also had 10 or 12 cows.

Although the first land acquisitions occurred as early as 1867, early settlement in the Trench did not begin until the 1880s. During this period, numerous ranches were established from Invermere to the U.S. border. Typically, ranches ran between 50 and 125 cattle but several ranchers had herds ranging from 200 to 300 head. James McKay, an early rancher near Invermere, had several hundred cattle by the late 1880s and over 1,000 cattle in the early 1900s.

Not all ranches ran cattle, at least in the beginning. For example, A.B. Fenwick purchased land in 1886 on the Kootenay River bottomlands between Fort Steele and Bull River. For many years, however, Fenwick used the land more for grazing his packhorses and harvesting native grass than for farming and raising cattle. The number of pack animals living in the Trench at that time is unknown but they were another grazing impact on local rangeland until the railroad was completed in the early 1900s.

Grasslands in the East Kootenay have been grazed by domestic livestock since the Kootenay Indians fed their horses on native grasslands in the area. From the late 1800s to the mid-1940s, cattle, and other livestock numbers, increased in the area. Indeed, sheep were brought to the Trench from California to Bummers Flats in about 1910. Between 1945 and 1954 beef cattle numbers averaged approximately 9,000. Horses still remain a factor on East Kootenay rangelands, albeit a minor aspect, as most ranchers and guide outfitters have horses for their operations.

Railway Building and Fires

More horses and cattle were moved into the East Kootenay between 1897 and 1915 for the Canadian Pacific Railroad (CPR) construction through the Crows Nest Pass and north to Windermere. During this era, more than 5,000 men worked on the railroad and about 1,000 teams of horses were employed. Shops in Cranbrook, Fernie, and Moyie handled from 300 to 400 cattle a month, mostly herded from Alberta, to feed the railway crews.

The Kootenay Central Branch of the CPR reached Bull River by 1911. By then, over 200,000 railway ties had been milled for construction of the line further north. Although Bull River was the center of operations for tie production, logging extended further north to Skookumchuck Prairie and beyond, and logs were boomed down the Kootenay River for processing at the Bull River mill.

Both the direct effects of logging, and the subsequent fires that followed, contributed to opening up large areas of range for cattle, horses, and wildlife throughout the southern part of the Trench. Numerous fires occurred between 1914 and 1931 as the litter of limbs, treetops and broadaxe chips dried and became extremely flammable. Some fires, like the fire of 1914, started in the logging camps but steam locomotives throwing out sparks along the railway ignited others. Many of these fires consumed large volumes of standing timber and covered extensive areas of the landscape. The last large fire in 1931, for example, burned about 81,000 ha (200,000 ac) of forestland alone.

Wildlife

Ungulate populations have probably been variable before, and after, Europeans entered the Rocky Mountain Trench. Early accounts by David Thompson and the Palliser Expedition indicate that elk and deer were not numerous during the period of exploration and both parties complained of food shortages to the point of near starvation. Additionally, the Kootenay made up to three trips annually to Alberta for buffalo meat because big game was scarce in the Trench, even before Europeans were present.

Elk may have been historically abundant in the Trench. In 1859, James Hector reported "Elk or wapiti must at one time have been very numerous in this district, as we saw a great many antlers lying on the ground, and sometimes the Indians had piled them in heaps of 50 or 60 together but the open nature of the woods, and the limited range, excepting up and down the valley, must have made them an easy prey to the Indians as soon as they acquired firearms." Conversely, he also commented, "We have not seen a single track of an elk yet in the valley but only a few of the smaller deer. " Walter Moberly, surveyor for the Government of Canada, also reported seeing large piles of elk antlers scattered over the country near Invermere in 1866.

Severe winters dramatically reduced elk populations throughout British Columbia in the mid- and late-1800s, including the East Kootenay. Native legend indicates that the winter of 1865-66 was very cold with a snowfall of 3.7 m (12 ft), which severely restricted elk mobility and they died by the hundreds. A series of severe winters during the 1880s further reduced elk populations, but from about 1900 to the 1950s, elk and deer populations began to increase. Part of this expansion likely resulted from the abundance of forage and new habitat created by the fires from 1914 to 1931.

Mule deer and possibly whitetail deer were apparently more abundant than elk when Europeans first arrived in the Trench. David Thompson mentions killing deer for meat from 1807 to 1811 more often than elk but he still complained that game was scarce. Although mule deer and whitetail deer were plentiful from the 1860s to the 1960s, populations of both species increased dramatically during the 1940s and 1950s. Undoubtedly, these increases contributed to further pressures on the range resource.

Feral Horses

Feral horses have been in the Trench since at least 1800 and probably earlier. In 1809, David Thompson reported that he "spent time chasing after some of the feral horses that grazed the foothills above the lakes" [likely Lake Windermere and Columbia Lake]. According to the Kootenays, these horses once belonged to members of their tribe who died from smallpox in the 1780s.

During the 1940s and 1950s powered farm and logging equipment replaced most of the horses used by these industries and many horses were turned loose on the range. At the same time, ranchers were increasing their cattle herds, taking advantage of the abundant range created by fires. By then, it was apparent that range condition was deteriorating and the Forest Service decided to remove about 5,000 feral horses from the range. Roundup corrals were constructed and some horses were trapped and sold. Others were too wild and were shot on the range. By the early 1950s, most of the feral horses were gone and their place taken by domestic cattle and elk.

Genesis of a New Paradigm

From 1846 to the early 1920s almost all grazing in British Columbia was confined to the grasslands although some of the low-elevation open forests had been grazed by the 1890s. Throughout this period, grazing was unregulated and by the turn of the century most of the grasslands were overgrazed while 90% of the forested summer range remained unused. Although the "Grazing Act", which became law in March 1919, provided a legislative framework for administrative control over the range, it would be some time later before scientific range management principles were applied.

In 1930, concern over the depleted condition of the interior rangelands led to the Grazing Committee Enquiry. The committee recommended that the Forest Branch should have more authority to deal with range issues and a need for range research was also identified. By 1935 a Substation of the Dominion Range Experiment Station at Manyberries, Alberta was established at Kamloops. Several range surveys were also conducted between 1930 and the mid-1950s, which confirmed that most of the grasslands were depleted. Among these, a soil survey in the East Kootenay in 1956, declared that most of the grasslands in the Trench were overgrazed and recognized the need for better management. The removal of feral horses provided an opportunity to manage the range properly, but competition between cattle and wildlife was becoming a problem.

From 1945 to 1956 the Grazing Division slowly grew in size and geographic distribution and by 1956 there were 8 professionals located at Kamloops, Williams Lake, Prince George, and Nelson. Unfortunately, progress was slow, and in 1956, the Sloan Report on the Forest Resources of British Columbia concluded that district staffing levels were still insufficient to administer both timber and grazing problems on Crown land. Additionally, Mr. Wilf Pendray, Commissioner of Grazing, concluded that an up-to-date inventory was fundamental to proper range management, and that each range unit should have a complete, easily-applied management plan. These events heralded the beginning of a modern era of range management in the East Kootenay, and British Columbia, based upon scientific principles, and range conditions began to improve on selected grasslands.

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What can long-term range reference areas tell us?

Here's an analysis of fifty years of plant succession in the Rocky Mountain Trench

By Timothy J. Ross and Brian M. Wikeem

Grassland and forest range provide forage and habitat for cattle, horses, elk, whitetail deer, and mule deer in the Rocky Mountain Trench of southeastern British Columbia (BC). Historically, these rangelands evolved and were modified by a number of factors including climate, soils, fire, forest encroachment, logging, land alienation, and grazing by domestic livestock and wildlife.

A series of wildlife, soil, and range surveys between 1953 and 1956 concluded that grasslands in the Trench were overgrazed and carrying capacity for wildlife and livestock was below its capacity. As a result, conflicts emerged during the 1960s and 1970s concerning dietary overlap and forage allocation among cattle, elk, whitetail deer, and mule deer.

In addition to historical influences, three important, and interacting factors, have dominated resource management in the East Kootenay since the 1960s: forest ingrowth, potential competition between native ungulates and domestic livestock, and deterioration of range condition.

Forest Ingrowth

Forest encroachment onto grassland was recognized as a problem of provincial scope as early as 1918. In 1950, Dr. Ed Tisdale reported that "invasion of open or lightly timbered ranges by forest growth ....is a significant problem affecting forest range carrying capacity...[and] the invasion of open or semi-open areas by tree growth, with consequent reductions in grazing capacity and usefulness as early range is a common phenomenon over much of the interior....it seems to be mainly a natural return of trees to areas deforested in the past by repeated fires."

Tisdale's comments appear prophetic in that forest succession in the Trench has been inexorable since the fires from 1914-1931 and open range for wild and domestic herbivores has declined dramatically.

Wildlife/Livestock Interactions

Coordinated Resource Management Planning (CRMP) was introduced into BC and the East Kootenay in 1975, primarily to resolve cattle-elk conflicts. Indeed, the need for a consultative process to allocate forage, and to ensure the long-term sustainability of the range resource, was a central issue in the East Kootenay.

Coordinated Resource Management improved forage availability, forage quality, and productivity for wild ungulates and domestic livestock in the East Kootenay. Between 1982 and 1991, however, the elk population in the Trench increased from nearly 10,000 to more than 25,000 animals while cattle AUMs remained relatively constant.

In 1982, Dr. M. Pitt reported that many resource managers believed increased grazing pressure, combined with forest ingrowth and land alienation, continued to produce downward trends in range condition. Wildlife supporters argued that high cattle stocking rates, and improper seasons of use, had altered species composition in plant communities and reduced forage production capability.

Conversely, ranching advocates maintained that grazing programs implemented under CRMP were responsible for the initial improvements in range productivity, and that overgrazing likely resulted from wildlife populations using low-elevation rangelands when cattle were not present.

The East Kootenay Trench Agriculture/Wildlife Committee was formed in 1990 to address resource management issues in the Trench through improved inventory and monitoring of the wildlife and range resources, better public education, and through habitat and range enhancement. Among the many projects proposed, it was generally agreed that re-sampling the historical range reference exclosure on Skookumchuck Prairie could provide valuable information regarding range recovery in the Trench.

Past, Present & Future Natural Communities

The Skookumchuck exclosure is located in the Rocky Mountain Trench about 60 km north of Cranbrook, B.C. The area is an important winter range for deer and elk, and has been grazed by livestock for over 100 years. Skookumchuck Prairie occurs in the Ponderosa Pine biogeoclimatic zone at about 780 m elevation and soils in the area are classified as Orthic Eutric Brunisols (Typic

Common and Scientific Names from Skookumchuck Prairie Exclosure

Common Name	Scientific Name
Grasses	
Bluebunch wheatgrass	*Agropyron spicatum*
Idaho fescue	*Festuca idahoensis*
Kentucky bluegrass	*Poa pratensis*
Needle-and-thread	*Stipa comata*
Pinegrass	*Calamagrostis rubescens*
Prairie Junegrass	*Koeleria cristata*
Rough fescue	*Festuca scabrella*
Sandberg's bluegrass	*Poa secunda*
Forbs	
Brown-eyed susan	*Gaillardia aristata*
Dandelion	*Taraxicum officinale*
Death camas	*Zygadenus venenosus*
Dune goldenrod	*Solidago spathulata*
Dwarf mountain fleabane	*Erigeron compositus*
Early blue violet	*Viola adunca*
Fairy candelabra	*Androsace septentrionalis*
Goatsbeard	*Tragopogon pratense*
Hairy goldaster	*Crysopsis villosa*
Holboell's rockcress	*Arabis holboellii*
Large-fruited lomatium	*Lomatium macrocarpum*
Low pussytoes	*Antennaria dimorpha*
Nine-leaf lomatium	*Lomatium triternatum*
Nodding onion	*Allium cernuum*
Old man's whiskers	*Geum triflorum*
Pacific anemone	*Anemone patens*
Prairie groundsel	*Senecio canus*
Rosy pussytoes	*Antennaria microphylla*
Sagebrush mariposa lily	*Calochortus macrocarpus*
Shaggy fleabane	*Erigeron pumilus*
Shooting star	*Dodecatheon pauciflorum*
Slender hawksbeard	*Crepis atrabarba*
Spiny phlox	*Phlox caespitosa*
Sulphur buckwheat	*Eriogonum umbellatum*
Sulphur cinquefoil	*Potentilla recta*
Thin-leaved owlclover	*Orthocarpus tenufolium*
Timber milkvetch	*Astragalus miser*
Western yarrow	*Achillea millefolium*
Wyeth buckwheat	*Eriogonum heracleoides*
Yellow buckwheat	*Eriogonum flavum*
Yellow owlclover	*Orthocarpus luteus*
Trees and Shrubs	
Bearberry	*Arctostaphyalus uva-ursa*
Douglas-fir	*Pseudotsuga menziesii*
Ponderosa pine	*Pinus ponderosa*

Eutrochrept) or Orthic Dark Brown Chernozems (Typic Boroll). Normal mean annual precipitation is about 370 mm and August (32.2° C) and January (–26.3° C) are the hottest and coldest months, respectively.

Built in 1951, Skookumchuck exclosure is the oldest maintained reference area in the Trench. It was established to compare long-term floristic changes resulting from the exclusion of elk, deer, and cattle with an adjacent grazed area. No baseline data were collected in 1951, but in 1972, Dr. A. McLean described the original plant community as being dominated by Sandberg's bluegrass, prairie Junegrass, needle-and-thread and low pussytoes. The first cover and frequency data were collected in 1960 and at approximately ten-year intervals thereafter.

Successional Patterns In The Grazed Area

In 1960 very little had changed on the site since McLean's first observations in 1951. Grass cover was nearly 55% while forbs provided about 35% cover in the grazed area (Table 1). Sandberg's bluegrass, prairie Junegrass, bluebunch wheatgrass, and needle-and-thread were still the dominant grasses, and low pussytoes was the dominant forb comprising >25% canopy cover. All other forbs contributed <2% cover and no trees or shrubs were present on the site (Table 1). Dominant species for the Ponderosa Pine zone, such as ponderosa pine and Idaho fescue, were absent in the grazed area while rough fescue accounted for only 6% cover.

Although several plant species varied in cover and frequency among sampling periods, the composition of the grazed plant community in 1994 was strikingly similar to the original communities described in 1951 and sampled in 1960. Bluebunch wheatgrass and prairie Junegrass initially increased in cover and frequency peaking in 1970 and 1982. By 1994, however, cover and frequency of both species had declined to nearly the same values as in 1960 (Table 1).

Sandberg's bluegrass, which was the dominant grass in 1960, declined to <1% cover and 2% frequency in 1994. In contrast, needle-and-thread increased from slightly >4% cover in 1960 to become the dominant grass (>25% cover) in 1994 replacing Sandberg's bluegrass (Table 1). Rough fescue, Idaho fescue, and ponderosa pine were all recorded on the grazed area between 1982 and 1991 but they remained minor components of the community after more than 50 years.

Successional Patterns Inside The Exclosure

In contrast to the grazed area, species composition changed in almost every sampling interval in the exclosure (Table 2). In 1972, Dr. A. McLean and Dr. E. Tisdale concluded that the plant community had advanced from poor to fair condition between 1951 and 1960, and to excellent condition by 1970. They also reported improvements in the grazed area, which had received heavy spring and fall livestock grazing for many years. In 1950, the grazing management was altered to reduce the stocking rate and delay spring turnout.

Successional trends inside the exclosure followed patterns that would be expected with protection from grazing. Prairie Junegrass, Sandberg's bluegrass and needle-and-thread, which were co-dominants with bluebunch wheatgrass in 1960, all declined over the 50 years (Table 2).

Bluebunch wheatgrass followed a similar, but less pronounced, trend. Although cover nearly doubled from 1960 to 1970, it had declined to about 33% of its original value by 1994 (Table 2). In addition, cover and frequency of bluebunch wheatgrass was similar to the grazed area in 1994 (Table 1, 2) suggesting that the presence or absence of grazing was not the only factor af-

Table 1. Percent cover and frequency of plant species at Skookumchuck Prairie exclosure, grazed area, 1960–1994.

	1960		1970		1982		1991		1994	
Species	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**
Grasses										
Bluebunch wheatgrass	6.8	26.0	13.0	62.0	14.0	54.0	7.6	44.0	6.4	36.0
Idaho fescue	0.0	0.0	0.0	0.0	0.0	0.0	0.5	20.0	0.1	2.0
Rough fescue	0.0	0.0	T	2.0	T	2.0	0.9	8.0	1.0	4.0
Prairie Junegrass	16.6	90.0	20.0	94.0	5.0	66.0	0.9	24.0	14.0	92.0
Kentucky bluegrass	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.9	6.0
Sandberg's bluegrass	26.2	98.0	10.0	94.0	0.0	0.0	0.4	0.6	0.1	2.0
Needle-and-thread	4.2	68.0	34.0	98.0	47.0	100.0	13.9	100.0	25.8	96.0
Total Grasses	53.8		77.0		66.0		24.4		48.3	
Forbs										
Brown-eyed susan	0.0	0.0	0.0	0.0	1.0	16.0	0.0	0.0	1.4	16.0
Dandelion	0.0	0.0	1.0	20.0	T	4.0	0.0	0.0	0.3	12.0
Death camas	0.0	0.0	0.0	0.0	T	2.0	0.2	8.0	0.2	8.0
Dune goldenrod	1.2	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goatsbeard	0.0	0.0	T	2.0	T	4.0	0.0	0.0	0.6	6.0
Hairy goldaster	0.0	0.0	0.0	0.0	T	2.0	0.0	0.0	0.1	2.0
Holboell's rockcress	1.3	14.0	T	14.0	T	18.0	0.0	0.0	0.3	12.0
Large-fruited lomatium	0.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Low pussytoes	26.4	98.0	8.0	58.0	T	2.0	0.6	16.0	0.8	4.0
Nodding onion	0.1	2.0	0.0	0.0	T	2.0	0.0	0.0	0.1	2.0
Pacific anemone	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0	0.0	0.0
Prairie groundsel	0.0	0.0	0.0	0.0	2.0	34.0	1.9	44.0	6.9	60.0
Rosy pussytoes	1.3	6.0	9.0	34.0	4.0	58.0	3.0	50.0	4.6	54.0
Sagebrush mariposa lily	0.0	0.0	0.0	0.0	T	2.0	0.0	0.0	0.1	2.0
Shaggy fleabane	1.2	30.0	4.0	54.0	4.0	90.0	0.2	8.0	1.9	24.0
Shooting star	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0
Spiny phlox	1.1	14.0	3.0	22.0	2.0	40.0	3.1	46.0	6.7	50.0
Sulphur buckwheat	1.4	38.0	2.0	22.0	T	2.0	0.1	2.0	0.3	2.0
Sulphur cinquefoil	0.0	0.0	0.0	0.0	0.0	0.0	1.3	22.0	2.0	30.0
Thin-leaved owlclover	0.0	0.0	0.0	0.0	T	2.0	0.0	0.0	0.0	0.0
Timber milkvetch	0.0	0.0	0.0	0.0	1.0	18.0	0.6	4.0	1.6	16.0
Western yarrow	0.4	6.0	0.0	0.0	2.0	14.0	0.1	2.0	2.2	18.0
Yellow owlclover	0.0	0.0	0.0	0.0	0.0	0.0	1.2	48.0	0.0	0.0
Other Forbs	1.6		1.0		1.0		1.5		3.0	
Total Forbs	36.3		28.0		17.0		13.9		33.2	
Trees and Shrubs										
Ponderosa pine	0.0	0.0	0.0	0.0	T	2.0	0.1	2.0	0.9	6.0
Total Trees and Shrubs	0.0		0.0		T		0.1		0.9	

fecting its position in the plant community.

Although the site was considered to be in excellent range condition in 1982, further changes have occurred in the plant community up to 1994. Bluebunch wheatgrass, for example, has been largely replaced by rough fescue and Idaho fescue between 1982 and 1994 (Table 2). Indeed, Idaho fescue has increased to 25% cover over this period (Table 2). In contrast, rough fescue cover has decreased and it appears likely that eventually it will be replaced by Idaho fescue.

The number of forbs present in the exclosure increased from 7 species in 1960 to 19 in 1994. Similarly, forb cover nearly tripled over the same time (Table 2). Low pussytoes, which dominated forb cover in 1960, declined to <1% cover by 1994. Meanwhile, rosy pussytoes, spiny phlox, and western yarrow increased to provide over 20% cover collectively. All other forbs contributed <3% cover in 1994 (Table 2). Further protection from grazing is unlikely to result in further forb cover in the exclosure.

Other than ponderosa pine, shrubs and trees were a minor component of the flora inside the exclosure, even after 50 years of protection from grazing. In fact, bearberry was the only shrub to immigrate into the exclosure up to 1970 but it disappeared from the site by 1994 (Table 2).

Recruitment of ponderosa pine seedlings occurred slowly inside the exclosure even though a few scattered trees were present in 1951. This species was not present in 1982 and only provided 2.5% cover 40 years after the exclosure was constructed. By 1994 ponderosa pine cover had quintupled from 1991 and further changes in the understory vegetation can be expected (Table 2). The absence of fire in the region likely contributed to the establishment and survival of ponderosa pine although increased litter cover provides slightly more mesic conditions for seeds to germinate and establish.

In 1968, Dr. A McLean and Mr. L. Marchand concluded that bluebunch wheatgrass was the dominant understory species with rough fescue and Idaho fescue as

Table 2. Percent cover and frequency of plant species at Skookumchuck Prairie exclosure, ungrazed area, 1960-1994.

	1960		1970		1982		1991		1994	
Species	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**
Grasses										
Bluebunch wheatgrass	24.7	72.0	55.0	96.0	12.7	68.0	5.4	52.0	8.1	42.0
Idaho fescue	0.0	0.0	0.0	0.0	1.0	18.0	7.9	80.0	25.0	84.0
Rough fescue	6.0	36.0	20.0	48.0	58.8	98.0	23.8	94.0	32.3	80.0
Prairie Junegrass	23.4	94.0	9.0	72.0	4.2	58.0	1.0	20.0	4.7	32.0
Sandberg's bluegrass	17.5	100.0	5.0	50.0	0.1	4.0	0.3	12.0	0.1	4.0
Needle-and-thread	16.7	74.0	1.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Grasses	88.3		90.0		76.8		38.4		70.2	
Forbs										
Fairy candelabra	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0	0.6	6.0
Brown-eyed susan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	4.0
Dandelion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	28.0
Death camas	0.0	0.0	0.0	0.0	0.0	0.0	0.1	4.0	2.0	38.0
Dwarf mountain fleabane	0.0	0.0	0.0	0.0	T	2.0	0.0	0.0	0.0	0.0
Early blue violet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0
Goatsbeard	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	4.0
Holboell's rockcress	0.3	14.0	0.0	0.0	0.2	8.0	0.0	0.0	0.1	2.0
Large-fruited lomatium	0.3	4.0	T	2.0	0.4	4.0	0.0	0.0	0.0	0.0
Low pussytoes	10.5	94.0	T	2.0	T	2.0	0.0	0.0	0.6	6.0
Nine-leaf lomatium	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0	0.1	4.0
Nodding onion	0.6	4.0	0.0	0.0	T	2.0	0.0	0.0	0.3	12.0
Old man's whiskers	0.0	0.0	0.0	0.0	T	2.0	0.0	0.0	0.0	0.0
Pacific anemone	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0	0.6	6.0
Prairie groundsel	0.0	0.0	0.0	0.0	3.4	40.0	1.1	34.0	2.5	40.0
Rosy pussytoes	0.0	0.0	6.0	30.0	7.6	54.0	2.6	34.0	8.3	48.0
Sagebrush mariposa lily	0.0	0.0	0.0	0.0	T	2.0	0.1	2.0	0.6	22.0
Shaggy fleabane	0.7	8.0	0.0	0.0	0.2	6.0	0.0	0.0	0.0	0.0
Slender hawksbeard	0.0	0.0	0.0	0.0	T	8.0	0.0	0.0	0.9	8.0
Spiny phlox	0.0	0.0	11.0	60.0	10.5	62.0	4.8	54.0	7.6	48.0
Sulphur buckwheat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.0
Thin-leaved owlclover	0.0	0.0	0.0	0.0	0.1	4.0	0.0	0.0	0.0	0.0
Timber milkvetch	0.0	0.0	0.0	0.0	1.9	26.0	0.2	0.8	2.2	18.0
Western yarrow	0.1	2.0	0.0	0.0	2.9	46.0	0.6	22.0	4.3	34.0
Wyeth buckwheat	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0	0.0	0.0
Yellow buckwheat	0.8	12.0	1.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0
Yellow owlclover	0.0	0.0	0.0	0.0	0.0	0.0	0.5	10.0	0.0	0.0
Other Forbs	2.1		1.0		0.9		1.1		6.7	
Total Forbs	15.4		19.0		28.1		11.5		39.2	
Trees and Shrubs										
Bearberry	0.0	0.0	T	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Ponderosa pine	0.0	0.0	0.0	0.0	0.0	0.0	2.5	14.0	12.9	32.0
Total Trees/Shrubs	0.0		T		0.0		2.5		12.9	

abundant associates in "climax" stands of Ponderosa pine. An additional 30 years of complete protection from all ungulate grazing and fire, however, has resulted in a plant community quite different than the conventional thinking of the 1970s. These changes underline the value of exclosures in demonstrating successional patterns on a site-specific basis, albeit under conditions that the exclosure has imposed on the plant community.

The existing plant community inside the Skookumchuck exclosure does not necessarily imply the most productive conditions, or the optimum plant community that management should strive for throughout the Ponderosa Pine Zone in the Trench. Changes in minimally disturbed habitats, however, should challenge our thinking with respect to successional pathways and the potential implications for management.

What Can Photographs Tell Us?

Considerable differences are apparent between the 1951 and 2001 photographs of plant communities in the exclosure. Changes in the plant community are illustrated by the dominance of low growing grasses and forbs in the 1951 photos, which have been largely replaced with rough fescue and Idaho fescue in 2001. Note the white rock in the foreground of Figure 1 and Figure 2. It demonstrates that considerably more vegetation and litter is present inside the exclosure in 2001 compared to 1951.

Ponderosa pine that occupied the site as pole-sized stems in 1951 are now mature trees (Figure 3, 4) and recruitment is clearly visible by comparing the 1951 and 2001 photos (Figure 1 to 4). Ponderosa pine appears to be acquiring dominance in the exclosure and it is also encroaching on the adjacent grazed area.

A repeat air photo study that was conducted in 1998

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Figure 1. ***Skookumchuck Exclosure 1951. Looking east along the north fence.***

confirmed that the conifer recruitment patterns observed in the exclosure are occurring at a landscape level in the Trench. Indeed, grassland and open forest have decreased by nearly 50% between 1958 and 1994. If this rate of decline is applied to the entire Ponderosa Pine and Interior Douglas-fir biogeoclimatic zones in the Trench, nearly 1500 ha of grassland and open forest could be lost annually. Consequently, ungulates will be confined to the remaining open areas, which ultimately will result in less forage for wildlife and domestic livestock, and deterioration in range condition.

Implications For Management

Disturbance patterns in plant communities in the Rocky Mountain Trench have been complex over the long- and short-term history of the area. While certain disturbance patterns such as feral horses, pack trains, and lightening-caused fire have been removed or suppressed, a different set of influences now prevail on these communities. Presently, the most important influences are fire suppression, and the impacts of wildlife and cattle grazing. Interpretation of present grazing effects, however, needs to consider all factors that influence vegetation change including the residual effects of historical disturbances.

Numerous approaches for assessing range condition and plant succession in grazed communities have been developed over the last 50–60 years. Range condition, as described by E.J. Dyksterhuis in 1949, evaluates the effects of a single herbivore on plant community succes-

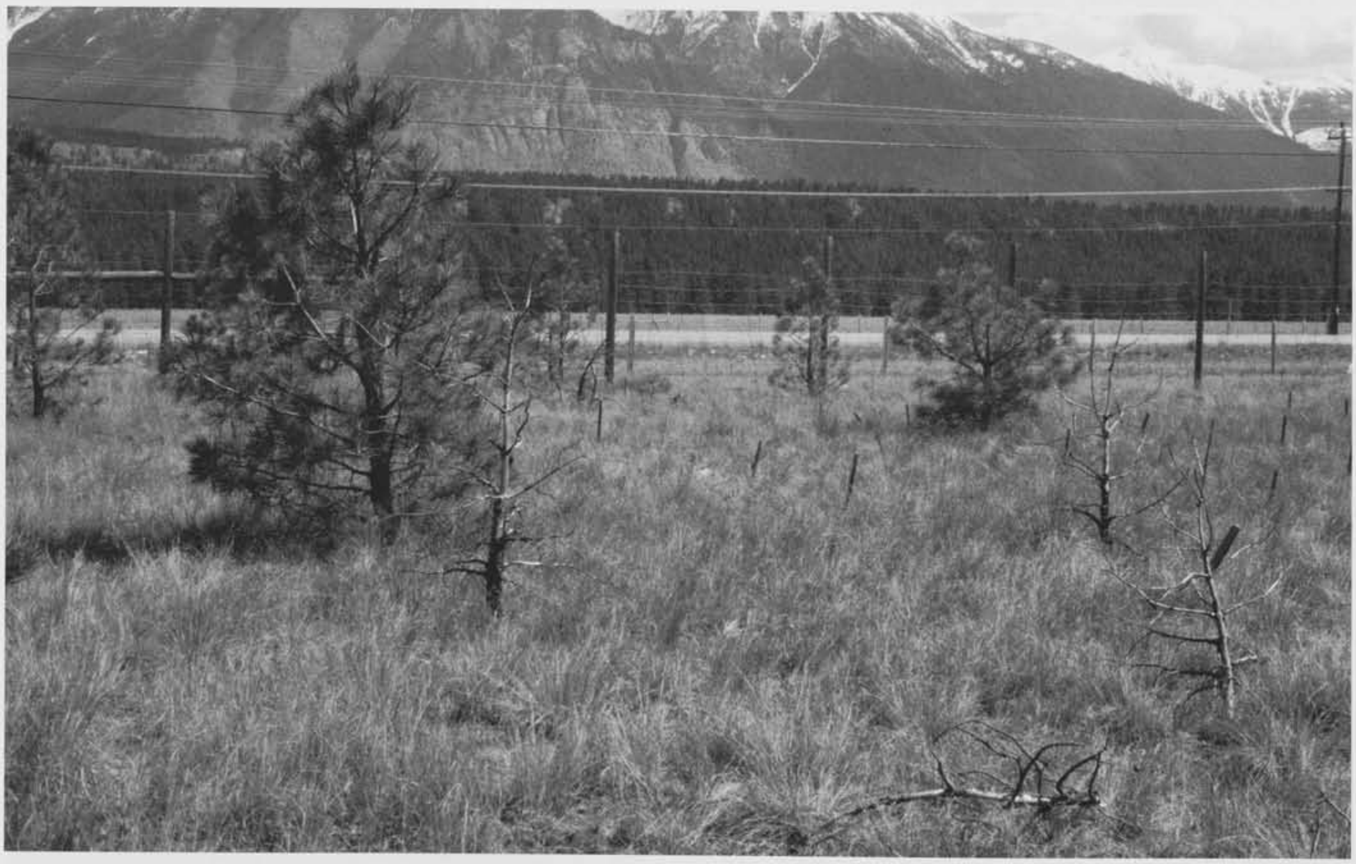

Figure 2. ***Skookumchuck Exclosure 2001. Looking east along the north fence.***

Figure 3. *Skookumchuck Exclosure 1951. Looking northeast from the southwest corner.*

sion resulting from variations in stocking levels, season of grazing, frequency of use, and intensity of defoliation on key species. This approach has limitations in interpreting the effects of multiple grazers on the same plant community, especially when wildlife populations and distribution patterns vary among years.

Deer, elk, and cattle often graze the same range pasture together, or sequentially throughout the year in the East Kootenay. Even though there is spatial overlap among the three ungulates, only about 12 forage species are eaten in common. Moreover, the species that are common in deer, elk and cattle diets are often grazed in different proportions, and at different times of the year. Consequently, the impacts of multiple grazers on the plant community will be different than for a single herbivore.

The "range condition" model may also have limited application on forested sites. For example, Dr. F. Hall stated in 1978 "Traditional range management concepts do not apply well to forested ecosystems because livestock is not the only factor affecting density and composition of vegetation". Higher successional stages on forest range do not necessarily result in higher range condition, especially as forest canopies close and plant communities respond to changes in light and soil moisture regimes.

Current ecological theories such as multiple steady states, discontinuous and irreversible transitions, and non-equilibrium communities appear relevant to the East Kootenay. The concept of multiple steady states is likely the most useful for predicting the effects of cattle grazing, wildlife grazing, and the impacts of fire or fire suppression.

Figure 4. *Skookumchuck Exclosure 2001. Looking northeast from the southwest corner.*

While various models have been proposed, the desired plant community (DPC) approach, developed by the Society for Range Management Task Group in 1995, provides a practical format for assessing vegetation goals and range trend relevant to management objectives. The DPC is based primarily on human values (including economic and social factors) rather than a concept of "climax" conditions that may have occurred in the past and are not achievable now. Despite the human focus, this approach does not exclude conservation issues, sustainability of resources, and ecological values. Indeed, these considerations should be the foundation for defining desired plant communities.

Regardless of the concept used, ecological principles and processes are of paramount importance in defining desired plant communities, as are current social values and management priorities. Integrated resource management recognizes different sites have different capabilities and multiple-use does not need to occur on every site. Management of public land, however, must be a blend of optimizing social values for products from the land base with environmental responsibility to maintain all values for future generations.

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Forage allocation: Science or politics?

Both must be considered in managing for common use in the East Kootenay, British Columbia.

By Brian M. Wikeem and Timothy J. Ross

Cattle, mule deer, whitetail deer, and elk have shared grassland and open forest range in the Rocky Mountain Trench of southeastern British Columbia (BC) (Fig. 1) for more than a century, and conflicts about overlapping ungulate populations and presumed competition have persisted for over 40 years.

Fig. 1. Rocky Mountain Trench from Radium Hot Springs to the Tobacco Plains in southeastern British Columbia.

While the direct impacts of large ungulates dominate the debate, other factors such as historical grazing and fires, fire suppression, forest encroachment, logging, land alienation, and recreation all have contributed to declining range and wildlife habitat resources in the area.

It was finally recognized that an equitable forage allocation process is necessary to mitigate conflicts. Although inventory and monitoring can tell us how much forage is available, they cannot tell us what is ecologically sustainable and equitable among users.

A Historical Look

Information on pre-European grazing in the Trench is largely anecdotal. Although it is widely contended that large populations of wild ungulates were not present in the inter-mountain regions of the Pacific Northwest, bones collected from two archaeological sites dating from 8000 B.C. to 100 suggest that bison historically occupied the Trench. Other sources suggest that bison may have been extirpated early in the 19th century.

Historically, ungulate populations have been variable in the East Kootenay. Both David Thompson and the Palliser Expedition reported that elk and deer were scarce in the early- and mid-1800s and they complained of food shortages to the point of near starvation.Additionally, the Kootenay Indians, who are indigenous to the Trench, travelled to Alberta for buffalo meat during the 1700s and 1800s because game was scarce.

Elk may have been traditionally abundant but severe winters significantly reduced populations throughout BC in the mid- and late-1800s. Apparently, no elk were west of the Kootenay River until the late-1940s, even though populations of both deer and elk increased dramatically during the 1940s and 1950s.

Horses were another historical factor on East Kootenay rangelands.As early as 1792, explorer Peter Fidler met Kootenay Indians in the Alberta foothills who were trading horses with the Peigan Indians of the Great Plains. Later, David Thompson reported trading the Kootenay for horses in the Trench from 1807 to 1811. By the 1880s, the natives around Joseph's Prairie (present day Cranbrook) had about 2,000 horses and another 5,000 horses were reported grazing at Tobacco Plains, south of Cranbrook, about the same time (Fig. 1).

The first cattle in the Trench came from Fort Garry (Winnipeg) in 1841 and 1854 but early settlement did not begin until the 1880s. During this period, most ranches ran 50–125 cattle, but several ranchers had herds ranging from 200 to 300 head. By 1900, James McKay, who ranched near Windermere, BC, had over 1,000 cattle.

Other disturbances such as logging, mining, hydro development, and recreation also contributed to the present composition of plant communities in recent history, but fire has been a major factor. The Kootenay Indians used fire to create open range for their horses before European settlement.

More recently, numerous large fires were started between 1914 and 1931 in association with early logging and construction of the Canadian Pacific railroad, which created large areas of habitat and abundant forage for livestock and wildlife.

Fire-suppression began in the Trench in the 1920s and, subsequently, forests have become overstocked and stagnant instead of regulating themselves by "self-thinning". Consequently, forest ingrowth and encroachment have resulted in a significant reduction of open range for wildlife and livestock grazing.

Current Wildlife & Cattle Numbers

The elk population increased from about 10,000 to more than 28,000 between 1982 and 1986, and currently the population is nearly 20,000. Wildlife managers concluded in a recent elk management plan that: "Current habitat condition on all potential winter range (gross suitability) is estimated to support 41,400 elk, while the net suitability (minus private land) has the potential to support 24,400 elk".

By contrast, livestock Animal Unit Months (AUMs) in the Trench peaked in 1964 (72,900 AUMs) but by 1980, they were down to 41,200 AUMs, and have remained relatively constant since.

A series of wildlife, soil, and range surveys between 1953 and 1956 concluded that grasslands in the Trench were overgrazed and the carrying capacity for wildlife and livestock was below its capability. Specifically, the following problems and concerns were identified:

- Livestock were being turned-out before range readiness.
- Ranges were overstocked with livestock.
- Bunchgrasses were being overused.
- Bluebunch wheatgrass and rough fescue were becoming scarce on the open range compared to areas protected from grazing.
- Livestock were reluctant to graze forest range and areas remote from water.
- Overuse was particularly high near water.
- Weeds were invading grassland range.

Dr. Michael Pitt from the University of British Columbia reviewed the problems associated with common use of rangelands by wildlife and cattle in the East Kootenay in 1982. He found that most resource managers agreed that combined grazing pressure, forest ingrowth, and land alienation were resulting in declining range condition in parts of the Trench.

Conversely, there was considerable disagreement regarding who was responsible for these trends. Wildlife supporters contended that high cattle stocking rates, and improper seasons of use were responsible for the deterioration in range condition and forage production potential on critical wildlife winter ranges. In contrast, ranching advocates argued that overgrazing resulted from increased wildlife populations using low-elevation rangelands when cattle were not present.

The East Kootenay Trench Agriculture/Wildlife Committee was established in 1990 to address resource management conflicts in the Trench. The Committee's principal objective was to recommend an equitable forage allocation process that protects Crown range resources while recognizing the interests of both the livestock and wildlife industries. A monitoring program was established to provide local biological information to assist in the process.

What Did Monitoring Tell Us?

Monitoring was conducted at four locations in the Trench within 60 km of Cranbrook, BC (Figure 1). Each site is an important winter range for deer and elk, and rotationally grazed by cattle. All four locations also represent significant areas of conflict in the Trench.

Skookumchuck Prairie is predominantly open grassland interspersed with groves of ponderosa pine and trembling aspen. Herbaceous vegetation consists of Kentucky bluegrass, Canada bluegrass, Richardson's needlegrass, rough fescue, Idaho fescue, bluebunch wheatgrass, and a variety of forbs, while bitterbrush and Saskatoon were important browse species on the site.

Vegetation at Premier Ridge and Pickering Hills consists of open grass/shrub land interspersed with groves of Douglas-fir mixed with ponderosa pine and trembling aspen. Both sites are in a low seral stage dominated by Kentucky bluegrass and western needlegrass although rough fescue and bluebunch wheatgrass can be found very infrequently. Again, bitterbrush and Saskatoon were the dominant shrubs on both sites.

Two sites are located at Peckhams Lake on pastures seeded to domestic forages and interspersed with Douglas-fir forest. Although some native species are present, orchardgrass, smooth bromegrass, slender wheatgrass, alfalfa, and alsike clover dominate both sites while shrubs are generally absent.

The climate in the Trench is semi-arid with weather patterns influenced by cold continental air masses from the north in winter, and from heated air masses from the southern interior plateau of the United States (US) in summer. Normal mean annual precipitation is 366 mm.

All four sites were monitored from 1990 to 1993 to address the following components of the forage allocation process:

- Total and seasonal forage standing crop during spring, summer, fall and winter grazing periods.
- Seasonal and annual diets of cattle, deer and elk.
- Seasonal and annual forage use.
- Range condition and trend.

1) Forage Standing Crop – Seasonal and total standing crops were measured to determine the amount of herbaceous matter produced during different grazing periods, and over the entire growing season. Total precipitation equalled 98, 133 and 90% of normal in 1992, 1993, and 1994, respectively. Both seasonal and total standing crop varied at all sites in response to annual precipitation patterns (Table 1).

Table 1. Total standing crop (kg/ha) among five sites in the East Kootenay between 1992 and 1994.

Site	1992	1993	1994
		(kg/ha)	
Skookumchuck Prairie[1]	715	925	900
Premier Ridge	830	1170	865
Pickering Hills	840	1110	1135
Peckhams Lake (New Seeding)	2370	3005	1115
Peckhams Lake (Old Seeding)	2280	4250	1760
Average	1405	2090	930

[1]Data rounded to nearest 5 kg/ha.

Averaged over all sites, total forage standing crop was 81% higher in the wettest year (1993) compared to the driest (1994). Similarly, average total standing crop ranged from 11 to 43% higher than seasonal standing crop among years but there were considerable differences among sites (Table 1).

Allocation procedures need to account for seasonal and annual variations in forage production, and carrying capacity must be based on the combined stocking rates of livestock and wildlife. Both cattle stocking rates, and wildlife population levels, must be set and maintained to ensure the sustainability of the range resource under common use.

Where forage is limiting on native spring ranges, the impacts of combined wildlife and cattle use can be mitigated by developing seeded spring pastures for livestock. Similarly, seeded pastures have been successful in other jurisdictions as "intercept ranges" to provide forage for wildlife before they occupy the winter range.

2) Ungulate Diets – Seasonal diets of deer, elk and cattle were monitored on all four sites to establish the degree of diet overlap. Results from the monitoring were generally consistent among the sites studied, and with previous research on deer, elk and cattle in BC, Alberta and the western US using similar habitat.

Deer and elk ate 31 to 63 species over the three years and 18 to 25 species annually. Cattle diets were less diverse and comprised only 70% of the species eaten by deer and elk. About 12 key species, however, dominated diets of all three ungulates.

Shrubs and trees dominated deer diets in all years (range 24 to 98%) with bitterbrush and buckbrush being the most important species in winter. Grasses were generally unimportant in deer diet (<10%) except in spring when they comprised nearly 20% of the diet. Alfalfa and clover were used infrequently (<5%) in all years.

Elk mainly ate grasses, especially in winter and spring. Rough fescue, Idaho fescue, and bluegrasses were the dominant species eaten but elk also grazed alfalfa and clover in summer and fall. Trees and shrubs averaged up to 35% of elk winter diet with soopolallie, low Oregongrape, and Douglas-fir the most important species browsed.

Grasses and forbs dominated cattle diets while shrubs generally were eaten sparingly. Rough fescue, Idaho fescue, and bluegrasses were the most important grasses in their diet while shrubs and forbs were eaten most in spring, summer and fall.

Competition for forage could be a factor on some, or all of the pastures monitored in this study given seasonal and annual diet similarities between cattle and elk. Indeed, cattle likely compete with elk in fall and winter through their summer grazing in some years. Similarly, elk can compete with cattle on summer range through spring grazing on sympatric habitats. Although cattle and elk diets were similar, competition is expected only if food or space is limited. No competition is expected by elk with deer, or by cattle with deer, except possibly for specific species such as bitterbrush in particular years.

3) Total Forage Use - A proper-use factor of 50% utilization is commonly recommended on many range types in North America. Combined use by wildlife and cattle ranged from about 50% to >90% of the total standing crop during the study but total use often exceeded 70%. Forage use on native range was equally split between wildlife (17 and 30% use) and cattle (18 and 35%) but cattle use ranged from 35 to 60% on the seeded sites.

Wildlife and cattle sequentially graze most range units in the Trench. Typically, cattle are grazed in spring or fall, while wildlife use the same ranges in early spring, fall and winter. Therefore, not all of the total standing crop is available to one ungulate species over the entire grazing season or during a specific foraging period. While cattle or wildlife may moderately use the forage available in a single grazing period, some range units are virtually continuously grazed even though range use plans prescribe rotational grazing for cattle.

Common and Scientific Names of Plants and Animals

Grasses	
Bluebunch wheatgrass	*Agropyron spicatum*
Idaho fescue	*Festuca idahoensis*
Kentucky bluegrass	*Poa pratensis*
Needle-and-thread	*Stipa comata*
Orchardgrass	*Dactylis glomerata*
Prairie Junegrass	*Koeleria cristata*
Rough fescue	*Festuca scabrella*
Richardson's needlegrass	*Stipa richardsonii*
Sandberg's bluegrass	*Poa secunda*
Slender wheatgrass	*Agropyron triternatum*
Smooth bromegrass	*Bromus inermis*
Western needlegrass	*Stipa occidentalis*
Forbs	
Alfalfa	*Medicago sativa*
Alsike clover	*Trifolium hybridum*
Clovers	*Trifolium spp.*
Low pussytoes	*Antennaria dimorpha*
Trees and Shrubs	
Bitterbrush	*Purshia tridentata*
Douglas-fir	*Pseudotsuga menziesii*
Low Oregongrape	*Berberis repens*
Ponderosa pine	*Pinus ponderosa*
Saskatoon	*Amelanchier alnifolia*
Soopolallie	*Shepherdia canadensis*
Trembling aspen	*Populus tremuloides*
Animal Species	
Cattle	*Bos taurus*
Elk	*Cervus elephus*
Horse	*Equus caballus*
Mule deer	*Odocoileus hemionus*
Whitetail deer	*Odocoileus virginianus*

Plant nomenclature follows Hitchcock and Cronquist (1973).

In addition to spring or fall cattle grazing, spring wildlife use ranged from 15 to 42% of the seasonal standing crop, from 14 to 50% in fall, and from 33 to 60% in winter among the four sites. Ultimately, range condition will decline if preferred species are repeatedly and heavily defoliated, and they are unable to store carbohydrates and set seed.

Spring cattle turnout dates should be based on plant growth stage and forage abundance, rather than on height measurements or calendar dates. In addition, cattle should not be turned-out on wildlife winter/spring ranges before forage plants have an opportunity to regrow after spring wildlife grazing. Not only will forage be limiting for cattle, but additional grazing may reduce the vigour of plants that were previously used.

Cattle rotations must provide adequate forage carryover for fall and winter wildlife demand. Although fall cattle grazing can reduce available forage for wildlife in fall and winter, pastures may receive more wildlife use in spring because forage plants contain less standing litter.

Cattle grazing is not the only factor affecting forage availability for wildlife on winter range. For example, deep snow limited herbaceous forage availability for deer and elk in winter 1993 at all sites except Premier Ridge. At Skookumchuck Prairie, browse increased to nearly 60% of elk diets in 1993 compared to about 20% in 1992 and 1994. Consequently, resource managers should not rely on herbaceous forage utilization entirely when estimating carrying capacity on common use ranges.

Multiple species grazing does not necessarily result in competition or deterioration of range condition. Facultative grazing, or using one herbivore to improve forage conditions for another species, can benefit both animal production and protect the range resource. For example, positive results have been achieved on mixed cattle, deer, and elk ranges in Oregon using 50% total forage use as the management goal.

4) Plant Communities and Range Condition – Results from monitoring, and personal observations, convince us that both cattle and wildlife are contributing to present conditions on Skookumchuck Prairie, Premier Ridge and Pickering Hills. All three sites are in early stages of succession and appear relatively static.

Several exclosures were constructed for this study but the duration of the project was too short to evaluate grazing effects. Very few reference areas exist in the East Kootenay where long-term data are available to compare grazed and ungrazed plant communities. An exception is the reference area exclosure at Skookumchuck Prairie that was constructed in 1951. This exclosure, and a grazed site adjacent to it, have been re-sampled at about 10 year intervals since 1960.

Both the grazed and ungrazed sites were dominated by Sandberg's bluegrass, prairie Junegrass, needle-and-thread and low pussytoes in 1951. Except for the replacement of Sandberg's bluegrass by needle-and-thread, and minor fluctuations in forb cover, species composition in the grazed area has not changed significantly in 50 years. Clearly, combined use by deer, elk and cattle has maintained the grazed plant community in a low stage of succession.

Significant changes have occurred inside the exclosure over 50 years. With protection from ungulate grazing, bluebunch wheatgrass and rough fescue increased; and Sandberg's bluegrass, needle-and-thread, and low pussytoes all decreased from 1951 to 1970. Rough fescue and Idaho fescue have largely replaced bluebunch wheatgrass since 1970, but succession may not be complete, as Idaho fescue appears to be displacing rough fescue.

Furthermore, ponderosa pine established in the exclosure in 1982 and, by 1994, it had increased to nearly 13% cover. Fifty years of total exclusion from grazing and fire has resulted in the plant community progressing to a higher stage of succession typical of other ungrazed

Ponderosa pine and Douglas-fir zones sites in the southern part of the province.

The plant communities at Premier Ridge and Pickering Hills will remain in a low successional stage if the present levels of heavy wildlife and livestock forage use continue. Both winter ranges are presently dominated by bitterbrush that successfully competes with bluebunch wheatgrass, rough fescue, and Idaho fescue.

Although bitterbrush can be valuable winter browse for mule deer in some years, it is generally used less by ungulates in the East Kootenay than elsewhere in the U.S. Consequently, a shift in the plant community to more perennial bunchgrasses will improve carrying capacity for combined use by cattle, elk and deer. In addition, forest encroachment is confining wildlife and livestock grazing to smaller areas at an escalating rate, and it is unlikely that grazing management alone will change species composition without other management inputs such as selective harvesting, juvenile spacing, and prescribed fire.

The conventional approach to range condition and trend using "climax" vegetation as the benchmark is not well suited to the East Kootenay because most of the valuable range for wildlife and cattle was derived from forestland. Moreover, higher stages of succession, with dense forest canopies, are not the most productive plant communities that optimize common use by wildlife and livestock.

The Society for Range Management Task Group on Unity and Concepts and Terminology (1989) recommended that multiple use objectives should be defined in terms of a Desired Plant Community (DPC). The DPC may not be the "climax" plant community, but it is the one best suited to meet the management objectives for the site.

We believe that the desired plant community approach is best suited for range management in large parts of the Trench, but objectives must be set on a site-specific basis and reflect attainable goals for the site. The present successional status of the community should be described and assessed with respect to the objectives of the plan.

If current species composition of the range needs to be altered, then options such as adjusting cattle stocking rates, fire, fertilizer, seeding, herbicides, or forest stand management can be explored.

Biological Considerations In Forage Allocation

Ostensibly, forage allocation is simply a process of dividing the forage on any management unit among herbivores. Often this process is applied to domestic livestock and wild ungulates but it could include any herbivores.

The biological foundation for forage allocation is carrying capacity, which links dietary preferences and forage utilization to the sustainability of the forage resource. In mixed grazing systems, carrying capacity needs to be based on all herbivores that significantly use the forage. As a result, carrying capacity for combined ungulate use on the same range will not be the same as for an individual species.

Forage left after ungulate grazing is not wasted and may be as important, or more important, than the forage consumed. Litter is required to protect soils from erosion, build soil organic matter, maintain soil structure, and promote water infiltration. Forage allocation must ensure that adequate herbage remains to provide suitable habitat structure and forage for non-ungulate species. Similarly, sufficient plant and litter cover should remain after grazing to impede weed encroachment.

You Can't Separate Science & Politics

Although biological factors provide essential information on the ecological capacity and limitations of a land management unit, forage allocation is essentially a planning and decision-making process. The fundamental basis of this process is a consensus on the overall land use ethic that will be pursued.

Conflicting agendas that attempt to maximize single use objectives often undermine land use planning for multiple-use goals. Therefore, political issues that will drive, or constrain, the process must be clearly identified and resolved before planning begins.

Current land use paradigms range from preservation with no use, to single use with little political or administrative influence. If forage allocation is a worthy goal, we must think broadly to balance social expectations, multiple-use objectives, and responsible ecosystem management. In other words - conservation with use.

This model acknowledges the importance of land-based products such as beef, wildlife, timber, water, and recreation while protecting soils and vegetation for long-term sustainability. Moreover, conservation values such as rare and endangered species, sensitive habitats, and archaeological sites, among others, can be identified and incorporated into the planning process.

In order for it to succeed, however, goals and objectives must be consistent with the ecological potential of the land management unit. Additionally, emphasis should focus on managing the landscape holistically with livestock and wildlife as components of the system.

In 1994, the East Kootenay Land Use Plan recommended "the government should direct the Ministry of Forests and the Ministry of Environment, as part of district and regional long-term planning requirements, to establish a strategic annual allowable livestock and wildlife grazing objective for Crown land based on the biological capacity of the resource, other user's interests and considering all potential forage sources."

We concur with this recommendation and believe that forage allocation should be a principal component of range use planning in the East Kootenay on range units where there is common use by livestock and wild ungulates. Moreover, plans must be based on definable land units so that specific knowledge of diets, animal distribution, forage production and use, and other information can be incorporated into the planning process.

Some progress has been made in managing common use ranges in the East Kootenay. For example, grazing prescriptions are being modified to accommodate the needs of all forage users. In addition, projects are underway that address forest ingrowth and encroachment, and monitoring results from these projects will provide valuable information for management in the future.

While scientific data provide essential baseline information for planning and decision making, much depends upon personal interests, social values, economic considerations, inter-agency priorities, and government policy and legislation, as these all relate to equitability. Politics, at various levels, play an integral role in allocating forage in a responsible manner, but successful plans depends on sincere negotiation, decisions must be flexible, and plans should be evaluated regularly to determine if objectives are being met.

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I certify that the statements made by me above are correct and complete –*Samuel Albrecht*, Executive Vice President.

Preserving the Heritage of the West

An innovative graduate program at Colorado State University aims to prepare land managers for the future by taking a holistic approach to resources.

Compiled by Kindra Gordon

In the West, particularly in Colorado, economic development and population growth are proceeding at a rate that is very different from that of the past 50 years. The numbers speak for themselves: Population growth in Colorado currently is occurring at twice the national average, with an estimated 1.5 million new residents arriving in the next 20 years. Agricultural land in Colorado is being converted into housing, shopping malls, roads and other urban uses at a rate of 10 acres per hour, 240 acres per day and 90,000 acres per year. Land in Colorado utilized in agriculture has declined 12 percent since 1960, while population has roughly doubled.

With those urban changes taking place, there has in turn been new pressure on environmental systems and competition for land use—and land managers are faced with being knowledgeable about a broad spectrum of topics from animal production to public policy.

To assist resource specialists in working in the changing landscape of the West, Colorado State University has designed a new graduate program that takes an integrated approach to land use management.

"The emphasis is not range or ranch management but the overall management of the land resource," says Kraig Peel, an animal sciences professor who is coordinating the program.

"Academic research and education programs directed toward ranching and other resource and land-use professions traditionally have focused on narrow disciplinary confines rather than looking at the entire system of land-use management and issues," says Peel. "Colorado State focuses on looking at the way land and resources can be and are used—ranches, public lands and non-ranching private uses—in a context that incorporates all of the influences on land."

Peel says this new approach toward land management will be increasingly important to aid in preserving ag lands that are still in production as well as help preserve open space. "The only way I can see to maintain these lands is to make sure they are profitable whether through traditional agriculture or non-ag uses." He says a holistic approach toward resources is also important as the recreational demands of people in the West continue to boom.

To that end, the CSU program, offered for the first time this fall by the university's Western Center for Integrated Resource Management, is one of the first educational programs in the nation to approach all land-use and resource-management factors with integrated courses and instruction. It's a merger of disciplines from within four colleges: Natural Resources, Agricultural Sciences, Veterinary Medicine and Biomedical Sciences, and Liberal Arts.

The program is designed with the belief that successful land management in the current environment requires and understanding of how the land, water, animals, hu-

Ag Lands Important

Despite the booming urban development in Western states, agriculture (especially livestock production), is still a primary foundation of most Western states' economies. For example, almost 50 percent of Colorado's 66.4 million acres of land is used for animal agriculture. Sixty-nine percent of Colorado's agriculture receipts in 1999 were generated from the livestock industry, representing an income of $3.01 billion. Agribusiness provides more than 105,000 jobs which is 4.4 percent of the state's total and generates nearly $16 billion.

Moreover, Colorado is home to more public land than any other state in the nation except Alaska. More than 25 million acres of national forests, national parks, state parks and Bureau of Land Management land are traversed by 11,000 miles of recreational trails. Public lands and resources are utilized in wide variety of ways, such as skiing, hunting, whitewater rafting and fishing. Recreational and agricultural activities are mainstays of Colorado's economy, with hunting and fishing expenditures contributing more than $2.5 billion to the state's economy in 1999. Public land in Colorado also is extensively utilized for agricultural activities such as grazing, with an unusually high percentage of Colorado's public land used for agricultural production (42 percent versus 30 percent nationally).

mans and finances interact to influence long-term sustainability and profits, according to Peel.

CSU's new program was designed with input from agricultural producers and other professionals in related fields whom overwhelmingly requested more in-depth, practical education that could be directly applied to real-world situations. Courses include management, business, land-resource management, animal management and production, grazing and public policy emphasis.

> Agricultural land in Colorado is being converted into housing, shopping malls, roads and other urban uses at a rate of 10 acres per hour, 240 acres per day and 90,000 acres per year.

Some topics addressed by the new program include an in-depth look at the influence of urban growth on livestock ranching, as well as, how diversification of land use to include wildlife and recreational activities may become more critical to long term profitability and sustainability of ranching - and resource management issues to consider from such diversification.

New Teaching Format As Well

In addition to being among the first programs of its kind, the graduate-level classes also are offered in a new modular format that allows students to complete a three-credit course in two weeks. The format is designed to fit the needs of full-time and part time students as well as professionals or producers who may want to attend just a few classes to enhance their skills. Each course is intensive and requires full-time attendance for six hours a day on weekdays for the two-week period.

"There aren't many master's programs in these disciplines that aren't research intensive," said Peel. "It's also difficult for professionals to fit graduate school into their schedules if they don't want to go full-time, so the format of this program provides an additional benefit."

Peel reports that 15 full time students as well as 10 part time students enrolled in the courses this fall, and he says there has also been considerable interest from government agency personnel in the area.

While a primary goal of the CSU program is to train resource managers with a holistic approach to ensure long-term sustainability of the ranching industry, it's equally focused to managers of public lands, or landowners with non-ranching uses.

Peel points out that there is a great need for public land managers who have an interdisciplinary background and an understanding of issues involved in private uses of neighboring land, as well as public land policy. Finally, a growing proportion of agricultural lands are being purchased by corporations and absentee landowners which increases the need for well trained resource managers.

For more information about this program, visit http://www.wcirm.colostate.edu or contact the Western Center by phone at (970) 491-1610.

Cows, Condos, or Neither: What's Best for Rangeland Ecosystems?

Find out how plant communities vary across ranches, ranchettes, and nature reserves in one Colorado watershed.

By Jeremy D. Maestas, Richard L. Knight, and Wendell C. Gilgert

Much debate is heard on the range about the role of cattle ranching in the western U.S. Fueled by rural population growth in this region, a "New West" is emerging in which many private ranchlands are being divided into low-density residential developments, commonly referred to as "ranchettes."

Subsequently, this settlement pattern and its residents are changing the West's character and economy. The land-use conversion from ranching to exurban development has caught the attention of conservationists and has generated heated discussion about whether cows are better for rangeland ecosystems than condos (see Wuerthner 1994, Brown and McDonald 1995, Knight et al. 1995). Many nongovernmental conservation organizations are taking the side of ranchers by working with them to keep ranchlands from being developed, but they are doing so with virtually no scientific evidence to support their actions.

Of course, the dichotomy of cows versus condos is too simplistic. Even though exurban development seems to be the most common alternative for private ranches that are sold today in the West, another land-use option is designation as a nature reserve. Nature reserves are lands that are permanently kept out of commercial or residential development and where uses such as grazing, mining, and logging are restricted or prohibited. Examples of this land use include federal wilderness areas, national parks and wildlife refuges, state parks and wildlife areas, and private reserves.

Some environmentalists purport that the only way to preserve healthy rangeland ecosystems is to get land out of the hands of ranchers and into some type of nature reserve. Until now, science has had a minimal role in this discussion. Here, we provide a summary of the results of a study that compared plant communities across nature reserves, ranches, and exurban developments in a rural northern Colorado watershed.

Changes In The Mountain West

The region of the United States known as the Mountain West (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming) is currently undergoing a human population boom and land-use conversion that rivals any in its history. In fact, five of the

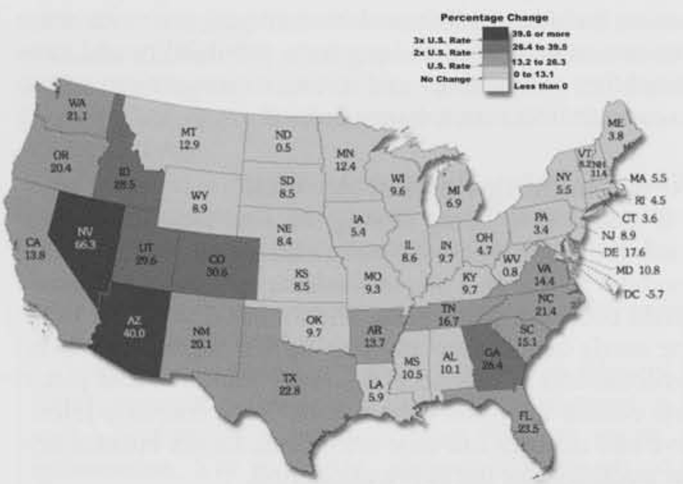


Fig. 1. *Percentage change in resident population in the U.S. between 1990 and 2000. Source: adapted from the U.S. Census Bureau (<http://blue.census.gov/population/www/cen2000/respop.html>).*

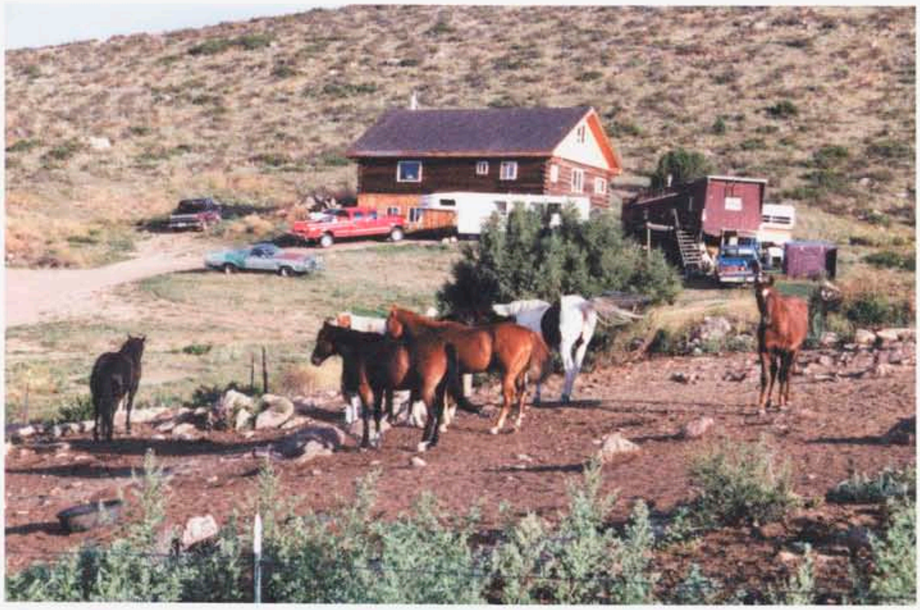
eight states in this region had the fastest population growth rates in the country between 1990 and 2000 (Fig. 1).

Although metropolitan areas such as Denver, Salt Lake City, and Phoenix have accommodated many newcomers, rural areas are actually growing at a faster rate and over a broader area. The USDA Economic Research Service reports that almost 80% of the land used for residential development in the U.S. between 1994 and 1997 occurred outside of incorporated city limits (see <http://www.ers.usda.gov/publications/aer803>).

Furthermore, the per capita rate of land consumption far exceeds annual population growth rate in this region. For example, whereas population growth rate in Colorado averaged around 3% yearly from 1960 to 1990, the annual rate of land conversion to houses averaged 8% (Sullins et al. 2002). So, concerns about growth are not just about population size, but also about the dispersed pattern of settlement residents are choosing.

Driven by a mixture of economic and quality-of-life features, people are moving to the rural parts of a region rich in public lands (Power 1996). In turn, private lands in agriculture are being exchanged for exurban developments as immigrants seek to live where they play, and has resulted in a "New West" characterized by its desire for natural amenities, its service and recreation-based economies, and its retirement communities. In other words, many counties in the rural West are shifting from areas of production to areas of consumption (Shumway and Otterstrom 2001).

Consequently, exurban development has become a principal use of rural land in the Mountain West, joining the traditional major land uses of livestock ranching and nature reserves (Vesterby and Krupa 1997). Although the amount of land being set aside for nature reserves annually is increasing slowly, lands in ranching and exurban development are in a rapid state of flux as ranches are subdivided for rural residences. For example, between 1992 and 1997 in Colorado, 270,000 acres per year were converted from agriculture to other uses such as residential development.



Overgrazed pastures on two ranchettes in northern Colorado. As exurban developments replace ranches across the Mountain West, rangelands may be changing also. Photos by Jeremy Maestas.

Conservationists Respond

These alterations of the Mountain West landscape have not gone unnoticed by conservationists. There is a growing concern that the conversion of ranchland to exurban development is altering the region's natural heritage, although we know of little scientific basis for this notion. Despite this lack of empirical evidence, many nongovernmental conservation organizations are working with ranchers to keep their lands out of development and in ranching because they believe rangeland ecosystems are better maintained on intact ranches (Weeks 2002).

This is being accomplished largely through conservation easements that restrict development rights but often allow continued livestock grazing (Morrisette 2001). Such a strategy has become increasingly popular with The Nature Conservancy, Rocky Mountain Elk Foundation, and other land trust organizations. In fact, recent statistics indicate that more than 1,200 land trusts nationwide have protected roughly 2,600,000 acres from future development through conservation easements (see www.lta.org/newsroom/census_summary_data.htm).

Despite its popularity, the use of conservation easements as a strategy to protect rangeland ecosystems has several assumptions that have not been tested. For example, this approach assumes that plant and wildlife communities on ranches are similar to those on nature reserves, or, at the very least, that native plant and wildlife communities are better maintained on ranches than they

This once working ranch was recently sold and platted for subdivision. Newcomers can now "ranch" 40-acre estates for the right price. Photo by Jeremy Maestas.

would be on exurban developments. This approach is being used even though some environmentalists argue that ranching is the most detrimental land use to native biodiversity and rangeland ecosystems in the West (see Fleischner 1994).

To assess the various assumptions of this new rangeland protection strategy, we conducted a study comparing plant communities across three of the principal land uses in Larimer County, Colorado: nature reserves, livestock ranching, and exurban developments.

Testing Assumptions Of New Conservation Strategy

We conducted this study in an area encompassing about 50,000 acres in the foothills of the North Fork of the Cache la Poudre River Watershed along the Colorado Front Range of the Rocky Mountains. Our study area is approximately 25 miles northwest of Fort Collins. The land-use matrix of the area is typical of the Mountain West and is composed of private ranchlands, National Forest lands, and state wildlife areas, with some ranchettes perforating the landscape.

Plant communities are dominated by grasses and shrubs, although some trees occur at higher elevations. Common species include needle-and-thread, blue grama, western wheatgrass, cheatgrass, fringed sage, mountain mahogany, skunkbrush sumac, and bitterbrush. Average annual precipitation ranges from 13-18 inches, with 75% of it falling between April and September according to the Soil Survey of the Larimer County Area, Colorado.

We selected study sites within this watershed with similar plant community types composed of shrubs (primarily mountain mahogany and bitterbrush) and grasses (mainly needle-and-thread and western wheatgrass), at similar elevations (5,700-7,200 feet), and on similar soil types to reduce natural variability among sites. Study sites ranged in size from 2,500-12,000 acres and included two nature reserves, three ranches, and two exurban developments.

Nature reserves were Colorado Division of Wildlife State Wildlife Areas, whose principal use was outdoor recreation and wildlife protection (no livestock grazing, logging, mining, or water development). For the most part, the two Division of Wildlife properties were ungrazed by livestock for 18 and 33 years prior to our study. However, livestock grazing was used to reduce noxious weeds until 5 and 7 years ago, respectively, on the two sites. Stewardship of these areas was primarily custodial.

Ranches were privately owned, and cattle grazing was managed through deferred-rotation grazing systems. Although specific stocking rates were not obtained, visual inspection of forage utilization indicated that all three ranches had moderate grazing intensities. These ranches have been in livestock production for at least 100 years.

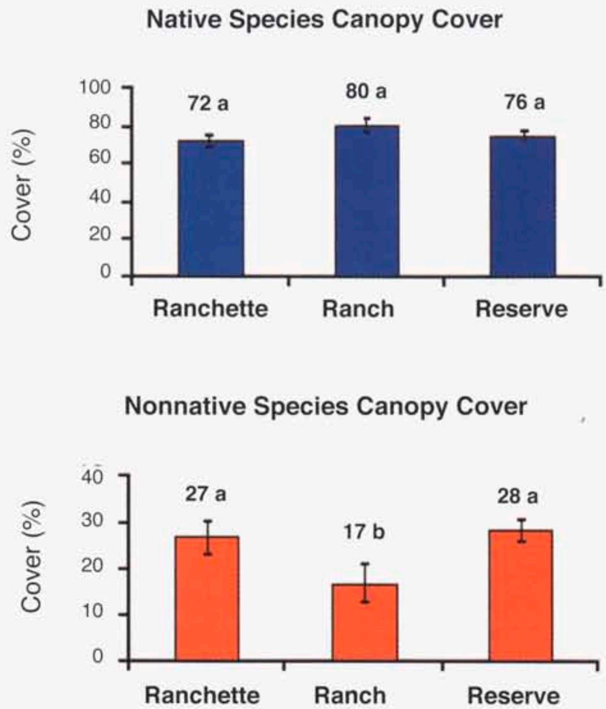


Fig. 2. *Average canopy cover (±SE) of native and nonnative plants at each sampling point on lands used for ranchettes, ranches, and nature reserves. Letters next to cover estimates indicate the results of statistical comparisons. Different letters represent statistically significant differences.*

Exurban development areas had lots from 35-50 acres, with ranchettes being used mostly for year-round residences. The average housing density within exurban developments was 1 house per 40 acres, and the average house age was 9 years. These areas began development about 30 years prior to our study and are still undergoing development. The amount of forage utilization on individual ranchette properties varied from no livestock use to intensive grazing.

We randomly selected 23 sampling points within each land use (nature reserve, ranchland, and exurban development) for a total of 69 points, which we used to characterize the plant communities. Points had to be at least 0.2 miles apart and occur on areas with slopes less than 35%. Also, points had to be away from riparian areas, hay meadows, site boundaries, built structures, and roads to reduce confounding variables between points.

At each sampling point, 8 x 20-inch Daubenmire microplots were sampled at 33, 66, 98 feet away from the point in each of the cardinal directions (N, E, S, W) for a total of 12 microplots per point. A trained plant taxonomist and a recorder documented percentage canopy cover of plant species, as well as percentage bare ground, litter, and rock within each microplot. Sampling was done during the period of peak standing crop in 2001.

After data were collected in the field, species were classified as native or nonnative and average values for species richness, canopy cover, bare ground, rock, and litter were obtained for each sampling point (Maestas et al. 2003).

Evidence From The Plant Communities

Ranchlands had slightly more native plant species than did nature reserves or exurban developments, with an average of 27 species per sampling point on ranches compared to 24 on each of the other land uses. Though ranches had more native species on average, the canopy cover of native plants did not differ statistically across the land uses (Fig. 2).

Both species richness and canopy cover of nonnative plants, however, were statistically significantly lower on ranches than on the other land uses. Average canopy cover of nonnative species at points sampled on ranches was about 17% compared to 27% and 28% on exurban developments and nature reserves, respectively (Fig. 2). Ranchlands had an average of three nonnative species per point, whereas, nature reserves and exurban developments had an average of five.

Examining the dominant nonnative plant, cheatgrass, we discovered that not only was canopy cover of this species statistically significantly higher on nature reserves (22%) and exurban developments (18%) than on ranches (14%), but also that this species accounted for much of the nonnative species cover on each land use.

A total count of nonnative plant species encountered in each land-use category revealed that there were over twice as many nonnative species found on lands devoted

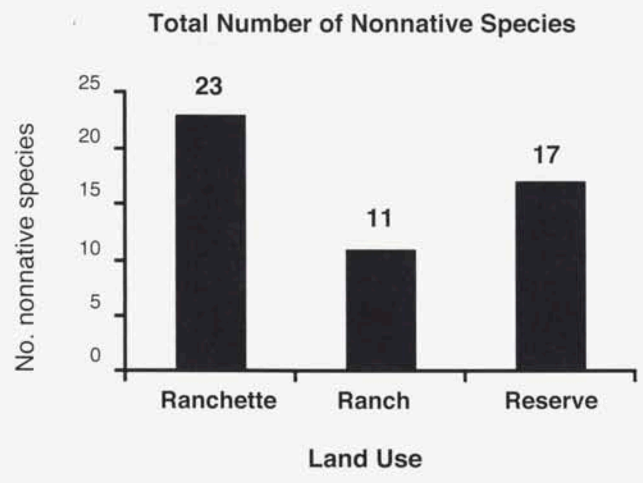


Fig. 3. *Total number of nonnative plant species found in each land use category. Eight out of the 23 species seen on ranchettes were unique to that land use, not being detected on ranchlands or nature reserves.*

to exurban development than on lands in ranching (Fig. 3). Eight of the 23 nonnative species found on exurban developments were not recorded on either of the other two land uses in the watershed we studied. Two of these eight unique species, spotted knapweed and leafy spurge, are considered noxious weeds in Colorado.

Exurban developments had a higher percentage of bare ground than did nature reserves, with about 30% of the soil exposed at each point on developments compared to 18% on reserves. Ranches fell in the middle of the spectrum with about 22% bare ground. The percentages of litter on ranchlands, nature reserves, and exurban developments were similar across land uses at 35%, 31%, and 30%, respectively. As expected, the percentages of rock did not differ significantly among land uses with 10% rock on both ranchettes and ranches and 8% rock on nature reserves.

The evolutionary history of herbivory in our watershed may help explain some of the patterns we observed. This region, which is a transitional zone between the shortgrass steppe and the Rocky Mountains, historically supported considerable numbers of bison. Grazing by these animals was an ecological disturbance that produced heterogeneous rangelands composed of plant species that co-evolved with herbivory (Milchunas et al. 1988).

Our results do not contradict findings of earlier studies in the shortgrass steppe showing that these plant communities will more likely have a negative response to the removal of grazing animals rather than a negative response due to grazing by domestic livestock (Milchunas et al. 1990). Even though cattle and bison have somewhat different grazing characteristics, proper management of cattle on ranches in this area may be effective at mimicking natural disturbances in the absence of bison.

Conversely, the removal of grazing by large herbivores on nature reserves or the mismanagement of hobby livestock (i.e., horses, llamas, cattle, etc.) on ranchettes may lead to rangeland degradation, resulting in more weeds and more bare ground.

Human activities occurring on nature reserves and exurban developments are likely to be promoting the relatively high number of nonnative species on these land uses. Humans often serve as accidental or deliberate sources of nonnative species (Mack et al. 2000). Roads and trails are two conspicuous human constructs that are notorious for their role in the spread of nonnative flora (Tyser and Worley 1992).

Besides the obvious disturbances associated with buildings, exurban developments have extensive networks of roads and trails that greatly enhance the likelihood of nonnative species introductions. Mitchell and others (2002) reported the improved road density for one of our exurban developments to be 3.38 miles per section (640 acres) in 1994, which is more than eight times the road density of this area before it was subdivided.

Nature reserves have few roads but the trail systems can be considerable and heavily used by outdoor recreationists such as hikers, mountain bikers, and horseback riders (Knight 2000). The amount of trails and recreational use on Division of Wildlife lands that we studied were not quantified, but personal observation and communication with property managers suggests many unofficial trails have been established and recreational use can be quite heavy in the summer and fall.

Other activities on ranchettes may also be contributing to the spread of nonnative plants. A deliberate source of these plants comes from the landscaping of yards with nonnative and ornamental plants. Although few of these species become invasive, planting with nonnatives alters local plant community dynamics and increases the likelihood of a species spreading onto natural areas. Also, homeowners in exurban developments may be unintentionally aiding in the spread of weeds by feeding hobby livestock non-certified hay and allowing their animals to overgraze native plants, thereby increasing the amount of bare ground and opportunities for weed invasion.

Our study was observational, so some caveats should be acknowledged. Like much of the American West, all of our study sites, including nature reserves and exurban developments, were grazed by livestock prior to their current uses. However, we believe that our sites have been in reserves, ranching, or exurban development long enough to produce the differences we observed in plant communities. Additionally, our results come from a single plant community type in one watershed so inferences should be restricted to our study sites. Further research examining whether the trends we observed hold true for other locales in the Mountain West might prove instructive.

Conservation Strategy Supported, Ranches Do Best

Are conservation organizations justified in assuming that cows are better for rangeland ecosystems than condos? Ultimately, this may be a question of values rather than science, but if the goal is to maintain native plant communities with less bare ground, results from our study along the Colorado Front Range support this assumption.

Interestingly, the notion that nature reserves are the best way to maintain rangeland ecosystems was not entirely supported by our data. Nature reserves had plant communities that were more similar to those found on ranchettes than on ranches, but nature reserves did have less bare ground than did exurban developments.

Although judging the condition of rangeland ecosystems based on a few plant community characteristics is rudimentary, data from wildlife communities on ranches, ranchettes, and nature reserves concur with our generalizations (Odell and Knight 2001, Maestas et al. 2003). An examination of songbird and mammalian predator communities across these rural land uses in our study area revealed that a host of so-called "human-adapted" species, such as the black-billed magpie, European starling, domestic dog, and house cat, had population sizes that were up to 15 times greater on ranchettes than on ranches or nature reserves (Maestas et al. 2002). In Pitkin County, Colorado, Odell and Knight (2001) showed that ranchettes had elevated populations of these human-adapted species and reduced populations of more sensitive species, such as the orange-crowned warbler and red fox.

Ranches and nature reserves, however, can maintain different populations of some species of conservation concern. For example, ranchlands in our study area had more Brewer's sparrows than nature reserves and ranchettes, while reserves had more green-tailed towhees than ranches and ranchettes (Maestas et al. 2003). These studies suggest a change in biodiversity with the subdivision of ranchlands, and differences in habitat conditions between ranches and nature reserves.

Implications For Conservation

To our knowledge, our study is the first to document and compare plant communities associated with ranches, ranchettes, and nature reserves. We were able to record some trends across these land uses that have implications for rangeland managers and conservationists.

First, nonnative species are likely to become an increasing issue as ranches are subdivided into ranchettes. Because exurban developments are embedded in rural areas, often adjacent to public lands and ranchlands, they may be supplying propagules of nonnative plants to surrounding lands. At the site scale, ranch and public land managers near developments should monitor their lands to locate and treat establishing nonnative plants before they have a chance to spread.

At the landscape scale, managers must recognize that exurban developments may be serving as regional sources of nonnative species. This implies that they must actively work with homeowner's associations in order to prevent the spread of weeds, both for the sake of the developments and nearby ranches and natural areas.

Second, in our study, ungrazed nature reserves did not maintain native plant community composition as effectively as grazed ranchlands did. This supports evidence from comprehensive studies of grazing that demonstrate that removing cattle from landscapes will not necessarily lead to restored rangeland ecosystems (Curtin 2002). Nature reserves are often assumed to serve as a benchmark of natural conditions and as strongholds for species of conservation concern, but when historic disturbance processes such as grazing are lacking, sites may not function in this capacity.

These areas may lack adequate stewardship to control nonnative plant species through the use of fire, grazing, and herbicides. Furthermore, outdoor recreational use both on and off trails should be monitored and regulated as it may be contributing to the spread of invasive species.

Management of nature reserves for native rangeland conditions will require active stewardship, such as the restoration of historic ecological processes, and not simply "hands-off" management.

Nongovernmental conservation organizations that work with ranchers to protect rangeland ecosystems in the foothills of the Colorado Front Range appear to be doing the right thing. Private ranchlands are critically important for biodiversity and rangeland conservation, especially considering that private landowners hold most of the highly productive, low elevation land and that most nature reserves occur on relatively unproductive, high elevation sites (Scott et al. 2001).

These facts, combined with the results from our study, suggest that conservationists will not be able to sustain native rangeland ecosystems in the Mountain West by relying solely on nature reserves. Future conservation efforts to protect rangelands will require a greater focus on private lands, conservation easements that permit active management, and an ability to work effectively across administrative boundaries (Knight and Clark 1998).

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Resource Roundup

Canadian Conference To Focus On Rangeland Productivity

The challenges of maintaining rangeland productivity in an era of high-pressure use is the focus of the second Western Range Science Seminar, slated **for Jan. 19-21 in Medicine Hat, Alberta, Canada.**

Five sessions will embrace the theme of rangeland viability and include: rangeland ecosystems, rangeland livestock production, rangeland ecology, rangeland hydrology and riparian areas, as well as the topic of range landscapes, ranching and wildlife. Of particular interest to ranchers will be presentations on the effect of drought on rangeland ecosystems and rangeland management.

Other topics include: manure application on rangeland, livestock water issues on rangeland, the effects of season of grazing and litter on plant selection, carbon sequestration on rangeland, rangeland reclamation, biting insects, weed research, livestock conversion efficiency, fire effects on rough fescue, wetlands and moss, pressures on rangelands and ranching, and tools to address challenges such as endangered species laws. For more info, contact Walter Willms at 403/317-2218.

Fences May Go Wireless

If building fence isn't your favorite pastime, there is good news on the horizon. Researchers are working on developing "virtual fences" where livestock movement is controlled by signals given to the animal through radio frequencies.

Oregon researcher Tom Quigley was among the first to start testing this technology on cattle nearly a decade ago. (Invisible fencing systems have been available to contain pets since the late 70s.) Quigley's intent was to utilize the virtual fence as a means to keep livestock out of riparian areas on grazing allotments. Here's how it worked:

Cattle were fitted with a collar containing radio transmitters and electrical stimulators with contacts touching the animal. A portable, battery-operated transmitter was installed in the middle of the area where grazing wasn't wanted. If the animal entered the exclusion area, the collar picked up a signal from the transmitter and gave an audio warning. If the animal didn't retreat from the exclusion area, it received an electrical shock. The shocks continued at regular intervals until the animal left the restricted area.

From his research, Quigley says they were able to control about 95% of the animals from grazing in the exclusion area, with most of the animals being trained within two days.

Today, research continues on improving virtual fence technology with the objective of making it a cost-effective alternative to traditional fences, says Bob Marsh. Marsh works with the Kansas-based company AgriTech Electronics, which is working to commercialize this technology for the livestock industry.

AgriTech Electronics currently has two products in development: one that is based on Quigley's research and would utilize ground based transmitters to define an area an animal shouldn't enter. The company's second product would utilize global positioning system (GPS) satellites to determine the animal's location and then transmit radio frequency signals to the animal if it gets too near the established boundary.

Marsh reports that the product with the ground-based transmitters could be on the market within the next 12 months. The GPS units could be available in the next two years, he says. "One of the biggest challenges in bringing this technology to the market is the development of a lightweight battery that will last as long as a grazing season," Marsh says.

Due to cost, he says initial applications for these units will likely be for research applications and special grazing areas where fencing isn't an option and some extra cost is justified. Long term, Marsh says his company hopes to offer the product as a radio frequency eartag for about $25/tag.

Dean Anderson, a research animal scientist with the USDA's Agricultural Research Service, has also been studying virtual fencing technology at the Jornada Experiment Station near Las Cruces, New Mexico. Anderson is working with a solar powered collar that receives radio frequency signals from GPS satellites. He too hopes that eventually an eartag in the "double-digit" price range will be available instead of a collar.

Anderson's research is focusing on technology that would give a variety of audio and physical cues to the animal in a bilateral (right or left side) fashion, rather than just one sound or one shock. Cues go from whisper soft to very loud and if necessary from a light shock to a severe jolt.

Anderson says, "The real value of virtual fencing will be in managing stocking density and animal distribution in real time." He foresees the virtual fence concept as a prescription grazing tool that can be used to move animals to graze in specific areas based on low stress animal management principles.

Eventually information about the pasture's quantity and quality of vegetation, rainfall, soils, topography and other features can be entered into the virtual fence using the system's Geographic Information System (GIS) capabilities, Anderson says. This feature will assist managers in deciding where to establish virtual boundaries and for how long in order to optimize utilization of the forage resource, he adds.

"We're not going to put conventional fences out of business. The exterior boundary of an area will still need to be fenced to keep livestock off of roads and railroads," Anderson says. "This technology is not 100% perfect at containing animals because we are dealing with animal behavior which is not 100% predictable."

Still, the applications look promising. And, with fewer actual fences, virtual fences should help eliminate arguments over who has to open and close the gate.

Resource Roundup is compiled by Kindra Gordon. Contributions welcome at kindras@gordonresources.com or call (605)722-7699.

Sneek A Peek At The Upcoming Issue Of *The Journal Of Range Management*

Prescribed Fire Effects on Erosion Parameters in a Perennial Grassland

M.E. O'Dea and D. Phillip Guertin

Grasslands in southern Arizona are susceptible to significant post-fire erosion during the summer rainfall season. A 2-year randomized field experiment quantified the interacting effects of a late spring prescribed burn and summer rainfall on seasonal runoff and erosion. Results showed that the interaction of burning and large rainfall events increases the amount of seasonal erosion, the susceptibility of the site to further erosion, and the length of the recovery period. The study illustrates important management considerations for burning prescriptions in southwest perennial grasslands, with specific focus on the effects of season of burning.

Diets of Plains Vizcacha, Greater Rhea and Cattle in Argentina

Javier A. Pereira, Ruben D. Quintana, and Susana Monge

Plains vizcacha and greater rhea are believed to be competitors to cattle for forage resources in South America farming areas. The food habits of plains vizcacha, greater rhea and cattle were studied over two years in the Parana River Delta, Argentina, using microhistological analysis of faeces techniques. Similarities between the diets of plains vizcacha and cattle support the ranchers' view that there is competition with domestic herbivores for forage. Greater rhea and cattle have different foraging patterns and hunting of greater rhea is not justified on the basis of forage competition.

Changes in Shrub Fecundity in Fourwing Saltbush Browsed by Cattle

Andrés F. Cibils, David M. Swift, and Richard H. Hart

Shrub fecundity is critical to long-term persistence of fourwing saltbush populations on the shortgrass steppe in Colorado. An experiment was conducted to study the influence of cattle-browsing on shrub fecundity-related variables. Sex shifts toward femaleness occurred more frequently in shrubs in exclosures. Such shifts, however, did not affect overall shrub sex ratios. Shrubs with no flowers were considerably more abundant in grazed pastures than in exclosures. Utricle fill was not related to previous year's cattle-browsing regime. The influence of cattle browsing on reproductive output of fourwing saltbush occurred mainly through the inhibition of flowering.

Female-Biased Herbivory in Fourwing Saltbush Browsed by Cattle

Andrés F. Cibils, David M. Swift, and Richard H. Hart

Female fourwing saltbush shrubs are more abundant in exclosures than in adjacent grazed pastures at our research site on the shortgrass steppe in Colorado. Experiments were conducted to determine whether female shrubs were being browsed more heavily by cattle than were male shrubs. Cattle browsed female shrubs more heavily than males in winter and summer. In spring, utilization of female and male shrubs was not different. Female-biased browsing increased with increasing overall levels of shrub utilization by cattle. Gender-biased herbivory may have promoted higher mortality among female shrubs leading to sex ratio alterations previously observed at this site.

Converting Mesquite Thickets to Savanna Through Foliage Modification with Clopyralid

R.J. Ansley, B.A. Kramp, and D.L. Jones

Standard brush control methods for honey mesquite achieve high above-ground and whole plant mortality but limit multiple use options by livestock and wildlife because little foliage is left for wildlife cover. A study in northern Texas evaluated aerial sprays of clopyralid to convert thickets of mature, multi-stemmed mesquite to savannas by reducing foliage amounts, yet preserving apical dominance and limiting basal sprouting. The herbicide reduced foliage per tree, live canopy area per tree and mesquite cover by over 55%, and over 70% of surviving trees maintained apical dominance. This approach may be effective for converting mesquite thickets to savanna.

In vivo Digestibility of Kleingrass from Fecal Nitrogen Excretion

Carlos M. Ferri, Néstor P. Stritzler, Miguel A. Brizuela, and Horacio J. Petruzzi

The precision of organic matter digestibility determination is affected by the accuracy with which the forage samples represent the actual diet of the animals. The changes in total fecal nitrogen and fecal nitrogen concentration were evaluated with rams in a Kleingrass feeding trial. Total fecal nitrogen did not change with feeding level but did change with time. The digestibility of organic matter can not be estimated from total fecal nitrogen unless the time of year is considered.

Understory Species Response to Utah Juniper Litter

Chad S. Horman and Val Jo Anderson

Several hypotheses, including allelopathy and litter depth, have been proposed to explain how juniper are able to suppress understory vegetation. A green house study was conducted to determine the effects of Utah juniper litter depth and allelopathy (using a litter leachte) on seedling emergence and emergence rate of eight common understory species. Litter depth was found to have a much more negative effect on seedling emergence and emergence rate as compared to litter leachate. Seeding into areas with more than three cm of litter is not recommended without first removing or scattering surface litter.

Creating Low-Cost High-Resolution Digital Elevation Models

M. Louhaichi, M.M. Borman, A.L. Johnson, and D.E. Johnson

Ecologists and agronomists are interested in topography because it affects soil, plant, and hydrologic processes; however, digital elevation models accurate to several centimeters of vertical elevation, which would help explain changes due to topography, have been time consuming and expensive to obtain. We have developed and tested a low-cost method for creating high-resolution digital elevation models. The method described has a working radius of 230 m with a leveling accuracy of better than 2 cm. The digital elevation model can help explain the role of topography on ecological processes and is suitable for research fields, wetlands, and experimental plots.

Date and plant community effects on elk sedge forage quality

Patrick E. Clark

Elk sedge is an important forage in the West but little is known about its forage quality variability. Date and plant community effects on fiber and protein of elk sedge were examined at two range areas in Oregon, during 1997 and 1998. Fiber content was lowest in October and highest in July and protein levels were higher in a Douglas-fir community than in a ponderosa pine community. Despite date effects, elk sedge forage quality appeared relatively stable compared to other native forages thus providing moderate forage quality during times when the nutrient content of other forages was low.

A Method for Determining the Onset Year of Intense Browsing of *Salix geyerianna*

Richard B. Keigley, Michael R. Frisina, and Craig Fager

Despite the potential management applications, the widespread use of browsing histories is uncommon due to the youthful state of technique development. A technique was developed for determining the year in which an increase in browsing level occurred in the Mt. Haggin Wildlife Management Area of Montana. During the period of 1976 to 2000, the trend census of moose increased from 7 to 56 and the reconstructed browsing history showed the onset of intense browsing occurred in 1985 when 23 moose were counted. To reverse the trend to a meadow-like condition, the moose population must be reduced by about half

Diffuse Knapweed and Bluebunch Wheatgrass Seedling Growth Under Stress

G. Kiemnec, L.L. Larson, and A.Grammon

Seedling establishment is a critical phase of knapweed invasion. Growth characteristics of diffuse knapweed and bluebunch wheatgrass were evaluated in two temperature regimes and two moisture regimes in an environmental chamber. Results show that bluebunch wheatgrass should be more competitive than diffuse knapweed for nutrients and water in warmer, drier conditions while the diffiuse knapweed should be more competitive in wetter conditions. A shift to a warmer climate would result in bluebunch wheatgrass being more competitive for nutrients and water at deeper depths..

Available Water Influences Field Germination and Recruitment of Seeded Grasses

Laurie B. Abbott and Bruce A. Roundy

This seedbag retrieval experiment suggests some of the reasons that Lehmann lovegrass establishes more consistently than native grasses in range seedings in the southwestern United States. Some native grass seeds germinate immediately after initial summer rains, then their seedlings wilt in subsequent rainless periods. Establishment of these native grasses could be improved by seeding during, rather than before the rainy season. Lehmann lovegrass retains ungerminated seeds throughout initial wet and dry periods of the rainy season which are then able to germinate and establish later when summer rainfall is more consistent.

Lessons in Developing a Successful Invasive Weed Control Program

G.L. Anderson, E.S. Delfosse, N.R. Spencer, C.W. Prosser, and R.D. Richard

Invasive weeds, like leafy spurge, cost the global economy billions of dollars in control costs and lost revenue each year. Long-term management programs must focus on the biological aspects of weed control, using a comprehensive and integrated approach. Lessons learned during the USDA, Agricultural Research Service program "The Ecological Area-wide Management of Leafy Spurge" (TEAM Leafy Spurge) highlights the importance of integrating weed control tools and other societal components. TEAM Leafy Spurge demonstrated that weed control programs must address the biological, ecological, scientific, economic, political, social and legal components of the system to obtain effective and sustainable weed control.

Vegetation of Chained and Non-Chained Seedlings After Wildfire in Utah

Jeffrey E. Ott, E. Durant McArthur, and Bruce Roundy

Although land management agencies have accumulated much corporate knowledge of wildfire rehabilitation planting techniques, few formal studies of rehabilitation effects have been conducted. The vegetation of chained treatments was compared with nonchained treatments for three years following wildfire and aerial seeding in the sagebrush and pinyon-juniper zones of west-central Utah. By the second year, seeded grasses dominated the chained treatments while cheatgrass dominated the non-chained treatments. Chaining aids the establishment of aerially seeded species over the alternative of no seedbed preparation or seed coverage in wildfire rehabilitation planting.

Share Your Success Stories With SRM

Has your department or university revitalized its range program or restructured its rangeland curriculum? Or, do you have a unique teaching program or educational strategy that you've found successful with your students? If so, we'd like to hear about them and may spotlight you and your program in a future issue of *Rangelands*. Let's help each other tell about the success stories in rangeland management. To share your ideas, contact Kindra Gordon at kindras@gordonresources.com

Letters to the Editor

Editor, Rangelands
September 13, 2002

In response to the letter by George Lea in the June 2002 issue of *Rangelands* critical of my article "The Statistical Power of Rangeland Monitoring Data" (April 2002):

- Mr. Lea describes as "totally not true" and "misleading" my statement that "monitoring of rangeland condition and grazing utilization are now required by court order. . ." My statement was a simplification of a complex situation. Environmental groups (e.g. Forest Guardians) have sued federal land management agencies (e.g. the, Forest Service) for non-compliance with the "Terms and Conditions" of Endangered Species Act Section 7 consultations with the US Fish and Wildlife Service, which generally require monitoring. The lawsuits ask the federal court to issue injunctions against the land management agency if the monitoring has not been done (reference www.biologicaldiversity.org/swcbd/Programs/grazing/BO-suit-10-18-01.pdf).

- Mr. Lea objects to my statement that "little attention has been paid to the methods of monitoring" and he claims that the BLM and Forest Service have for many years used "research based methods." I assume that he refers to the Parker 3 step methods, which have been in use since the 1960s, involving evaluation of vegetation in a 3ft by 3ft square and in a 3/4in loop placed at every foot along 100ft transects. A search of the literature does reveal some analysis of these methods, summarized in Bonham 1989, and mostly dating from the 1970s or earlier. In general the analyses were not favorable to the methods; Bonham states "A number of studies have indicated that the loop method overestimates cover" (p. 123). But the point of my article was not to lambast the public land management agencies or their methods. It was to point out that numerical data is too often assumed to have greater precision and power than the methods allow, and too rarely are precision and power of the methods evaluated (reference Bonham, C.D. 1989. Measurements for terrestrial vegetation. John Wiley & Sons. New York.).

- It was certainly NOT my intent to "make the case that only [range consultants] are capable of conducting monitoring... and that federal range managers are not capable..."–I am sorry if the tone of my article left that impression. It is true that, cuts in funding and lawsuits are restricting the availability of federal agency people to take care of monitoring, and some of the work is being done by consultants (including me), but in no way do I wish to suggest that agency people in general are not competent.

Peter Sundt
Rangeland Consultant
Pima, Arizona

Dear Editor

It is always a pleasure and stimulating to read the many good manuscripts and articles in your magazine. September 2002 was no different. I must, however, take exception to "Vegetation of prairie dog colonies and non-colonized short-grass prairie."

Statements like "Black-tailed prairie dogs have declined by 98% in the past century, and due to continued recent declines, the U.S. Fish and Wildlife Service designated the species as a candidate for listing in 2000." This statement cannot be substantiated because it is not know how many prairie dogs there are or were. Substituting conjecture, political bias and assumptions for sound science is reprehensible in such a fine publication.

Secondly, the U.S. Fish and Wildlife Service was sued by the Wildlife Federation in an attempt to list the prairie dog. A federal judge ruled the prairie dog was "warranted but precluded." Having spent two years participating in Montana's Prairie Dog Working Group to come up with a plan for Montana and having measured the prairie dog towns on this ranch it is obvious the data used to make such assertions was greatly flawed. The initial findings of Craig Knowles of Fauna West in 1988 reported-acreages on the ranch of~880 acres. In 2001, the ranch's prairie dogs towns were measured using GPS. A total of 1973.03 acres were measured using the outermost active burrow as reference, not impacted area. Even with an increase of 10% for accuracy in the 1988 survey, the above hardly suggests a decline. The prairie dog population of Montana is not known nor is it likely to be.

Species that occur where prairie dogs have relocated are all "increasers" such as cheat grass, club moss, gum weed, gamma and western wheat grass. "...ensuring the maintenance of biotic integrity and economic vitality of western range lands" is an oxymoron.

Thank you for the opportunity to comment.

Steve Roth,
Big Sandy, Montana 59520

Listening To The Land

On Understanding and Iteration

by Thad Box

We aspire to be the voice of the land. To speak about land is straightforward. We have records, albeit of varying quality, of what has been done to the earth. We have principles based on science by which we measure conditions, past and present. We can calculate with some. confidence that current land status is related to past actions, both natural and human-caused. But to speak for the land is a horse of a different color

In my October commentary I argued three points: we are spokespersons for the land, we are not very good at predicting the future, and our most logical mission is to keep options open for whatever future use society may want. Thus, our mission is more conservation than production. We differ from preservationists because we conserve future options—production or passive.

For the sake of argument, let us assume future cultures will want meat from rangelands. Given vegetarian trends, desire for low-fat diets, the quest for biodiversity, and the indisputable record that overgrazing has damaged much of the earth, this assumption is challenged today. I suspect demand for meat production will likely fade and increase as social conditions change.

If society, or even a minority in it, wants to keep the option of raising domestic animals on rangeland open, we have the expertise and the people to do it. And we know how to keep from closing future options. Managing grazing is one of our strong points. It is an honorable mission. But the way we approach grazing may well determine our effectiveness as spokespersons for rangeland. To make domestic animal grazing our primary goal may hinder us from keeping other equally important options open. To argue that any single use is the best—or imply any one is the only reasonable use—of rangeland costs us credibility. We are at out strongest when we speak for the land, regardless of how it is used or who uses it.

To speak for land can be both pretentious and arrogant. Especially, if we claim we know what is best for it. In the last issue I wrote that our first objective "to properly take care of the basic rangeland resources of soil, plants, and water" was central to our mission of land care. But the "properly take care of" was a reflection of desires of the generation that lived at a particular time. What is best for the land is a value judgement. Often people value their wants over the land's needs.

To say we speak for the land implies we understand land and those who use and abuse it. This leads to the second objective we publish in each of our journals: "to develop an understanding of range ecosystems and to the principles applicable to the management of range resources."

We are a young profession that depends on the messy sciences of biology, sociology, and economics. Our understanding of rangelands will never have the precision of math or physics. Because our science is fuzzy our understanding of rangelands will always be a work in progress. Our understanding, of necessity, is iterative rather than absolute.

We constantly form hypotheses and test them. We make management plans, implement them, monitor the results, and adjust our management. When we become disciples of an outmoded theory or try to manage by dogmatic rules, our understanding of rangelands is flawed. The land suffers.

A decade or so ago, I was at an SRM meeting where a select committee was evaluating range condition and trend. One of my ex-students who had risen to a high position in one of the agencies stopped me in the hall. Distressed, he said, "That committee will ruin our ability to manage ranges. They are violating Clement's and Dyksterhuis's rules you taught us in the first range management class."

When I told him I no longer believed the Clementsian paradigm could explain rangeland condition, he acted like I said his god was not God. He asked, "If you can't depend on ecology to understand range condition, what can you depend on?" Ecology can help us understand rangelands, but it is the science, not the dogma, that underpins our understanding. Rules based on a belief rather than facts cannot describe the changing rangelands we protect.

True believers, in politics, religion or range management, are dangerous people. Some of our critics say that because we passionately defend land uses (especially livestock grazing) and cultural subgroups (the "western way of life") our science spawns "I wouldn't have seen it if I hadn't believed it" studies. We all know of exercises like that passed off as science in our profession, but I do not believe they are widespread.

Because we are a profession, we must speak out against shoddy science and discredit those who will not see unless they first believe. And because our second published objective is to develop an understanding of rangelands, we need to be diligent in maintaining honesty in presenting of our science. In an earlier column I suggested that our communications should follow the suggestions of physicist Harmut Grassl: 1) determine what we know for sure, 2) calculate probabilities of outcomes based on what we know, 3) make our best judgement, and 4) admit what we do not know.

We are not an exact science like physics. We search for an understanding of rangelands through an iterative process. We change our rules and recalculate probabilities as our science changes. We attack what we do not know with research.

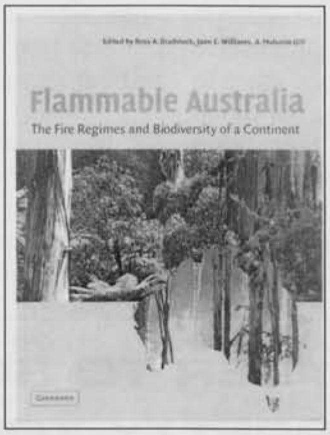
There is a lot of good new research that can lead to the understanding of rangelands. Some of it is published in our own journals; a lot of it in those of other professions. Our knowledge base is growing rapidly. And some new information conflicts with old ideas.

Most of us welcome new information. Like most humans though, we hang on to long held beliefs when new facts conflict with our teaching. But when our understanding depends on iteration, we must constantly reinvent ourselves—accept the new, refine the old and throw out that which is not true. Maybe conquering our resistance to change and accepting the iterative nature of our understanding is more important than a new name or a new logo.

Book Review

Flammable Australia. The Fire Regimes and Biodiversity of a Continent. Edited by Ross A. Bradstock, Jann E. Williams, and A. Malcolm Gill, with 30 text contributors. 2002. Cambridge University Press, Cambridge. UK. 462 p. US$130.00 hardbound. ISBN 0-521-80591-0.

Considering the news releases during Australia's last summer concerning catastrophic fires there, the new book *Flammable Australia* seems especially timely. The collected peer-reviewed work contains chapters that address a variety of aspects of fire, focusing especially on the complexities of regional fire regimes and their effects on Australia's ecosystems, particularly on their biodiversity. The editors are ecologists, and the contributed chapters have a consistent theme that emphasizes ecological effects rather than such topics as the mechanics of prescribed burning or control of wildfires. In general, the book's analyses are conducted on a regional landscape scale.



Flammable Australia is divided into eight parts. Parts 1 and 2 examine fire histories and current and future regimes. Part 1 examines the past and future fire regimes of the continent. Individual chapters include Chapter 1 on the continental history of fire. Australians, in a generally arid landscape rife with climatic variation, are always concerned about climatic change, and Chapter 2 analyzes the effects of a changing climate on Australia's fire regimes. The four chapters of Part 2 focus on fire regimes in general, and their relationships to heterogeneity in landscapes. Individual chapters include *Fire Properties and Burn Patterns in Heterogeneous Landscapes*, and *Fire Regimes in Landscapes: Models and Realities*.

Parts 3–7 discuss the fire ecology of the four main terrestrial ecosystems of Australia, the grasslands, shrublands, woodlands and forests. Chapters 7 and 8 examine the arid spinifex landscapes, and the southeastern temperate grasslands, respectively. Of the three chapters on shrublands, Chapter 9 addresses the Australian heathlands, Chapter 10 the mallee ecosystems, and Chapter 11 the acacia landscapes. The tropical and subtropical savannas of northern Australia and the largely vanished temperate woodlands of southern Australia are the topics of Chapters 12 and 13, respectively. Chapters on the fire ecology of the rainforest communities of northern Australia and the forested landscapes of southern Australia constitute Part 6.

Chapters 16 and 17 in Part 7 on *Applications* are more applied, and are concerned with managing biodiversity and ecosystem function on semi-arid and tropical pastoral lands (Chapter 16) and fire management and conservation of biodiversity (Chapter 17). Chapter 17 involves an interesting, generalized, mostly qualitative, management science approach to fire regimes and biodiversity. It includes discussions of such topics as legislative and policy considerations, flexibilities and ranges in fire management targets, temporal and spatial options in resolving conflicts among fire management goals, Aboriginal fire regimes, and risk and uncertainty analyses. Also it includes a brief outline of a fire management plan for a specific area.

Part 8 consists of Chapter 18, a brief but informative concluding discussion of the legacy and future of fire regimes and biodiversity in Australia. The chapter begins with a brief historical sketch, followed by discussions of attributes of ecosystems, management legacies, events versus regimes, and management philosophies. The chapter asks many questions, reinforcing a frequent observation by the book's contributors of the paucity of research on critical aspects of fire ecology and management. The chapter then offers a discussion of adaptive management of fire regimes and biodiversity, and ends with a diverse list of general recommendations for future research, future management, institutional organization and government policy.

The book contains extensive cited literature listed at the end of each chapter. A taxonomic index and a general index complete the book.

Flammable Australia has a significant management science flavor to it. The book's emphasis on landscape-scale analyses and generalized management science approaches to fire regimes suggests that future research on fire in Australia has a good chance of being designed within appropriate objectives and diverse considerations in mind. Scientists and managers in Australia, in the United States, and elsewhere who are involved with fire ecology and fire management will find it worthwhile technical reading.—*David L. Scarnecchia*, Washington State University, Pullman, Washington, USA.

Board of Directors' Meeting Highlights
2002 Summer Meeting
Flagstaff, AZ

The Society for Range Management 2002 Board of Directors' Meeting was held at the SW Forest Science Complex on the Northern Arizona University campus in Flagstaff, AZ. President Rod Heitschmidt presided.

EVP Albrecht reviewed the mid-year budget and financial reports. He reported that the SRM Annual Meeting profits were considerably higher than budgeted and thus will reduce this year's deficit substantially. Reviewed audit recommendations from the 2002 audit and reported that all have been implemented.

Membership has increased past 4 months. Letters to expired members brought back 64. Life Membership fund drive brought in $16,129.

Kothmann will take the lead in development of a membership plan prior to Casper meeting. Dues increase of $20 for Regular and First Family effective January 1, 2003.

Issue papers will be developed on Climate Change, Biodiversity, and Fire with funds from EPA grant and California-Pacific Section donation. Process for development of issue papers has been established. An MOU for an IPA agreement has been signed with Bureau of Land Management to provide an individual to work out of the headquarters office. Individual should be on board by the end of the year.

Budd presented draft of new committee structure, which will be presented to the Advisory Council and finalized at the Casper meeting.

Jolley reported on the Third Party Vendor issue and how SRM can make certain they are qualified on range issues? A letter with background information is being prepared to send to the Advisory Council and Sections. Will seek to have MOUs between NRCS and SRM, with rules written by the end of the month.

Through a donation from the Redd Foundation, ten ranching families each from Colorado, Idaho, Utah, & Wyoming will be invited to attend the 2003 Annual Meeting in Casper, WY. Funds will pay for registration, banquet & tour.

SRM will co-sponsor the 2003 North American Wildlife Conference.

SRM developed and distributed a press release on the National Research Council's report on Yellowstone National Park. Also developed a draft press release on the NRCS report on riparian areas, which is currently being reviewed.

Albrecht is developing an advertising effort for the 25th anniversary of *Rangelands*.

The poll conducted on the SRM name change yielded a 5% response from the membership, with 102 overwhelming opposed, 77 in favor, 1 didn't care. Rod will follow-up article in *TBN*.

Jolley presented a draft communications & marketing plan. He will be contacting each BOD member by phone or email to get individual thoughts/feedback.

The Awards Committee recommendations for 2003 Honor Awardees was accepted.

Although the Advisory Council did not have a quorum at this meeting, they presented the following items to the Board:

1. In order to remove the implied concurrence, the BOD should no longer "accept" the recommendations of the AC, but rather "receive and take under consideration" the recommendations made by the AC.
2. AC Bylaws be amended to clarify the role of the AC in selection of the AM location. The AC recommends that if the BOD does not approve the AC's meeting site recommendation, it must be sent back to the AC, with justifications, and ask for another recommendation.
3. AC considered the point of order requested by the International Mountain Section and find that the bylaws are unclear and recommend that the bylaws need to clarify if the recommendation for meeting location by the AC is advisory or a directive.
4. Recommends that the issue of changing the name of SRM be dropped and that the BOD increase emphasis marketing the professionalism of the Society.

Sims provided historical update of RAM efforts. Committee is working on a policy statement to be presented to the Board at the 2003 Annual Meeting in Casper.

O'Rourke reported on REAP Task Group's first meeting here at Flagstaff. Developed list of issues with REAP and prioritized top five. Developed vision, mission and goals for task group.

Browsing The Literature

Jeff Mosley

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*.

Animal Ecology

Habitat use by desert mule deer in a semidesert grassland. K.K.G. Koenen and P.R. Krausman. 2002. Southwestern Naturalist 47:353-362. (P. Krausman, School of Renewable Natural Resources, Univ. of Arizona, Tucson, AZ 85721). "Current management practices on Buenos Aires National Wildlife Refuge for masked bobwhite quail appear to benefit desert mule deer."

The effect of vegetation structure on predation of artificial greater sage-grouse nests. M.E. Watters, T.L. McLash, C.L. Aldridge, and R.M. Brigham. 2002. Ecoscience 9:314-319. (Dept. of Biol. Sci., Univ. of Alberta, Edmonton, AB T6G 2E9). Trimming grass around artificial sage-grouse nests did not increase nest predation.

Hydrology/Riparian

Comparison of riparian plant communities under four land management systems in southwestern Wisconsin. L.K. Paine and C.A. Ribic. 2002. Agriculture, Ecosystems and Environment 92:93-105. (Univ. of Wisconsin Extension, P.O. Box 567, Portage, WI 53901). In a comparison of Best Management Practices used to protect stream water quality, this study documented that native vegetation biodiversity was greater with well-managed rotational grazing vs. grass buffer strips.

Grass response to picloram and clopyralid applied before seeding. R.L. Sheley, T.D. Whitson, V. Carrithers, J.S. Jacobs, and J. Gehrett. 2002. Weed Technology 16:645-650. (J. Jacobs, Dept. of Land Resources and Environmental Sciences, Montana State Univ., Bozeman, MT 59717). Applying picloram or clopyralid 24 days or more before seeding reduced weed competition and improved seedling establishment of bluebunch wheatgrass, pubescent wheatgrass, and crested wheatgrass.

Historical trends in willow cover along streams in a southwestern Montana cattle allotment. M. Manoukian and C.B. Marlow. 2002. Northwest Science 76:213-220. (C. Marlow, Dept. of Animal and Range Sciences, Montana State Univ., Bozeman, MT 59717). Extended periods of rest (> 3 years) from livestock grazing are not necessary for willow recovery if livestock and/or wildlife use is moderate.

Native American methods for conservation and restoration of semiarid ephemeral streams. J.B. Norton, F. Bowannie, Jr., P. Peynetsa, W. Quandelacy, and S.F. Siebert. 2002. Journal of Soil and Water Conservation 57:250-258. Simple, bio-engineering structures effectively controlled ephemeral channel erosion in New Mexico.

Riparian vegetation of the lower Rio Grande. R.I. Lonard and F.W. Rudd. 2002. Southwestern Naturalist 47:420-432. (Dept. of Biology, Univ. of Texas Pan American, Edinburg, TX 78539). Two introduced species, Guinea grass and buffel grass, dominated the herbaceous layer.

Restoration of riparian meadows degraded by livestock grazing: above- and belowground responses. D. Martin and J. Chambers. 2002. Plant Ecology 163:77-91. (J. Chambers, USDA Forest Service, Rocky Mountain Research Station. 920 Valley Rd., Reno, NV 89512). Nebraska sedge and Kentucky bluegrass were unaffected by clipping late in the growing season after plants had begun to senesce. Aeration increased rooting activity and rooting depth and may be an effective method for restoring degraded meadows.

Streambank and vegetation response to simulated cattle grazing. W.P. Clary and J.W. Kinney. 2002. Wetlands 22:139-18. (USDA Forest Service, Rocky Mountain Research Station, 316 E. Myrtle St., Boise, ID 83702). Heavy season-long grazing degraded streambanks, but moderate grazing in early or mid-summer did not.

Improvements

Instability in a grassland community after the control of yellow starthistle (*Centaurea solstitialis*) with prescribed burning. G.B. Kyser and J.M. DiTomaso. 2002. Weed Science 50:648-657. (Dept. of Vegetable Crops, Univ. of California, Davis, CA 95616). Unless a site is revegetated, long-term control of yellow starthistle requires periodic prescribed burning or herbicide treatments.

Multi-species grazing and leafy spurge. Team Leafy Spurge. 2002. Team Leafy Spurge's IPM Information Series No. 2. (USDA-ARS, Northern Plains Agr. Research Lab., 1500 N. Central Ave., Sidney, MT 59270). This CD-ROM contains a narrated PowerPoint presentation, photos for use in your own presentations, and several in-depth reports on prescribed livestock grazing to control leafy spurge.

Turpentine (*Eremophila sturtii*) control by mechanical uprooting. H.T. Wiedemann and P.J. Kelly. Australian Rangeland Journal 23:173-181. (Biological and Agricultural Engineering Dept., Texas A&M Univ., College Station, TX 7783-2117). Following grubbing, covering exposed roots with soil prevented regrowth by a root-sprouting shrub.

When less is more: Optimization of reduced agent-area treatments (RAATs) for management of rangeland grasshoppers. J.A. Lockwood, R.A. Sprecher, and S.P. Schell. 2002. Crop Protection 21:551-562. (Dept. of Renewable Resources, Univ. of Wyoming, Laramie, WY 82071). Grasshopper control is optimized with carbaryl applications of 0.25-0.40 lbs active ingredient per acre applied to only 50% of an infestation using 100-ft swaths.

Measurements
Estimation of leafy spurge cover from hyperspectral imagery using mixture tuned matched filtering. A.P. Williams and E.R. Hunt. 2002. Remote Sensing of Environment 82:46-456. (USDA-ARS, Hydrology and Remote Sensing Lab., BARC W., Beltsville, MD 20705). Satellite imagery'can be used to map leafy spurge in prairie sites, but less so in wooded sites.

Plant-Animal Interactions
Transformations of the Chihuahuan borderlands: grazing, fragmentation, and biodiversity conservation in desert grasslands. C.G. Curtin, N.F. Sayre, and B.D. Lane. 2002. Environmental Science and Policy 5:55-68. (Arid Lands Project, Box 29, Animas, NM 88020). This ecological-based review of the ranches vs. ranchettes debate concludes that ranching represents the most viable means of sustaining ecological function.

Plant Ecology
A state-transition approach to understanding nonequilibrium plant community dynamics in Californian grasslands. R.D. Jackson and J.W. Bartolome. 2002. Plant Ecology 162:49-65. (Ecosystem Sci. Division, Univ. of California, Berkeley, CA 94720). These authors present a state-transition model for Californian grasslands.

Assessing the rate, mechanisms, and consequences of the conversion of tallgrass prairie to *Juniperus virginiana* forest. J.M. Briggs, G.A. Hoch, and L.C. Johnson. 2002. Ecosystems 5:578-586. (Dept. of Plant Biology, Arizona State Univ., Tempe, AZ 85287). Grassland species are virtually eliminated when tallgrass prairie converts to closed-canopy red cedar forest, a process that can occur in as little as 40 years. Livestock grazing can reduce fine fuels, thereby decreasing fire-induced tree mortality.

Interspecific competition and resource pulse utilization in a cold desert community. R.L.E. Gebauer, S. Schwinning, and J.R. Ehleringer. 2002. Ecology 83:2602-2616. (Dept. of Biology, Keene State College, Keene, NH 03435). Rubber rabbitbrush, greasewood, and broom snakeweed primarily competed with each other for water in deep, rather than shallow soil layers.

Nonequilibrium dynamics of sedge meadows grazed by cattle in southern Wisconsin. B. Middleton. 2002. Plant Ecology 161:89-110. (Dept. of Plant Biology, Southern Illinois Univ., Carbondale, IL 62901). Results support the concept that past cattle grazing history can cause plant succession to reach endpoints that differ from ungrazed sites.

Reclamation/Restoration
Competition and survival of perennial cool-season grass forages seeded with winter wheat in the Southern Great Plains. B. Kindiger and T. Conley. 2002. Journal of Sustainable Agriculture 21:27-45. (USDA-ARS, Grazinglands Research Lab., 7207 W. Cheyenne St., El Reno, OK 73036). Crested wheatgrass, tall wheatgrass, intermediate wheatgrass, smooth brome, and western wheatgrass can be grazed by livestock during the first year of sowing when they are inter-seeded with winter wheat in the southern Great Plains.

Long-term survival of direct seeded Wyoming big sagebrush seedlings on a reclaimed mine site. G.E. Schuman and S.E. Belden. 2002. Arid Land Research and Management 16:309-317. Wyoming big sagebrush survival averaged 59% after 8 years. Seeded grasses sheltered sagebrush seedlings from wildlife browsing, thereby increasing sagebrush survival.

Socioeconomics
Profitability of grazing versus mechanical forage harvesting on New York dairy farms. B.A. Gloy, L.W. Tauer, and W. Knoblauch. 2002. Journal of Dairy Science 85:2215-2222. (Dept. of Applied Economics, Cornell Univ., Ithaca, NY 14853). Dairy farmers using rotational grazing were at least if not more profitable than farmers using mechanical forage harvesting.

Soils
Soil nitrogen availability under grasses of different palatability in a temperate semi-arid rangeland of central Argentina. A.S. Moretto and R.A. Distel. 2002. Australian Ecology 27:509-514. (R. Distel, Univ. Nacional Sur, CONICET, CREZOS, RA-8000 Bahia Blanc, Buenos Aires, Argentina). Replacement of palatable grasses by unpalatable grasses may reduce nitrogen cycling.

Author is professor of range science and Extension range management specialist, Dept. of Animal and Range Sciences, Montana State Univ., Bozeman, Mont. 59717.

Rangelands Index for 2003

New Products and Services

Field Computer (Pictured at Right)

Juniper Systems, Inc. introduces the Allegro CE, a rugged waterproof PC built for collecting data in harsh environments. The versatile technology provides mobile GPS and GIS applications and can be used for forest inventories, timber cruising, regeneration surveys, wetland delineation, land mapping, hydrology studies, range analysis, vegetative and trend studies and much more.

The Allegro CE weighs only 1.84 lbs; battery and PC card compartments are easily accessed; the rugged case is shock and chemical resistant and operates in temperatures ranging from -22 to 130 degrees F.

For more information visit www.junipersys.com

Monitoring Services

Telemetry Solutions offers equipment and services for wildlife and livestock monitoring studies. They offer a variety of collars for tracking using GPS positioning or traditional VHF equipment.

For more information visit their recently updated website at www.telemetrysolutions.com.

To submit a new product to be featured in future issues contact Kindra Gordon at kindras@gordonresources.com or call (605)722-7699.

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