Rangelands

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COVER PHOTO: Front: Discussions of grazing conditions with various herders. **Back:** Young Mongolian horseman in dry mountain steppe. Photos by Donald J. Bedunah. See related article starting on page 18.

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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

Rangelands serves as a forum for the presentation and discussion of facts, ideas, and philosophies pertaining to the study, management, and use of rangelands and their several resources. Accordingly, all material published herein is signed and reflects the individual views of the authors and is not necessarily an official position of the Society. Manuscripts from any source—nonmembers as well as members—are welcome and will be given every consideration by the editors. *Rangelands* is the nontechnical counterpart of the *Journal of Range Management*; therefore, manuscripts and news items submitted for publication in *Rangelands* should be in nontechnical nature and germane to the broad field of range management. Editorial comment by an individual is also welcome and, subject to acceptance by the editor, will be published as a "Viewpoint."

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Executive Vice-President's Comments

The Board of Directors has recently been re-visiting our strategic plan for the purpose of an update, and adding a business plan to aid in implementation. Because of this activity I will try and bring the membership up to date on this important process.

Strategic planning is the process of examining an organization's current situation and future prospects, setting goals, developing a strategy to meet those goals, and measuring the results. It is an ongoing process, not a project with a beginning and an end. Success is to have engaged in the process of "planning strategically", not put a plan on a shelf.

SRM initiated a planning process back in 1993, and developed information that since that time has served as our "strategic plan". We did not follow the text book approach to strategic planning so we don't have a well defined set of goals and a strategy to meet them. What we do have is a set of three issues and recommended actions to deal with two of them. These issues are:

1. A weak base of support.
2. The desire to exert timely leadership on rangeland issues.
3. Lack of funds for program expansion.

We have not moved much over the past seven years in aligning our committees, staff and funds to address these identified issues, although in 1999 the Board did take action to add the original objectives at the time SRM was incorporated, to the strategic plan. They then organized the committees into focus groups, each group addressing one of the original objectives. These objectives are printed on page one of each issue of *Rangelands*. By taking this action, at least one very valuable element was added to the plan. This was the idea of serving the membership, or as the objective states "to promote the professional development of its members".

Much of the discussion in our planning effort in 1993 was centered on the "death of SRM". I personally feel that too much energy has been expended on solving current and past problems, and not enough thought given to what we want to be in the future. Planning the necessary actions to solve today's problems is an annual work plan. Setting goals and determining actions to achieve what and where we want to be at some point in the future is a strategic plan.

A logical approach in the ongoing update of our plan might be to focus on the five basic questions for strategic planning in an organization like SRM.

1. Why do we exist? What is our organization's primary purpose?
2. What essential thing do we do, what service do we render or value we contribute?

3. For whom do we exist; who benefits most from what we do?
4. What do we do better than all others?
5. If we did not exist, would it make any difference?

By addressing these questions, SRM may be able to identify those things we are not doing today, which we must be doing at some point in the future to be successful. This implies change—doing new things or doing more or less of current activities to ensure a successful future.

Our current effort lacks two important elements: more emphasis on membership service, and more direction on a business management strategy for the organization. The Board, with assistance from appropriate committees and individuals, will soon have updated our plan to cover these important areas. Also, more visible implementation strategies for the existing issues will be developed. The hope is that by the end of the year we will have a business plan, an updated five-year financial plan, and a communication and marketing plan. What will all of this solve? One will be an issue that I face each year in budget planning called "dilution of resources". If you don't have a firm, agreed on plan, money, staff, and the energy of volunteers can be spread too thin in many directions. What we hope is that the assets and resources will be focused on the best interests of the organization.—**Craig Whittekiend, EVP**

CHEATGRASS CONTROL AND SEEDING

James A. Young and Charlie D. Clements

Currently, there is a rebirth of interest in using herbicides to control the invasive annual cheatgrass in conjunction with seeding perennial grasses, forbs, and shrubs to restore what once were big sagebrush/bunchgrass plant communities. This work is being conducted by a new generation of range scientists who may benefit from knowledge of how some of the basic principles of herbaceous range weed control were established.

This is a brief account of the development of several of the basic principles of herbaceous range weed control conducted in conjunction with seeding perennial grasses. It is the story of the accomplishments of three quality range scientists: Richard E. Eckert, Jr. and Raymond A. Evans of USDA, Agricultural Research Service (ARS) and Burgess L. Kay of the University of California.

The Cast of Players

Evans, Eckert and Kay started working together in the late 1950s. They came from diverse backgrounds and educational experiences. B. L. Kay was a graduate of the School of Forestry of the University of California at Berkeley. He was a range weed control and seeding specialist with the California Agricultural Extension Service at Davis. R. A. Evans received his Ph.D. from the botany department at the University of California at Berkeley. His dissertation was about seedling competition among annual range plants. He worked for the California Soil and Vegetation Survey before joining the ARS at Reno, Nevada. R. E. Eckert, Jr. received his Ph.D. in range science at Oregon State University where his dissertation concerned soil and vegetation relations in the high deserts of eastern Oregon. Previously, he completed a masters of science degree at the University of Nevada, working on winterfat communities and halogeton invasion.

These three conducted cooperative research in California and Nevada. Occasionally, they disagreed, rarely they fought, and for over 30 years they developed revegetation technology for rangelands. Their research effort defined the ecological principles of herbaceous range weed control. They built on the generation that preceded them and left a legacy for those that followed.

Setting the Environmental Stage

Perhaps, the first range scientist to state the most basic aspects of range weed control and seeding was Arthur Sampson working in the Wallowa Mountains of Oregon in 1907. He was not very successful in trying to seed degraded rangelands because of the limited choice of plant material available, but he had the vision to define the nature of the problem.

The basics of seeding degraded big sagebrush/bunchgrass to crested wheatgrass were developed by USDA, Forest Service scientists during World War II. The post war years brought a tremendous increase in rangeland seeding as a result of programs to suppress the poisonous weed halogeton. These efforts were highly successful, but most of the early seedings were established in degraded sagebrush sites where cheatgrass was not a problem. What principles did these initial trials conducted by scientists such as Joe Robertson, A. C. Hull, Jerry Klomp, or A. Perry Plummer establish (Table 1)? These points seem ridiculously simple, but at the time many seedings were lost to continuous grazing during the seedling year.

Table 1. Principles of seeding degraded big sagebrush/bunchgrass ranges with perennial grasses that were developed by the initial group of range scientists working in this area.

1. Tillage was necessary for control of big sagebrush. Disk plowing with wheatland type plows was used until the rangeland plow was developed.
2. The better the seedbed preparation, the better the chances of seedling establishment. Rough, trash covered seedbeds that resulted from plowing were a problem.
3. The seedling stands had to be protected from grazing until after seed ripe the second year after seeding.
4. If the seedings were protected by fencing, water development was required before they could be utilized.

Most of the early crested wheatgrass seedings in the Great Basin were established by plowing degraded big sagebrush stands. One exception to the requirement for mechanical tillage to control big sagebrush was the seeding of areas burned in wildfires. Prescribed burning, followed by seeding was not extensively practiced during the 1940s because of lack of herbaceous vegetation to carry fires. If there was enough native perennial vegetation to carry a fire, seeding was not necessary.

Gradually range managers reported seeding failures when they tried to seed degraded sagebrush ranges that were infested with the exotic pest cheatgrass. J. H. Robertson, in the early 1940s, determined that cheatgrass dominated plant communities were closed to the recruitment of perennial grass seedlings because of competition for moisture. Robertson became a professor of range science at the University of Nevada where he was the mentor of R. E. Eckert during his Masters of Science program.

B. L. Kay worked on the complex annual-dominated communities on the west of the Sierra Nevada where his aim was to establish annual legumes. Raymond Evans was familiar with the research being conducted by B. L. Kay and both cooperated with C. M. McKell when he was an ARS scientist stationed on the University of California, Davis campus.

First Rangeland Herbicides

The phenoxy herbicides had been discovered during World War II and such materials as 2,4-D found numerous applications in agriculture in the immediate post war years. Range scientists such as Don Hyder and A. C. Hull were quick to discover that 2,4-D could be used to reduce competition from over abundant woody species. Big sagebrush control was widely practiced in the Intermountain Area with 2,4-D applications. The early range herbicidal weed control scientist soon determined that it was useless to control sagebrush unless there were sufficient remnant perennial grasses to occupy the environmental potential released by killing the woody species. The standard for predicting the success of a herbicide application became, "You had to be able to step from one remnant perennial grass to the next for the brush control to be successful." Obviously, short range legged conservationists were at a disadvantage, but the general concept was valid.

"You had to be able to step from one remnant perennial grass to the next for the brush control to be successful."

Halogeton was the major issue in range management in the Intermountain Area in the 1940s and 1950s. The herbicide 2,4-D was proposed and tried for the control of the poisonous exotic annual halogeton. The herbicide is a physiologically selective material in that when applied at proper rates it will kill broadleaf plants and not injure grasses. In the case of halogeton control it was not selective when applied to salt desert shrub communities infested with the poisonous weed. Although it readily killed halogeton it also killed the native broadleaf shrubs, creating more habitat for halogeton in subsequent years. In salt desert plant communities, the hazards of applying 2,4-D to halogeton infestations was exasperated by the lack of adapted plant material to revegetate areas where halogeton was controlled. You have to close the ecological near voids created by weed control treatments on rangelands

Evans, Eckert and Kay used screen boxes to exclude cheatgrass seeds in an effort to determine the extent and nature of seedbank on sagebrush rangelands.

with desirable plants. This applies to all types of weed control practices from mechanical, through herbicidal, and includes biological control.

Evans, Eckert, and Kay were faced with a very challenging weed control problem. They wanted to control an annual grass, cheatgrass, and replace it with seedlings of a perennial grass.

New herbicide formulations were proliferating rapidly in the 1950s, but truly physiologically selective material never became available for cheatgrass control. Researchers turned to herbicides that killed cheatgrass and would also kill perennial grass seedlings. To make weed control systems work with such herbicides, they would delay seeding until phytotoxic residues of the herbicide were dissipated.

Seedbed Ecology of Annual Grasses

It became apparent that cheatgrass builds a large seedbank that contains 2 or 3 times as many viable seeds as the current years population of plants. A herbicide was never developed that killed dormant seeds in the seedbank. Control measures had to be applied after at least a portion of the seedbank had germinated or a herbicide had to be used that maintained herbicidal activity in the soil for a long period of time, killing the annual grass seedlings as they emerged.

The dynamics of germination and seedling establishment of annual grasses on rangelands put further constraints on the development of herbicidal control and revegetation treatments. In California annual grasslands, germination occurs with the first effective rain in the early fall. The first species to germinate and establish, gain initial dominance until the taller growing grasses win the competition for light. An effective herbicide must kill the emerging annual grass and broadleaf seedlings and leave no residue so seeding of forage species can follow immediately. If seeding is delayed until late in the fall it will be too cold for seedling growth of the revegetation species. In cheatgrass communities in the Intermountain Area, some germination can occur in the fall, but often the bulk of germination occurs in the very early spring. Again timing is of the essence. You have to wait until the cheatgrass emerges, control it with a herbicide, and get the seeds of the forage species to germinate, emerge, and establish before the onset of the summer drought.

Paraquat

The discovery of the herbicide paraquat in England and its subsequent development in the United States offered a new potential for herbaceous range weed control. Paraquat was a broad spectrum herbicide that killed most annual weeds upon contact. The unique aspect of paraquat was that it was deactivated upon contact with the soil. This meant that herbicide application and seeding could be done simultaneously. For use on the California annual range, B. L. Kay installed a sprayer on a modified rangeland drill. Because in this environment competition was for light instead of primarily moisture, he successfully experimented with spraying bands directly over

In well established cheatgrass stands seedling density can reach 1,000 plants per square foot.

the drill row to reduce the cost of herbicide applied. For cheatgrass in the Intermountain Area, Evans and Eckert found that only broadcast spraying gave sufficient reduction in cheatgrass to allow for perennial grass seedling establishment.

In well established cheatgrass stands seedling density can reach 1,000 plants per square foot. In a pioneer competition study, R. A. Evans determined that cheatgrass densities from 64 to 256 per square foot severely decreased seedling growth of crested wheatgrass. Cheatgrass densities as low as 4 plants per square foot were detrimental to crested wheatgrass establishment. This study provided a guideline for the level of weed control that was required in the field. This was confirmed in the field in the studies where Evans and Eckert compared band and broadcast application of paraquat.

The paraquat technique became popular on the California annual ranges for establishment of annual legumes, but never was widely used in the Intermountain Area for cheatgrass control. There were several interacting reasons for lack of popularity for cheatgrass control. First was a general lack of interest by public land management agencies in the application of herbicides. Secondly, paraquat was never consistently aerially applied for cheatgrass control under Intermountain conditions. The final blow to paraquat was the discovery of its high mammalian toxicity (for a herbicide). Paraquat became a restricted use pesticide.

Chemical Fallow

Paraquat application with simultaneous spring seeding was a substitute for light disking or harrowing to reduce competition before planting. Chemical or herbicidal fallows are a substitute mechanical tillage to allow land to lie in a weed free fallow for a growing season before planting. Fallows are widely used in cereal grain production. Besides providing weed control, the fallow period stores moisture and nitrate for use by the subsequent planting.

The advantage of a herbicidal fallow is the weed control procedure can be applied aerially over soil surfaces and topography that make mechanical tillage impossible. The system proved to be very successful for the cheatgrass ranges of the Intermountain Area.

Evans and Eckert tried virtually all the available herbicides that had soil activity. These are herbicides that plants picked up through their roots rather than their leaves. This allows the herbicide to be applied before cheatgrass germinates (pre-emergence) and still kill the annual grass. Their two main evaluation criteria were: 1) the spectrum of control be broad enough to kill virtually all cheatgrass and associated annual species at an economical rate, and 2) the herbicidal active residue be gone by 1 year after application. Based on extensive trials they selected the herbicide atrazine applied at the rate of 1 pound per acre active ingredient. Atrazine was ap-

Successful large scale seeding in Nevada where a herbicidal fallow technique was used to suppress cheatgrass.

plied in the fall (October through November), the treated area was fallow the next growing season, and then seeded to perennial wheatgrasses the following October.

Evans, Eckert and Kay did not work in a vacuum. Harold Alley was very active in the field in Wyoming. Range Weed meetings and tours were sponsored every 2 years by the USDI, Bureau of Land Management where ideas were shared among researchers and land managers. Many land managers experimented with weed control-revegetation techniques. Herbicide manufacturing provided input through quality scientists such as M. D. Christensen who made valuable contributions to the success of the techniques.

Seedbed Quality

Eckert and Evans made the atrazine fallow technique work and fine tuned the process by understanding why the system was so effective. Atrazine is a very insoluble material that

Range weed control and seeding tours were jointly sponsored by research and land management agencies during the 1960s and 1970s as a means of informing researchers about the needs of managers and for transferring the latest research information. Range weed tour near Worling, Wyoming attended by Ray Evans, B. L. Kay and Gerry Klomp in the early 1960s.

Ray Evans and Dick Eckert determined through micro-environmental monitoring that small furrows greatly enhanced the establishment of wheatgrass seedlings.

stays very close to the soil surface where the cheatgrass seedbank was located. Atrazine did not kill un-germinated, but viable cheatgrass seeds. The researchers consistently obtained better stands by seeding at the bottom of small furrows. This built on the research of William McGinnies that showed the favorable micro-environment for germination and seedling establishment that furrows created. In the case of atrazine fallows the furrowing action pushed any herbicide residues to the side, away from the planted wheatgrass seeds. The same action also moved the cheatgrass seedbank to the side.

There was virtually no cheatgrass competition in the seedling year of the perennial wheatgrass planting. There were still plenty of viable cheatgrass seeds in the surface soil seed-

As soon as electronic temperature, moisture, and relative humidity sensors became available, Evans, Eckert and Kay built from scratch data recorders that would operate at remote locations using batteries for power. They used this data to define the parameters of field seedbeds on both Intermountain and California annual dominated rangelands.

bank, but they could not germinate because during the fallow year the thin skiff of cheatgrass litter had decayed or blown away leaving the seeds in a seedbed environment that was outside their inherent potential to germinate. The finding that the herbicidal fallow created a physical change in the seedbed that limited germination of the weed is among the most significant of Evans, Eckert and Kay's contribution to range science. The cheatgrass germination limiting aspect of the treatment is even more astounding when you consider that nitrate accumulations during the fallow help to break the dormancy of cheat-

Ray Evans (extreme left) and Dick Eckert (extreme right) reviewing with land managers (unidentified) the success of a 1,000 acre experimental plot in northern Nevada where cheatgrass was controlled with atrazine and perennial grasses established.

grass seeds in the seedbank making more seeds available if they were in an environment that permitted germination.

Fate of the Paraquat and Atrazine Methods

Eckert and Evans conducted cooperative atrazine weed control-revegetation trials with land management agencies where a single experiment was over 1,000 acres in extent. The experiments featured aerial application of the herbicide and the use of specially modified rangeland drills. The trials were uniformly successful.

Evans, Eckert, and Kay were instrumental in collecting the myriad of data that was necessary for the registration of paraquat and atrazine for use on rangelands for cheatgrass and other annual species control. Their innovative methods were outstanding, their interpretations of why systems worked was brilliant, but their timing was terrible. By the time their herbicide techniques were perfected in the mid-1960s the public land management agencies turned completely away from range improvement. The cheatgrass problem could be solved through grazing management systems. The requirements of new environmental laws made it impossible to apply pesticides without a prolonged environmental review process.

As previously mentioned, paraquat was found to be dangerous to handle and apply so it became a restricted use material. By the time it was necessary to renew the registration for the use of atrazine on rangelands it was a restricted use pesticide because of problems with water contamination in the mid-west. These water problems are real, but they occurred in a humid environment where over 10 pounds per acre atrazine was applied annually to cropland for over 2 decades. The proposed range usage was 1 pound per acre and this was to be applied once only. At the time of registration renewal, atrazine was no longer a proprietary product. The original patent had expired. The current manufacturers looked at the record of rangeland sales and could not determine any potential for profit in the field so the registrations were not renewed.

The Future of Herbaceous Range Weed Control

The extent of cheatgrass dominance of former sagebrush/bunchgrass rangelands has grown to such a huge problem that the general public is demanding that public land management agencies do something to stop the endless cycles of destructive wildfires. A new generation of herbicides is being experimented with by a new generation of scientists and land managers. The previous generations of scientists such as B. L. Kay, R. A. Evans, and R. E. Eckert, Jr. did not evolve all the answers for cheatgrass control and revegetation, but their awesome legacy of knowledge should not be ignored.

Suggested Reading

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Campbell & Sons Ranch

Colorado Section SRM 1999 Excellence in Rangeland Conservation Award

by David Bradford, Floyd Reed, Jess Campbell, Calvin Campbell and Chad Campbell

The Campbell & Sons Ranch is a 500 acre family-owned and operated ranch located on the North Fork of the Gunnison River in western Colorado. The ranch lies between the towns of Hotchkiss and Paonia. As part of their ranching operation the Campbells hold a grazing permit on the 9,000 acre West Terror grazing allotment, north of Paonia, on the Gunnison National Forest.

Campbell & Sons Ranch received the 1999 Colorado Section SRM's "Excellence in Rangeland Conservation Award" for their outstanding management of the West Terror grazing allotment. The Campbells run 312 cow/calf pairs on the allotment from June 16 to October 15. In 1996 the Campbells initiated a new management strategy that is based on grazing their cattle as a single herd using time-controlled grazing. This grazing strategy was accomplished by developing seven pastures on the allotment using temporary electric fence, permanent electric fence, standard barbed wire fences and natural barriers and constructing six new spring developments. Pasture moves are based on the frequency that plants are grazed, intensity of grazing and opportunity for

plant growth or regrowth. The grazing periods on the seven pastures vary from 3 to 33 days.

Prior to 1999, the management on the West Terror allotment was typical of many National Forest grazing allotments. Cattle were turned on to the allotment when the low-range vegetation was ready for grazing, usually on June 16. They were moved to higher elevations as the vegetation developed. The cattle stayed on the allotment until

Schools for Ranchers that were sponsored by Colorado State University Cooperative Extension (see related article in this issue). Based on the principles taught in these courses the Campbells and the Forest Service developed the new management strategy.

The change in management in 1996 produced immediate and dramatic improvements. Early grazed pastures were allowed to regrow after grazing and late grazed pastures were allowed to reach

maximum development prior to grazing. Areas that were repeatedly grazed prior to 1995 were grazed only once under the new management. We have observed a continual improvement in conditions from 1996 through 1999.

The change in management and improvement in conditions has been noticed by neighbors and the public. On one piece of private land that borders the West Terror allotment the owners requested that the Campbells graze

the property to improve conditions for wildlife. The owners had originally purchased this oakbrush/aspen property for hunting—mule deer and elk. At the time they purchased the property there had been a grazing lease. The leasee was grazing approximately 90 head of

Campbell & Sons Ranch located on the North Fork of the Gunnison River—livestock handling facilities. Mt. Lamborn (L) and Lands End Mountain (R) of West Elk Mountains, Gunnison N.F. in background.

October 16 and were kept scattered by riding, salting and water developments. Management was acceptable but some areas were repeatedly grazed as cattle drifted back to preferred sites resulting in over-use. In 1995 the Campbells attended the first Range Management

Campbell & Sons Ranch located on North Fork of the Gunnison River—Cattle just coming back to the ranch after grazing on the West Terror allotment, Gunnison N.F. for the summer.

cow/calf pairs or yearlings from May through September. This type of grazing, allowed the cattle to repeatedly graze preferred sites, resulted in over-use of these areas and caused a decline in conditions. As a result the owners terminated the grazing lease. Over the next few years as the ungrazed vegetation became more overgrown and coarse, the owners noticed that the deer and elk were using their property less and less—resulting in reduced hunting opportunities. However, they noticed on the adjacent West Terror allotment that deer and elk were commonly found grazing on the green regrowth. They asked the Campbells if they would be willing to graze their land in a similar fashion to what they were doing on the West Terror allotment. The Campbells have incorporated this private land property into their grazing rotation. They graze this area with their full herd from June 1 to June 15, just before they turn-on to the National Forest. This early grazing followed by a full summer of rest, allows the vegetation to regrow and provides more palatable, nutritious forage for wildlife. It also provided two weeks of late spring grazing for the Campbells' livestock.

There are four generations of Campbells that live and work on the Campbell & Sons Ranch. The family

has owned the ranch since the late 1880's. The ranch consists of approximately 500 acres of private deeded land and runs 300 cow/calf pairs, 30–40 heifers, and a small herd of bison. The ranch lands are all managed as improved pastures. Irrigation water comes from the North Fork River. The ranch produces 400–450 tons of grass or grass/alfalfa hay per year, in two cuttings. The Campbells have worked at increasing the productivity of their lands by using time-controlled grazing on their private lands as well as on the National Forest. Some pastures are grazed in the spring, hayed one time in the summer and grazed in the fall. Some pastures are hayed twice during the summer and grazed only in the fall. The ranch emphasizes grazing where possible.

The Campbells run primarily Angus/Angus-Hereford-cross cattle. They calve from early February through early April. They wean over 90% of their calves and finish 60% to slaughter. Last fall their steers averaged 610 lbs. at weaning in October. Since initiating the new management the cattle have come off the Forest in better condition than in the past—the cows rate an average of condition class 7.

Like most ranches in the North Fork, the ranch is fairly small. The North Fork valley has been a fruit growing region

since the 1880's. The development of the fruit industry caused much of the valley land to be broken up into small parcels that were practical for fruit-growing. The large, open range livestock operations that are common in many parts of the West are unusual in the North Fork. The Campbells' present operation is actually made up of seven different original homesteads, nearly all of which were in fruit at one time. It is now the largest area of open space between Hotchkiss and Paonia. The demand for land for housing subdivisions is moderate in the North Fork, compared to other parts of Colorado. But even this demand has caused real estate prices to increase. This demand is hampering ranchers from adding additional property to their land base. As a consequence the relationship of the ranch and the adjacent Gunnison National Forest is critical. Without the National Forest grazing allotment, the Campbells would not be able to maintain their operation. This would likely result in the land being broken into smaller parcels, thus reducing open space in the valley as well as the land being used more intensively and probably being maintained in reduced condition. The Campbell Ranch is a good example of the importance of public land grazing permits to privately owned ranches and how these ranches provide open space in the West.

The Campbell & Sons Ranch was recognized by CSSRM for their exemplary management and demonstrating that improved grazing management can be implemented on a moderate sized allotment with moderate investment and produce excellent results.

Authors are Range Conservationist on the Paonia Ranger District, Gunnison National Forest; Range Staff for the Grand Mesa, Uncompahgre and Gunnison National Forests; and owners/operators of the Campbell & Sons Ranch, Hotchkiss, Colorado.

Range Management Schools for Ranchers: Or How to Teach Plant Phenology, Forage Utilization, Plant Physiology and Other Esoteric Range Management Concepts to a Bunch of Cowboys

Robbie Baird LeValley, John Murray, Floyd Reed, John Hawks and David Bradford

Western Colorado, like many parts of the West, has experienced conflict over livestock grazing on public rangelands. This conflict has often created discord, uncertainty and stress. The early 1990's were very troubling times for public lands ranchers. It was in this atmosphere of apprehension that public land ranchers of the Uncompahgre Basin began asking for help in learning what was expected of them. In response to these requests Colorado State University Cooperative Extension in 1995 brought together representatives from the Natural Resources Conservation Service (NRCS), the U.S. Forest Service (FS) and the Bureau of Land Management (BLM) to develop a range management training program for ranchers. The agency representatives identified key permittees who were interested in getting more information on the science and practical application of progressive range management. Eighteen producers were invited to help determine the curriculum content. From this initial meeting developed the idea of the Range Management School for Ranchers.

The permittees told us what they wanted. They wanted details. They did not want the basics; however, they also did not want to be overwhelmed with scientific jargon. They wanted information that would help them understand what was happening on the range. They wanted to know how to evaluate the range and how to influence conditions. They wanted information that would help them defend their livelihood. They asked for material that would be presented in a concise form with an emphasis on fieldwork that demonstrated the classroom instruction. They asked that the government agency people also attend the sessions—so that everyone involved in the on-the-ground management was hearing the same things. With these sideboards, the Range Management School for Ranchers was developed. Two courses, the introductory course—Range 101, and a more advanced course—Range 501, were set up to meet the ranchers' requests.

The first Range 101 course was held in December 1995. Sixty-two grazing permittees, federal land managers, private

rangeland owners and environmentalists attended. The class consisted of two days of classroom instruction and two days of field instruction. Subjects covered in the classroom included plant identification, how a grass plant grows, plant responses to grazing, range nutrition, biological planning, range monitoring, animal behavior, range economics, range improvements and poisonous plants. The field session emphasized plant identification and on-the-ground examples where improved management had resulted in significant improvements.

The Range 501 course was held the following spring of 1996, with the same participants returning. In the more advanced 501 class, we went into the details of designing a grazing management plan. This included what the federal agencies require—carrying capacity, trends, rangeland monitoring, grass growth curves, and biological planning. The participants were required to develop a grazing plan on an actual allotment with all of the resource concerns and landscape characteristics of that allotment. The participants then had to present their plans to the class. This proved to be an invaluable exercise. The field session for Range 501 included a trip to the allotment that they worked on in class, additional plant identification and areas where changes were being made on the time and timing of grazing.

Each course participant received a resource notebook. The information contained in the notebook included material from Colorado State University Rangeland Ecosystem Science Department, pertinent articles from *Rangelands* and the *Journal of Range Management*, NRCS publications, reports from the USDA-ARS Poisonous Plant Lab and speakers handouts. The publication *Grass: The Stockman's Crop* by Harland Deitz is particularly useful. The cost of the notebooks was covered in part by a Renewable Resources Extension Act grant. The cost to each participant was \$15 per session.

We went back to the course participants and asked them for a critique of the courses. The result of that survey was that some topics were deleted and each course was condensed down to one day. However, we found that we were right-on with the focus of the schools—to provide in-depth range education via classroom instruction, field tours and practical application. The newly formatted classes were presented in Gunnison and Norwood, Colorado in January 1996. The revised sessions included the subjects of grass growth, plant responses to grazing, grass growth curves, range nutrition, the time and timing of grazing, rangeland monitoring, indicators of range health, grazing response index, and designing a grazing plan. The field sessions followed in September 1996 and again looked at areas where improved management has taken

Range 101 Curriculum	Range 501 Curriculum
Grass Plant Physiology	Plant Identification
Plant Phenology	Designing a Grazing Plan
Grazing Responses	Range Health Indicators
Range Nutrition	Plant Growth Curves
Rangeland Monitoring	Biological Planning
	Grazing Response Index

place. We received positive feedback on both these sets of courses.

With the positive responses for these first four schools and additional requests from other ranchers in the area, courses have also been taught in Rifle, Colorado in November 1997, Steamboat Springs, Colorado in December 1997, and again in Delta/Montrose, Colorado in December 1997. A 1998 total of 410 permittees, federal land managers, environmentalists and private rangeland owners have attended the Range Management Schools (RMS) since their inception in 1995. Pre and post-course evaluations have shown an average 34% increase in knowledge gained from the RMS. The range management school idea has spread to other parts of Colorado. In Southeast Colorado, Regional Range Specialist, Tim Steffens is teaching a grazing school over a six-week period. But the bigger story is what is happening on the ground.

Dozens of grazing allotments on the Grand Mesa, Uncompahgre and Gunnison National Forests have initiated significant changes in management on their allotments. The same is true for BLM allotments on the Uncompahgre Resource Area. A number of grazing permittees have initiated their own monitoring programs. Colorado State University Cooperative Extension assists the permittees in the first three years in setting up and developing their monitoring program. In fact the response has gotten so strong that it is a major

challenge to the Forest Service and BLM to keep up with all the proposed management changes. (See related article on the West Terror allotment).

The Dry Fork Allotment

One specific example of ranchers who have initiated changes in their management is the Dry Fork Livestock Association. The Dry Fork Allotment is located near Paonia, Colorado and borders the West Elk Wilderness. This group of four ranchers historically grazed 405 cow/calf pairs on four areas/allotments from May 15 to October 15.

Some of the areas/allotments were grazed for the entire grazing period while some were split into pastures. For the most part, grazing periods were 30 days long. This had resulted in the typical pattern of over-grazed/under-grazed areas. The over-grazed areas had low plant diversity, reduced plant density and low plant vigor. They also looked bad. The under-grazed areas were over-rested—usually showing a significant accumulation of plant litter, reduced plant diversity and reduced plant vigor.

In January 1996, after participating in the Range Management School the permittees proposed a number of management changes on the allotments. The changes involved creating smaller grazing units and grazing these units with larger numbers of cattle for shorter periods of time. Taking

advantage of natural barriers and temporary electric fence created most of these units. The current management system uses 25 grazing units, with grazing periods varying from 5 to 22 days.

These changes have provided a number of benefits - most notably there is a more even utilization of forage plants on the range and grazed plants were given the opportunity to grow before grazing occurs or to regrow after grazing. This has resulted in improved plant density, vigor and diversity. This management strategy has also provided more flexibility, as the increase in grazing units has given the permittees more control of their cattle and allows them to make easier adjustments due to cold weather, drought, poisonous plants, etc.

The Dominguez Allotment Example

Another specific example of a change based on the principles learned in the Range Management School are the Dominguez, Smith Point and Ridge allotments on the Uncompahgre Plateau. Historically, these allotments were managed separately. The allotments were grazed by three separate herds of cattle using a 5-pasture, a 4-pasture and a season-long management system, respectively. After attending the Range Management School, the permittee who ran on these three allotments, understood the concepts when the Forest Service proposed combining them into one allotment and grazing them with one herd of cattle. Beginning the summer of 1998, this combined allotment has been grazed by 1,000 cow/calf pairs, June 1—October 30. The new management approach calls for cattle to be grazed as a single herd in 10 separate pastures, with grazing periods from 15 to 20 days. Pasture moves are based on grass growth.

Historic Management		
Area/Allotment: Grazed:	Livestock #'s:	Period
Jumbo Mountain - BLM	30 Cow/calf pairs	5/15–9/13
Lion's Mesa - Private	85 Cow/calf pairs	5/15–6/15
Oak Ridge - BLM	163 Cow/calf pairs	5/15–6/15
	163 Cow/calf pairs	10/16–10/30
Dry Fork - FS	405 Cow/calf pairs	6/16– 10/16

These changes are making a difference on the ground and improving relationships between the federal land management agencies and permittees. Testimonials include the following:

"This can only result in healthier local communities and enhanced environmental conditions on the public and private rangelands here on the Western Slope."

"It made me more aware of the need for information to work the land. Information is very important in the use of this system."

"Excellent sessions—really got something."

"Those who criticize grazing on public lands must learn that as a use, grazing can be organized to improve range condition."

In January of 2000, Range 701 was offered. Sixty-five per-

Current Management		
Area/Allotment: Grazed:	Livestock #'s:	Period
Jumbo Mountain - BLM	196 Cow/calf pairs	5/10–6/24
Lion's Mesa - Private	373 Cow/calf pairs	6/15–6/24
Oak Ridge - BLM	288 Cow/calf pairs	5/10–6/14
Dry Fork - FS	584 Cow/calf pairs	
	45 Yearlings	6/25–10/19

mittees and federal land managers attended. Topics included grass growth curves, integrated forage systems, range nutrition, wildlife use and managing with wildlife. Pre and post evaluations of the course indicated a 32% increase in knowledge and understanding of range management. Future plans include starting a range focus group and additional field trips.

Collaboration improves the resource and relationships

Does the Range Management School approach work? The on-the-ground examples and the acceptance into other parts of the state would indicate it does. Variations of the course have been taught in the Southeast and Northwest corners of Colorado. Inquiries about the school have been received from Wyoming, New Mexico and California. The strength of the schools is that participants hear the same messages in the class and on the ground. It is backed up when they actively participate in the planning of their allotment with their range conservationist. The collaborative approach works for the resource and the relationships.

The Range Management Schools for Ranchers have worked because there is a good working relationship between the permittees, the federal land management agencies and the university to provide information that ranchers need and have requested. The permittees helped develop the curriculum and have input into changes. (Changes are considered as long as the overall goal of the course continues to be met.) Ranchers are hearing the same message from the NRCS, the FS, the BLM and the University. With the mix of instructors there is a strong sense of camaraderie and cooperation. There is a common understanding of what to do and what can be expected. The tie between animal nutrition and improved management is an especially important link, that ranchers have generally not heard before. The ranching community feels more stable and less threatened. The federal agencies have worked well together to offer the courses and then back it up when they are in the field. The permittees have seen the improvement on the range and have a better understanding as to why the changes are occurring and what can be done to continue the improvement. Including the environmentalists in the courses has significantly improved relationships as well. Their understanding has increased and the shared experiences of the classes have eliminated "us-versus-them" attitudes. The Range Management Schools for Ranchers have produced a win-win opportunity in the rangeland conflict in Western Colorado.

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Guarding Against Invaders: Remote Sensing on the Range

By Evelyn Boswell

More than a dozen companies and government organizations joined forces this summer in Montana to try out new weapons in the battle against noxious weeds. "This is Big country," says Bill Tate, a Montanan of 65 years. "Problems like noxious weeds can beat you if you're not all over them."

Tate serves on the Ruby Watershed Council and spends summers fighting weeds on media executive and local rancher, Ted Turner's Snowcrest Ranch. By all accounts, he is doing what he can to battle the weeds around him. He is alarmed, though, by the leafy spurge and spotted knapweed that invade the Ruby River drainage and gobble up the native range. "What we need is a tool that can help us look beyond our own fences and set priorities as a community," Tate said. "Is remote sensing that tool?"

To help find a solution, Tate is participating in a unique experiment to see if aerial images can accurately map leafy spurge and spotted knapweed. Distinctive for its scope and sample size, the \$250,000 project is being fully cost-shared by the private companies and government entities who are evalu-

ating the effectiveness of multispectral and hyperspectral imaging technology. Never before has a large-scale scientific study with this technology been conducted on Montana weeds.

"Multi- and hyperspectral imaging can capture information well beyond what is visible with the naked eye," explained Dan Swanson, project coordinator and director of Agriculture Initiatives at the Montana State University-Bozeman (MSU) TechLink Center. "As such, they offer the promise of mapping weeds from airplanes and even from space. But can they deliver?"

To find out, crews headed out to the fields and airfields in August. The ground portion of the experiment involved six people mapping two, 4-square mile plots. One site was southwest of Twin Bridges in the Ruby Valley drainage. The other was located just west of the historic Virginia City in Madison County. With hand-held global positioning system (GPS) equipment and topographic maps, the two-person teams started by determining their locations on a grid map. Each four-square mile area was divided into 16 blocks. The teams then

navigated to the center of each block and walked in the direction previously determined by computer. They mapped every weed or other kind of vegetation that stood in their path. "We're trying to get a random assessment of what's out there," said Elizabeth Roberts field project leader.

The above-ground information came from three companies using remote sensing equipment and one company taking video images. Flying in the same kind of airplanes used for aerial photography, these crews covered the identical plots the ground crew had hiked.

Hyperspectral Sciences, Inc. of Sonoma, Calif. flew first, using an Airborne Real-Time Imaging System (ARTIS) to capture multispectral images in three slices ranging from green through near-infrared. Each pixel represented about one foot. The ARTIS system is based on a multispectral camera developed by Kodak, and was developed by Hyperspectral Sciences for the NASA-Ames Research Center. In this project, GPS technology guided the airplane and also revealed the exact location every time the camera took a digital snapshot. The camera was linked to computers that told it how often and when to take pictures.

Next was Positive Systems of Whitefish, Mont. This company used the ADAR(tm) System 5500 to collect

multispectral images in four bands—the blue, green, red and near infrared. Each image covered about 1.5 square kilometers (370 acres) on the ground, with each pixel showing one square meter (about 1 square yard) of area. Similar to the ARTIS system, the ADAR System 5500 captured digital images through the belly of the plane. But instead of using a single camera with a color infrared filter, ADAR used four separate cameras that were individually filtered to record specific wavelengths in each spectral band. The cameras were synchronized via computer to also record a GPS position while controlling the exposure of the image and the firing of the shutter. "This system is frequently used in remote sensing applications requiring vegetation monitoring," said Bruce Burger, Positive Systems market development manager. Examples include precision agriculture, natural resource management and environmental compliance.

The third flight was by Earth Search Sciences, Inc. of McCall, Idaho. Using the Probe 1 system, this company col-

lected hyperspectral images in the blue through medium-infrared range. Each pixel represents five meters (about 15 feet) on the ground. Light from the ground struck a mirror and split into 128 bands of the spectrum. "This level of spectral resolution provides details not only on the whereabouts of plants, but also differentiates among plant species," said Tim Monroe of Earth Search about the Probe 1's capabilities. "We are going to look at each of these to evaluate their efficiency, accuracy and cost-efficiency," Rick Lawrence said of the three remote sensing approaches. Lawrence is one of two principal investigators for the weed experiment. He is also responsible for analyzing the information in his computer remote-sensing laboratory at MSU-Bozeman. "The most critical goal is to establish the statistical relationship between the noxious weeds detected from the air in a range of spectral bands, and the noxious weeds detected on the ground in the visible range," added a memo about the project.

Before Lawrence and his team can an-

Field test mapping.

alyze the information, however, they must pre-process the images. That includes mosaicing multiple images into a single scene, correcting for camera distortion and geo-referencing the material. The analysts will then compare the maps made by the MSU ground teams with hyperspectral and multispectral images. These images will be supplemented by GPS-referenced video provided by Red Hen Systems of Fort Collins, Colorado and Precision Partners of Fargo, N.D.

Researchers will use two computer programs to examine the multispectral and hyperspectral data, Lawrence said. ERDAS Imagine will handle the multispectral data. ENVI will be used to analyze the hyperspectral data. Within those two programs, the MSU researchers will also develop their own algorithms for handling the information.

It could be a couple of years before the analysis is complete, but preliminary results may be available in the spring of 2000. Lawrence said, "It will take a long time to really know entirely how much we can push this imagery because we are trying new things."

Although remote sensing has been used in the past to detect spotted knapweed and leafy spurge, the current experiment is unique in many respects. Lawrence and his colleagues are developing training data from the imagery based on GPS sites. Collaborators believe that this has greater potential than previous approaches for making the technology operational because it relies on data that can be readi-

ly gathered over large areas and does not depend on ground spectro-radiometer readings at the time of the flight. The project is also comparing three image sources of varying spectral range, spectral resolution, ground resolution, and cost. Finally, the project is using a more extensive training and validation data set than previous studies.

"This information will let us know how the accuracy of technology changes with different levels of density, different types of weeds, different sizes of patch-

es of weeds," Lawrence said. "We can compare and see. When do patches get so small that we can't accurately detect them any more? Do we have to wait until they bloom because they can have a different color?"

One problem with remote sensing is that "Vegetation is essentially all made up of the same stuff—like chlorophyll, lignin, but in varying proportions," Lawrence explained. "Therefore, vegetation tends to look very similar spectrally. Basically, it's green." Current methods for mapping and monitoring weeds, even with GPS, are also slow, expensive and do not offer economies of scale over large areas.

Participants in the experiment hope to overcome those traditional challenges and discover that remote sensing is a powerful ally in the war against noxious weeds. If the information can be gathered efficiently and provided commercially at an affordable rate, organizers say the experiment will be a success. "This is no trivial experiment. Noxious weeds are probably the No. 1 environmental threat in the West today," says Roger Sheley, the other principal investigator in the project. Sheley is an associate professor at MSU-Bozeman and noxious weeds specialist for MSU Extension. Leafy spurge and spotted knapweed are the two primary weed pests in Montana and the surrounding

Dr. Lawrence at his computer.

region. Leafy spurge infests at least 29 states and costs Montana, Wyoming and The Dakotas an estimated \$144 million every year. Spotted knapweed infests all of Montana's counties and is spreading rapidly. "Without understanding where these weeds are or where they fit across the landscape, it's impossible for us to develop strategy," Sheley said.

Dow AgroSciences is one company that's interested in this strategy. Dow became involved in the experiment because it has traditionally supplied weed and brush control products for pasture and rangeland, said Karl Schnelle who works in global ag math modeling and analysis at Dow. "With increased competition globally, the company is now trying to determine how to better support our products for the future," Schnelle said. "One way would be to have our technology development or sales force be able to easily identify weed locations, coverage and even species."

From global to local, collaborators on the project have high hopes. "This new tool will be unbelievably useful," said Kim Hudson who works for the Madison County Weed Board and supervises crews that spray weeds on Bureau of Land Management (BLM) property. Hudson currently relies on hikers and others who frequent the backcountry to let him know about weed infestations he hasn't discovered himself. "The noxious weed issue is one that we've been working on very diligently with land owners and land managers for a number

of years," says Dave Schulz, weed coordinator for the Madison County Weed Board. "We haven't fixed the problem by any means, but I believe with vigilance and certainly a lot of hard work, this is one problem that we are going to beat."

The Montana weed mapping project was organized by the MSU TechLink Center, a technology transfer center funded by the National Aeronautics and Space Administration (NASA) and the Department of Defense. Other collaborators, besides those already mentioned, include Turner Enterprises, BLM and the U.S. Forest Service.

Evelyn Boswell is a writer in the Office of the Vice President for Research and Creative Activity at Montana State University-Bozeman. Before working at the university, she was a newspaper reporter in Montana and Iowa. She received a degree in journalism and political science from Iowa State University.

Rangelands of Gobi Gurvan Saikhan National Conservation Park, Mongolia

Donald J. Bedunah and Sabine M. Schmidt

Gobi Gurvan Saikhan National Conservation Park is an area of stark, natural beauty and an invaluable natural and cultural resource. To visit this area is much like going back in time with pastoralists herding their livestock with methods similar to Chinggis Khan's era. Snow leopards, wolves, argali, and Ibex still roam the mountains and thousands of gazelle graze the steppe. During the summer of 1998 we examined the park's rangelands and visited with the pastoralists almost daily gathering information for a conservation plan to benefit the park and the pastoralists utilizing the park.

Park Overview

Gobi Gurvan Saikhan National Conservation Park is one of Mongolia's 35 protected areas. It was established in 1993 on the recommendations of Mongolian conservationists and the World Wildlife Fund. The park is approximately 5.68 million acres or more than twice the size of Yellowstone National Park and is located in south central Mongolia in the Omnogobi *aimag* (Mongolia's 21 *aimags* are like states or provinces).

Since Mongolia passed its Protected Areas Law of 1994, the country has greatly expanded the amount of land with protected area designation; by late 1997 there were 39 million acres or about 11% of the country in protected areas. There are four types of protected area designations: Strictly Protected Areas, National Conservation Parks, Nature Reserves, and Monuments. Each is managed by the Protected Area Bureau

within the Ministry of Nature and Environment, but each designation has its own restrictions concerning human use. Gobi Gurvan Saikhan National Conservation Park is one of 6 National Conservation Parks (NCP). These areas were designated as NCP because their natural condition is relatively intact and they have historic, cultural, scientific, educational, and ecological importance. By Mongolian law, the NCP are divided into three zones: a special use zone, a tourist zone, and a limited use zone. Livestock grazing is prohibited in the special use zone, but allowed in the limited use zones. Currently, it is ambiguous if livestock grazing will be permitted in the tourism zone. Gobi Gurvan Saikhan National Conservation Park has submitted a zonation proposal to the Mongolia Ministry of Environment for approval. The proposed special use zone where livestock grazing would be prohibited will be limited to very high elevations and areas that currently have very low grazing use (more extreme desert type). Currently the park is utilized by 1,100 herding households and over 218,000 head of livestock. Controlling grazing in these zones will be difficult because of political and social constraints, but the park administration has adopted a participatory approach toward management planning with local herders.

Gobi Gurvan Saikhan can be interpreted as the "Three Beauties of the Gobi" referring to the mountain ranges, Zuun Saikhan, Dund Saikhan, and Baruun Saikhan (East, Middle, and West Beauties) that rise above the dry steppe. Although the park is named for these mountain ranges, other spectacular

Mongolia, its aimags or provinces and the location of Gobi Gurvan Saikhan National Conservation Park (GGSNCP).

mountain ranges within the park include Bayan Tsagaan, Zoolongiin, Sevrei, and the Nemegt Ranges. The Altan (Gold) Mountain, located just outside of the park, is an area of religious and biological importance and was certainly an area that conservationists and local peoples wanted as part of the park. This area was removed from the park to allow for the operation of a gold mine. However, there continues to be local support to protect this area from development. There are no paved highways in the region and few roads within the park. As the park is in its infancy there are few tourists in comparison to U.S. parks. However, this area has been one of the prime tourist destinations of Mongolia for several decades and tourist numbers continue to increase.

Rangelands

The rangelands of Gobi Gurvan Saikhan National Conservation Park have evolved with both domestic and wild ungulate grazing for thousands of years. These rangelands vary from alpine meadows to sandy deserts, but desert and semi-desert conditions dominate the region. The park's rangelands are the eastern extension of the Gobi Altai and the Mongolian word Gobi refers to both desert and desert steppe. These rangelands are dominated by low and highly variable rainfall conditions, both spatially and temporally, resulting in a non-equilibrium ecological system. The climate is continental with cold-dry winters (-31°F), dry-windy springs, and hot summers (104°F). In general, precipitation decreases from east to west and from north to south. At Dalanzadgad, the location of the park's headquarters, the average annual precipitation is 5.2 inches, but at Khurmen, further west and at the southern border of the park, precipitation averages only 2.2 inches. Elevation varies from approximately 3,280 to 9,300 feet and in the higher mountains of the eastern portion of the park, precipitation is greater than 8 inches. Spring (April and May) is a period of very low precipitation, high winds, and low relative air humidity. Severe dust and sand storms can develop in the early afternoon as rapid increases in temperature result in powerful air movements. These storms dry out the soil even more and inhibit early plant growth and the appearance of spring annuals. Although winter/spring precipitation is low, occasional spring snow storms can result in significant livestock losses.

As visitors of the park we saw many similarities to western U.S. rangelands, but also some very different and unique types of rangelands. Some species native to the park but introduced in the U.S. are crested wheatgrass, quackgrass, smooth brome, red fescue, Kentucky bluegrass, stinkgrass, rhubarb, lambsquarter, and fanweed. Common native species of the park and to the western U.S. include junegrass, fringed sage, common reed, and winterfat; however, there are many shared genera including *Artemisia*, *Allium*, *Ephedra*, *Aristida*, *Stipa*, *Calamagrostis*, *Trisetum*, *Elymus*, *Juniperus*, *Kochia*, *Populus*, and *Ulmus* to name only a few.

Expanses of *Stipa* and *Allium* dominate much of the park's eastern rangelands. In the

Common and scientific names of plants found in the U.S. and Gobi Gurvan National Conservation Park.

Crested wheatgrass	<i>Agropyron cristatum</i>
Junegrass	<i>Koeleria cristata</i>
Quackgrass	<i>Agropyron repens</i>
Smooth brome	<i>Bromus inermis</i>
Red fescue	<i>Festuca rubra</i>
Kentucky bluegrass	<i>Poa pratensis</i>
Stinkgrass	<i>Eragrostis minor</i>
Common reed	<i>Phragmites communis</i>
Rhubarb	<i>Rheum nanum</i>
Lambsquarter	<i>Chenopodium album</i>
Fanweed	<i>Thlaspi arvense</i>
Fringed sage	<i>Artemisia frigida</i>
Winterfat	<i>Krascheninnikovia ceratoides</i>

south and west, semi-desert shrub and desert shrub are more prevalent. Dry streambeds, desert pavement, rock outcrops, canyons, sand dunes, and mountains break the topography throughout the park. The diversity of land forms and vegetation support diverse wildlife populations and the nomadic lifestyles of the herding families. For this paper we have separated the vegetation of the park into 3 broad categories: montane, semi-desert, and desert.

Montane Rangelands

The montane rangelands, dominated by mountain steppe with smaller areas of alpine vegetation, wet meadows, "dwarf forests", and submontane, are the most productive rangelands within the park. These areas receive intense livestock use, especially in the summer, but many of these areas also receive winter, spring, and fall use. The mountain steppe is found on finer textured soils at elevations above 6,500 feet. Crested wheatgrass, *Stipa krylovii*, *Festuca lenensis*, *Poa attenuata*, junegrass, and *Carex pediformis* are common graminoids. Several *Artemisia* species, especially fringed sage, are quite common and increase on heavily grazed sites. Other common herbaceous species include *Allium bidentatum*, *Arenaria capillaries*, *Bupleurum bicaule*, *Hedysarum pumilum*, *Iris*

Montane grassland in Zunn Saikhan (East Beauties) Mountain Range.

"Dwarf forest" type in montane rangelands.

potaninii, *Pedicularis flava*, *Ptilotrichum canescens*, *Potentilla sericea* and *Sibbaldianthe adpressa*. On more southern aspects or drier sites, half-shrubs become a more common community component.

Many high elevation, northern aspects or protected sites have areas of wet alpine meadows, dwarf forests, and low shrub formations. The rich alpine meadows are dominated by *Kobresia* species with a rich herbaceous component including *Polygonum* spp., *Ranunculus* sp, and *Gentiana* spp. The dominants, *Kobresia sibirica* and *K. mysouroides*, and other alpine-sedge species are utilized by grazing animals, especially yak. A dwarf forest type, consisting of subalpine birch and willow up to 15 feet high, occurs as isolated stands mostly in Dzun Saikhan. These birch/willow forests have a large component of shrubs such as *Lonicera*, *Spirea*, *Cotoneaster*, *Ribes*, *Grossularia*, and *Rosa* that are more characteristic of a boreal type than of the Gobi. These areas are surrounded by mountain steppe and are probably a relic of much cooler, wetter conditions.

A low-growing shrub type found in all mountains of the park is formed by two dwarf junipers (< 2 feet), *Juniperus*

sabina and *J. pseudosabina*. *J. sabina* is considered a rare species but it is common in the park. Since it is often collected for fuel there is concern about its status. These dwarf juniper types are found at lower elevations in montane zones on north slopes or as "pockets" in protected sites. At higher elevations this type is found on all exposures where there is some protection from winds, typically on coarser soils, rocky areas, and slopes. These juniper shrub types protect many palatable plants from overgrazing and often the only grass seed-heads observed are in these areas.

In submontane zones *Caragana* spp., winterfat, and *Amygdalus* are common on coarser soils and rocky slopes. Two species of *Amygdalus*, *A. mongolia* and *A. pedunculata*, are common on rocky areas and along many dry water courses. These shrubs, related to our apricot, produce a small fruit that is eaten by many wild animals. Two unique and widely distributed grasses from the submontane to the semidesert are *Stipa inebrians* and *Stipa splendens*. *Stipa inebrians* is poisonous, according to the herders. Livestock avoid this species and often it is the dominant plant near sites of livestock concentration such as gers (the herders round felt, tent), where there are increased nutrient loads from livestock urine and feces.

Semi-Desert Rangelands

The major portion of the Gobi Altai region is semi-desert. Productivity is relatively low in this zone and drought is frequent, but this range type supplies a significant amount of the forage for the park's domestic livestock. Semi-desert rangelands of the park are dominated by desert-steppe, but significant areas of semi-desert shrub occur in many areas. The desert-steppe zone supplies forage for cattle, horses, camels, sheep, and goats, but flexibility in management is critical in this zone. The main plant forms in the desert-steppe are low caespitose grasses (*Stipa gobica*, *S. glareosa*, *Cleistogenes soongarica*) and *Allium* species (predominately *A. polyrrhizum* and *A. mongolicum*). Shrubs and half-shrubs such as *Caragana* spp., winterfat, *Anabasis breviloia*, and forbs such as *Ajania achilleoides* and *Convolvulus ammanii* are common, but generally of minor coverage. Twelve species of *Allium* have been identified in the park, and these species often provide considerable forage. These *Allium* rangelands

Stipa splendens (splendengrass) in submontane steppe.

are generally quite simple floristically and we were told that livestock only use the *Allium* in early spring and fall because at other times it is too "hot" for the animals.

Semi-shrub desert communities are also a significant grazing resource and the shrubs are often a significant source of fuel. Important semi-desert shrub dominants include *Caragana leucophloea*, winterfat, *Amygdalus pedunculata*, *Atraphaxis pungens*, *Zygophyllum xanthoxylon*, *Potania mongolica* and *Calligonum mongolicum*. Often these communities have a sparse to moderate herbaceous component, commonly with *Stipa* and *Allium*. These shrub communities are an especially important resource in the winter and during droughts, when other plants are not available or have low forage quality.

Desert

Desert dominates much of the western one-third of the park. The majority of the desert vegetation is a desert-shrub type that is dominated by shrubs and half-shrubs mostly in the Chenopodiaceae, Polygonaceae, Zygophyllaceae, and Tamaricaceae families. In general, rocky desert terrain dominates, but there are also large expanses of sand, including active sand dunes that are quite spectacular because of their size. Halophytic shrubs such as *Salsola passerina*, *Anabasis brevifolia*, ephedra (*Ephedra* spp.), *Nitraria sibirica*, *Reaumuria soongorica*, and *Kalidium gracile* are common on salty areas and are quite succulent. On stabilized sandy soils and some lower slopes and basins, saxaul (*Haloxyton ammodendron*) "forests" are unique. These shrubs can be over 10 feet high, which provides the desert with an unusual tall shrub component in a very xeric area. The "forests" also occur in many semiarid zones and are important because they protect fragile soils from erosion and arrest sand movement. *Populus diversifolia* and *Elaeagnus moorcottii* are found on non-saline water courses or oases.

There is little doubt that firewood gathering is a serious threat to these plant communities. Overgrazing and roads that accelerate soil erosion will likely harm these important communities. Herders utilized these desert rangelands to raise camels, goats, sheep and horses, but use of these areas is greatly limited by water availability. Localized thunderstorms and "wet years" make seasonal grazing possible.

Saxaul (*Haloxyton ammodendron*) stand in sandy desert.

Wildlife

Gobi Gurvan Saikhan National Conservation Park is rich in wildlife and many of the wildlife populations are among the largest remaining in Mongolia. Certainly all species are important for maintaining biodiversity, but the park's large ungulates and their predators are among the most spectacular animals. There are relatively large and stable populations of Siberian ibex, Mongolian or white-tailed gazelle, and goitered or black-tailed gazelle. The ibex are often seen in the rugged mountains, on rocky outcrops, sheer cliffs, and on steep, vegetated slopes. Mongolian gazelle are found in the eastern part of the park, and goitered gazelle are in the non-mountainous areas. On one late August day, as we scanned the steppe from a small rise, we saw an unbelievable number of gazelle. Vast herds spread across the steppe as far as we could see, and our Mongolian counterparts estimated there were 10,000 gazelle.

Herd of Mongolian gazelle in semi-desert grassland.

There are several globally threatened or rare species found in the park. Argali, a similar species to our bighorn except larger, is relatively common in the park but its population status is a concern. Argali are listed in the Mongolian Red Book as threatened and are included in the Appendix II of the Convention of International Trade of Endangered Species of Flora and Fauna (CITES). Most herders believe argali numbers are decreasing and there is little doubt that maintaining quality habitat for this species is a concern because of increasing livestock numbers. Argali are observed mostly along the grassy mountain slopes in the mountain steppe, but are also seen in semi-desert shrub in areas adjacent to mountain slopes.

Khulan, or Asiatic wild ass another CITES species, are seen in semi-desert and desert areas of the park, but population numbers are considered low and their use of the park is mostly seasonal. Occasional use of the western portions of the park by wild Bactrian camels and Gobi bears, both critically endangered species, have been reported, and small populations of wild boar are found in *Phragmites* marshes of the Zulganain River in the far western portion of the park areas.

Two species of note that have been lost from the park during the 20th century are Przewalski's wild horse, or Takhi, and Asiatic wapiti, or elk. Przewalski's wild horse was once an inhabitant of the park and if re-introductions are successful in other parts of Mongolia it would be exciting to see a return of

this species to the park. In Owen Lattimore’s book, *Mongol Journeys* (1975 preface, reprint of 1941 edition), he describes a trip to the "Three Beauties of the Gobi" and mentions seeing elk. Elk do not presently occur in the park, except as photographs, and it is difficult to determine when elk were exterminated from the area.

Common and scientific names of animal species.	
Siberian ibex	<i>Capra sibirica</i>
Mongolian or white-tailed gazelle	<i>Procapra gutturosa</i>
Goitered or black-tailed gazelle	<i>Gazella subgutturosa</i>
Argali	<i>Ovis ammon</i>
Asiatic wapiti or elk	<i>Cervus elaphus</i>
Khulan or Asiatic wild ass	<i>Equus hemionus</i>
Przewalski’s wild horse or Takhi	<i>Equus przewalskii</i>
Wild Bactrian camels	<i>Camelus bactrianus</i>
Gobi bears	<i>Ursus arctos</i>
Wild boar	<i>Sus scrofa</i>

Important large predators include snow leopards, found in the mountains, and wolves, reported as relatively common throughout the park. Little is known about these predator populations, but herders often mentioned significant predation problems, mostly by wolves. Many herders reported wolves are "rampant" and cause large losses; other herders said if livestock are herded well, only minor losses occur. It is worth noting that predation by wolves is an ancient problem for Mongolian herders and Haslund, a Danish expedition member to Mongolia in the late 1920s, commented on the aggressiveness of Mongolia’s wolves:

"Then there were the audacious wolves, the Mongols’ hereditary foes, whose acquaintance we were forced to make. One day they took a big heifer only six hundred yards from the tent where the cowhands lived. Another time the wolves attacked our flock of sheep in broad daylight. The boy and girl who herded the sheep howled and yelled, and the sheep scattered in every direction, but in a few minutes five sheep were bitten to death and three badly torn."

Total livestock numbers and total forage sheep units within Gobi Gurvan Saikhan National Conservation Park in 1996 (from the Park Management Plan).

Animal Type	Sheep Unit Equivalent	Total Head	Total Sheep Forage Units ¹
Cattle/Yak	6	6,947	41,682
Horse	7	14,610	102,270
Camel	5	8,239	41,195
Sheep	1	47,293	47,293
Goat	0.9	141,454	127,309
Total		218,543	359,750

¹ Sheep forage units are a Mongolian measure used to express the feed requirement of one sheep per year or 805 lb/year forage intake.

We also saw "scarecrows" on three occasions. When we asked about the scarecrows the herders told us they were used to frighten wolves. Thus, there is little doubt that snow leopards and wolves are a concern to the herders. In most cases, the predation losses were apparently considered part of herding. However, as livestock populations increase, and if wild ungulate populations decrease, there is a strong likelihood of increased conflicts between these large predators and domestic livestock.

HERDERS AND LIVESTOCK

In 1996 there were over 218,000 head of livestock in the park managed by approximately 1,100 herding families. Mongolians have a rich herding heritage of utilizing their rangelands to produce an array of livestock products for consumption and trade. They are proud of their nomadic tradition and their varied knowledge and use of different types of livestock. Herders within the park generally have 3 to 5 types of livestock and the animals are not only a source of food, but also personal capital and a barometer of social status. Almost

Mongolian fat-tailed sheep and goats in semi-desert grassland.

all Mongolian herding families have horses, and certainly the Mongolian horse is famous as a riding animal, but horses here also produce dairy products (for example, the national drink "arak" or fermented mare's milk), their hair is collected for various products, and their meat is sometimes consumed.

Most herders in the park also raise sheep and goats of several breeds. The sheep breeds are of the fat-tailed sheep, a sheep that has a broad, flat tail which enlarges with fat as grazing conditions improve. The tail is considered a delicacy by Mongolians. Sheep provide meat, milk, hides, and wool. The wool is sold or bartered and is also used in the park to produce the felt for the ger (herders' round tent). Goats produce milk, meat, hides, and cashmere. The cashmere is an extremely important product for herders within the park because there is a good market for cashmere.

Cattle and camels are relatively common throughout the park, but cattle are more common in the east and camels are more common in the west. The camels are the two humped Bactrian camel that can endure extreme heat and cold. Camel meat, milk, hair, and hides are utilized, but the camel is most significant as a draft animal. The hair combed from the camel wool is a high quality fiber utilized in clothing and in blankets. The cattle are primarily native breeds, small compared to our breeds, but well adapted to the local environment. Yaks, which Mongolians include as cattle, are common at higher elevations, especially in the east. Cattle and yak are utilized as dairy, meat, and draft animals, and their hair and

hides are utilized for many products such as coats, blankets, and ropes.

Although Mongolian herders use animals for meat, fiber, milk, and work, and these livestock products have been an important part of the culture and economy of Mongolia for a very long time, herders often express a dislike for killing and trading animals. They believe their animals deserve respect for what they give to the household and to merely maximize output is conventionally regarded as immoral. Thus, many Western concepts regarding livestock production become difficult to apply to the Mongolian herder who has a much different paradigm regarding the value and benefits of having livestock. Certainly Mongolians have a different perspective on risks, slaughter, and use of livestock products compared to Western cultures. These large differences in paradigms between our Western extensive system and the Mongolian system, coupled with large and significant changes in the socio-political system of Mongolia, certainly indicate a need for careful study and continued examination of livestock issues within the park to conserve the parks resources.

Critical Issues

A central and critical issue is how to preserve the park's resources while maintaining the pastoralist's culture. Of great concern are the increased numbers of herders and livestock in the park and lifestyle changes of many herders which affects

Sheep units¹ for sums (Bayandalai, Bulgan, Gurvantes, Sevrei, Khanghongor, Khurmen, and Dalanzadgad) located within Gobi Gurvan Saikhan National Conservation Park.

¹Sheep units are a Mongolian measure used to express the feed requirement of one sheep per year or 365 kg/year forage intake. Accordingly, horses, cattle, camels and goats have been assigned as equivalent to 7, 6, 5 and 0.9 sheep units, respectively.

the management of livestock. No doubt the change from a Soviet command economy to a market economy following the collapse of socialism has had a profound influence on the pastoralists of Mongolia. In the park, and apparently in many parts of the country, there has been a shift from urban to rural existence which has increased the number of people using the park's grazing lands. It is difficult to predict how Mongolia's economic transition will continue to affect the park's users. However, current trends are of concern. Since 1992, the year when most livestock *negdels* (collectives) were disbanded and livestock were privatized, livestock numbers have increased dramatically. Livestock numbers in the park were available only for 1996, but livestock numbers for the Omnogobi aimag and sheep units for those *sums* (administrative unit similar to a county) located in the park reveal an obvious increasing trend. Between 1990–93 there was a slight decrease in livestock numbers for the aimag, probably associated with changes in the socio-political system. For the *aimag* and the park *sums* there has been a 13 % and 12% increase annually in total livestock and sheep units, respectively since 1993.

Another concern is the increasing number of herding families. Since 1992 the number of herders in those *sums* located partially in the park increased by 25%. This increase is largely associated with few other opportunities for making a living, thus resulting in a change from urban to rural existence. Limiting herders use of the park could significantly affect their livelihoods. Certainly, with the increase in the number of herding families there will be increased resource use on the rangelands of the park that may detrimentally affect other resources. The *aimag* median age of 20, with 24 % of the human population between 5 to 15 years old in 1996, is further evidence that human population growth will likely significantly increase resource pressures on the park's rangelands if other employment opportunities are not available.

Pastoralism evolved in Mongolia largely in response to environmental factors. In the Gobi, mobility and flexible grazing allow for less risk and fewer environmental problems. A policy that restricts herder movements and/or increases concentration points will increase livestock induced environmental degradation. Livestock issues and problems associated with control of pastoralists utilizing the park's rangelands are critical problems facing land managers. These problems will be extremely difficult to solve. But if they are not solved, the impacts on the park's natural resources and the pastoralists using these resources could be devastating. Livestock grazing can have positive or negative influences on wildlife species, but overgrazing will no doubt result in a loss of habitat for wild ungulates and other valuable wildlife species. Changes in the ungulate populations will influence predator populations. A number of rare plant species have been identified in the park that could be negatively affected by human uses. These species, *Amygdalus mongolica*, *Juniperus sabina*, *Potania mongolica*, *Incarvillea potaninii*, *Caryopteris mongolica*, and *Populus diversifolia* are either utilized extensively by livestock or by herders for fuel wood or both. Without proper management, these activities may result in a significant decrease of these species.

Summary

Gobi Gurvan Saikhan National Conservation Park has an extremely varied landscape resulting in a high diversity of flowering plants and wildlife. It is also an area that has historically been utilized by nomadic herders and their livestock. The extensive livestock production system is an important current use of the park and surrounding areas and allows for the maintenance of the pastoralists' culture. Mongolia is extremely proud of its nomadic herding culture and this culture deserves respect and consideration. Extreme changes have occurred in Mongolia recently and throughout this century. The current grazing system of Mongolian pastoralists is, in general, not the type of management that would have been found at the turn of the century, nor is it the same as during more recent, collective times. Current livestock management is influenced by both old and recent cultures and will continue to change with socio-economic changes. Because of the scarcity of both money and expertise to manage the park, it is imperative that the pastoralists become active in managing the park. Identifying community groups within the park and getting resource information to the herders are difficult tasks. We believe that the herders do want to organize but may need facilitation and support. Conservation of park resources, including the pastoralists' culture, should be the priority in managing Gobi Gurvan Saikhan National Conservation Park.

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Turkish Rangelands and Shrub Culture

Ali Koç

Turkey is located between northern latitudes of 36°–42° and eastern longitudes of 26°–45° and covers 814.6 thousand km². The average elevation is 1,100 m and average annual precipitation is 600 mm. From recent statistical data, the land use in Turkey is; field crops (30%), horticulture (5%), forests (20%), shrubs (10%), rangelands (25%), meadows (1%) and the others (9%).

Animal husbandry produces 5% of the gross national product (approximately 122 billion US \$) of Turkey. Twelve million animal units graze on Turkish rangelands. Most of these rangelands are located in the Central Anatolia, Eastern Anatolia and Southeastern Anatolian Regions. The average annual precipitation in these regions ranges between 200 and 600 mm. As is always in the world's grazing lands, the rangelands of Turkey have problems.

The State of Turkey's Rangelands

Rangelands in Turkey are common property and every individual who lives in a village has a right to graze their animals on them. Currently, people start grazing at the first opportunity and continue yearlong depending on the conditions and regardless of the lands carrying capacity. Until recently, there was no legislation regulating the use of rangelands. A law recently introduced by parliament, however, will likely take 5–10 years to regulate proper use of these areas.

At present, the rangelands of Turkey are grazed 2 to 3 times higher than their carrying capacity. As a consequence of bad management, up to 90% of the climax vegetation of Turkey's rangelands has been lost (Genckan et al. 1990), and valuable range plants are scarce. Canopy cover has become sparser and moderate to severe erosion problems have appeared in more than 90% of the rangelands (Koç et al. 1994). Except for relatively light degradation of rangelands in Eastern Anatolia and high elevation rangelands, most Turkish rangelands have moderate to high levels of degradation. Koç (1995) reported that the canopy cover and forage production of Turkey's rangelands changed from 10% to 70%, and from 450 to 1,200 kg ha, respectively, depending on the regional conditions. Heavy grazing began in the past decades, especially after developments in agricultural mechanization in the 1950's.

As a result, almost all of the rangelands of Turkey need improvements.

The State of Turkey's Shrublands

Although shrublands are regarded as grazing lands in most countries of the world, these lands are officially accepted as forestlands in Turkey. Utility regulations are overseen by the Ministry of Forestry and grazing is prohibited by the law. But, these lands are illegally grazed and suffer from overgrazing. Shrubland vegetation is common in Mediterranean Region and Aegean Region in Turkey. Shrublands of these regions include about 90 maquis (Evergreen shrubs and dwarf trees common in Mediterranean climate zone similar to chaparral in California) and 60 woody shrub species (Yılmaz 1993). Herbaceous shrub species like *Atriplex* sp. and *Artemisia* sp. are common in Turkey's flora. Research on the forage value of these plants needs to be conducted in Turkey.

The Importance of Shrubs in Range Improvement

Rangelands in Turkey receive less than 900 mm annual precipitation and generally suffer from heavy grazing. Heavy grazing causes not only destruction of range vegetation but also degradation of the soils by erosion. Vegetation of heavily grazed rangelands in arid and semi arid regions has a tendency towards conversion to shrublands. For example, as a result of bad management of the rangelands in Eastern Anatolian Region in Turkey since the 1950's, thorny species of *Astragalus* (Fabaceae family having chamaephyt life form; cushion forming plants whose buds are held close to the soil surface) have increased in rangeland vegetation (Figure 1, 2).

Fig. 1. A general view of *Astragalus microcephalus* Willd which is wide spread in the rangelands in Turkey.

Fig. 2. A typical view of mountainous rangeland dominantly covered with *A. microcephalus* Willd.

Insufficient soil moisture, competition from non-forage plants and loss of the upper soil layer are important factors restricting re-vegetation with better plants in arid and semi-arid regions (Allen 1995). Shrubs are important plants for the rehabilitation of arid and semi-arid lands, because they grow successfully in degraded soils. Many species of shrubs are valuable for controlling erosion and providing animal forage in arid environments. Many species are salt tolerant.

Shrubs are adapted to adverse environments and many species are capable of providing green forage for livestock in early spring and in summer drought period. Seeds can be valuable feed

sources for wild animals in winter. Shrubs are used as firewood and fruits are eaten and some are used medicinally. Their shade provide suitable seedbed habitat for herbaceous plants.

Management Needs for Grazing Lands in Turkey

Almost all of the rangelands in Turkey need moderate to drastic reclamation measures. The rangelands of Eastern Anatolia and in high elevation areas in the other regions may be improved by enhancing present plant cover by fertilization and regulation of grazing, but in the other areas rangeland vegetation needs to be totally re-established.

Water erosion is a critical problem especially on degraded rangelands (Figure 3). It is estimated that while 368 tons of soils from per km² on average are lost to erosion every year in the world, 600 tons of soils from per km² are lost to erosion in Turkey (Gunay 1995).

Fig. 3. An area in Eastern Anatolia Region with erosion problem sparsely covered by shrubs (i.e. *Colutea* sp., *Cotinus* sp., *Juniperus* sp., *Quercus* sp, *Rhamnus* sp. and *Rosa* sp. are common genus). The area in the middle rarely covered by shrubs is heavily degraded.

Important Turkish rangelands are located in high altitude areas. Snow is the most important water supply in these areas. Snow is moved from open areas by wind. Hilly sites on these rangelands lose their snow covers through wind storms and the other areas benefit from this snow movement. This affects uniformity of soil moisture over the area. If windbreaks were established with suitable shrub species into open range vegetation, a better distribution of soil water would be accomplished. Also forage production on the rangelands may be increased. A study on the windbreak effects of tall wheatgrass by Steppuhn and Waddington (1996) in Saskatchewan estimated that winter recharge of water in the upper 120 cm of soil was 22 mm greater in the windbreak area than in the open area. This extra water provided a 40% increase in hay yield of alfalfa.

On almost all of Turkey's rangelands, the herbaceous layer dries in the summer period with a considerable loss in forage value. Shrubs remain green in summer due to their rooting characteristics. If suitable shrub species can be established into open rangelands, green forage periods on these areas may be extended.

Another important problem on Turkish rangelands is salinity. About 80 million ha area in the Mediterranean Basin are affected by salinity (Osman 1996), 1.5 million ha of which are located in Turkey (Kantar and Elkoca 1998). Some shrub species such as *Atriplex* grown successfully in the area are affected by excess salinity. Research efforts should concentrate on salt tolerant shrub

and other halophytic plant species to rehabilitate the areas affected by excess salt.

There is an immediate need to restore plant cover on these rangelands to protect soil resources. Mixtures of desirable shrub and herbaceous species are advantageous since grazing pressure will change to different species in different periods and soil moisture will be used more effectively with a variety of rooting characteristics.

Recommendations for Change

To stop further degradation of rangelands and increase productivity in these areas in Turkey the following short- and long-term measures should be taken;

1. Biological, morphological and ecological properties of native shrubs in Turkey should be determined.
2. Research should begin on shrubs which have value for forage production and erosion control.
3. A nationwide program should be started in collaborating with international institutes for the introduction and improvement of shrubs.
4. After suitable shrubs species are determined for every location, agronomic methods have to be determined for re-vegetation.
5. Southern districts of Turkey are affected by drought and salinity. Herbaceous shrubs like *Atriplex* sp. and *Artemisia* sp. should be given priority in these districts.
6. Turkey should develop and implement erosion control and re-vegetation programs.
7. In maquis vegetation of Mediterranean and Aegean Regions of Turkey, grazing should be regulated to reduce erosion.
8. It is important that Turkey immediately implement legislation to regulate the use of shrublands.

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Invited Paper:

Public Rangelands Without Cows?

Thad Box

"The Western Range Revisited—Removing Livestock From Public Lands to Conserve Biodiversity" by Debra L. Donahue is a disturbingly good book.

It should be required reading for every member of the Society for Range Management. Although many, maybe even most, may not agree with its premise or its subtitle, it raises important questions. Answers to those questions are based on SRM objectives, printed in every one of our journals:

- 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 to 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

Livestock grazing, or any other use, is not mentioned in the objectives. Yet many members circle the wagons when anyone suggests removing livestock from public range.

The book's importance to us lies in making us look at ourselves. It rises above other writings of the "remove cows" ilk. Its author is a legal scholar who is Professor of Law at the University of Wyoming. She has degrees in wildlife from Utah State University and Texas A and M. She has worked alongside many SRM members in government Agencies.

The book is an easy read, unfolding like a brief prepared by an excellent lawyer. Professor Donahue makes her case for biodiversity reserves using literature from a wide range of historical, scientific, and legal sources. Her use of range management literature separates it from most anti-grazing books.

Her extensive citations are subverted in the text in a way that is often difficult to follow, even by one who is familiar with most papers cited. I found myself flipping pages trying to decide if she was quoting primary or secondary sources. Another frustration is style shifts. Sometimes she presents material like a scientist and lets conclusions flow from data. Other times, her legal training dominates, resulting in an advocacy argument based only on papers that supported her position, complete with impeachment of witnesses. These shortcomings irritated me, but the book is a major contribution.

She makes her arguments clearly.

- (1) Current law and secretarial authority now exist for removing livestock from the public range, and
- (2) many ranges are now grazed that do not contribute materially to national and local economies.

Her case for biodiversity reserves is less compelling. This is partially because the science supporting it is inexact (like range science). It is also because the biodiversity reserve "use" is based more on values than science (like grazing for food production).

The book offers an excellent opportunity for another scholar to present a different brief on the management of rangelands. Several alternative cases could be made, many supported by different interpretations of the same literature Professor Donahue used.

I was asked to write an opinion piece about the value of the book to SRM. I try not to defend or discredit her positions, but concentrate instead on what I think they mean to the future of our profession. I will discuss book content only enough for my opinion to make sense to one who has not read the book.

Chapter 1. The Historical and Cultural Landscape; Chapter 2. The Early Legal Landscape.

The first two chapters deal with historical, cultural, and early legal landscapes of the West. Professor Donahue uses standard, respected sources. It is not greatly different from something your own public lands hero in SRM might have written. It set the stage well.

There are two things here for SRM to consider. First, any range problem should be put in historical perspective with a scholarly, accurate discussion of the important issues that produced the problem. Second, historical information should be understandable to the audience.

I have often heard SRM members complain that "they" do not understand range problems. Do we do an adequate job presenting problems in context and language "they" can understand?

Chapter 3. The Physical Landscape.

In this chapter Professor Donahue gives her opinion on the condition of public ranges. She relies heavily on Senate Document No. 199, *The Western Range*, for pre-Taylor Grazing Act conditions. For more current conditions she uses various papers and government documents. Her statement on page 61 speaks volumes about our profession:

The message is readers beware. Attempting to use the literature to generalize about current range conditions, or about the individual contribution of livestock, is problematic not only because vegetation, soils, and climate vary widely and because historical and current land uses and thus disturbance factors differ. Investigators' methods, objectives, and predispositions can also dramatically influence results. Results may be portrayed carelessly or even misrepresented, intentionally or otherwise, by the investigators or others.

This hurts because it is true. Anyone who has tried to sift through old range surveys knows the frustration Professor Donahue, or anyone else, feels trying to get a handle on the condition of rangelands. Each survey is based on different techniques and most were made for a particular purpose. Those who wrote *The Western Range*, knew their work was more important for its political statements—improve legislation to protect rangeland and put the public range in the Department of Agriculture—than it was for determining the condition of rangeland.

In the 1970s, I was asked, first by the Council on Environmental Quality, and later by the Congressional Budget Office to look at range surveys to see if there were ways to accurately compare them and document change through time. I concluded that condition through time could be estimated only by understanding the techniques used and getting inside the heads of the people who did the survey. Even then, it was a matter of professional judgement, not science. This conclusion was not new or unique. Most who worked with range surveys had their own horror stories. The paucity of data, inconsistency of the methods, and political objectives were well known.

What should we have done thirty years ago to improve the situation? More importantly, what should we do now?

Chapter 4. The Political and Cultural Landscape.

Professor Donahue begins this chapter with the cattleman's clout, describing both how and why livestock people wielded

a heavy hand in the development of the West. She uses current examples, such as the Domenici grazing bill, to show continuing influence of cattlemen. She describes how powerful organizations such as the U. S. Congress, state legislatures, county commissions, corporations, the LDS Church and land grant universities have helped solidify the power of ranchers.

In the second half of the chapter she demythologizes the ranching mystique. She describes the mythical image portrayed by the likes of Teddy Roosevelt and John Wayne. Then she contrasts it with the reality of ranchers barely making a living and depending heavily on government subsidy. She concludes:

"That [rancher] power, whatever its source or ontology, remains a significant obstacle to achieving substantive 'range reform' or improving range conditions."

This chapter raises again two big questions about our profession. Are we really captive of cattlemen? Are we letting the myth of the cowboy limit our effectiveness?

Many of us, perhaps a majority of SRM members, have our roots in the ranching culture. The fact we wear a hat and boots does not necessarily make us captive of the livestock industry. In fact, we may know more about why some lands should not be grazed than those getting their information from conservation biology texts. For instance, Professor Donahue's opinion that livestock should be removed from some arid lands is neither new nor earth shattering. Most of us were taught in our first range class that some lands were not suited to grazing. Whether we use economics, ecology, or energetics we have long known some land should not be grazed.

So why do we get excited when a lawyer or professor of biodiversity says what we knew all along? Is it because we have been intimidated by livestock folks? Or is it guilt that we should have made the fuss ourselves? Or is it because our core values (religion) are different from those of preservationists?

Whatever the answer, the fact remains, a range professional's image is often that of being apologist for livestock operators. Is this because we have defended a use that is dear to our hearts rather than land we have pledged to preserve?

Chapter 5. The Ecological Landscape.

This chapter discusses grazing and related activities on rangelands, the relation of coevolution and aridity to changes in rangeland biodiversity, aridity and grazing optimization, and rangeland vegetation dynamics. The section on vegetation dynamics includes a discussion of theories of succession and how it has been used by the profession in range condition analysis. It takes up about half the chapter.

In the introduction to the chapter Professor Donahue suggests, quite correctly, that the emphasis in range management has been on products, production, and on technology. She also says, that we have emphasized improvement over nature, or what she calls "optimizing."

I am somewhat at a loss as to how she came to that latter position. She used as its defense a definition Art Smith and I wrote, "range management is the science and art of optimizing the returns from rangelands in those combinations most desired by and suitable to society through the manipulation of range resources." Our intent was to balance such things as aesthetic and biodiversity values against commodities.

Apparently by using "manipulation," we missed her. The sections on grazing impacts and coevolution use standard references that are not very different than those that would be used by most SRM members. Her "spin" is toward the abuses caused by livestock and the value of ecosystems existing prior to the introduction of domestic livestock. The "spin" of grazing advocates using the same literature could be substantially different and equally valid.

These differing opinions of the same facts are similar to the differences found in agricultural texts and biodiversity books. A major cause of differing tolerances to domestic livestock appears to be on whether one sees technological humans as part of the natural system or a disturbance factor outside nature.

The question arises again, should SRM defend any use, including grazing? Is our defense of grazing based on our science, or our values (religion), or both?

In the section on rangeland dynamics Professor Donahue discusses the Clementsian influence on range condition concepts and the development of state and transition models. Again, this section could have been written by and for range professionals. However, several times she refers to Bill Laycock's statement that range management has not kept pace with ecology. It is not a case of range people ignoring ecology literature, but ignoring their own ecological research that caused the problem.

Lincoln Ellison, who is credited with an early recognition that the Clementsian model didn't work well, was a range researcher for the Forest Service. Ray Perry and his colleagues in the old Christensen-Perry land survey were among the first to apply landscape ecology to rangelands. Margaret Friedel, Barney Foran, and other range folks at Alice Springs were developing range surveys based on state and transition concepts before Mark Westoby, Brian Walker, and Immanuel Noy-Meir brought together American, South African, and Israeli range concepts, using Australian examples, in their *Journal of Range Management* article. *Why did range professionals not use their own ecological research?* Could it be a case of Clementsian dogma?

Professor Donahue suggests range managers were uninformed because range textbooks do not use current ecological concepts. When Art Smith and I were revising Stoddart and Smith in the early 1970s, we were well aware of the work of arid land range ecologists based in Australia and Africa, but their work was still unpublished. We opted to stick with published concepts rather than write a text based on evolving concepts. We chose to leave those changes to the next edition—an edition we never produced. I cannot speak for authors of newer texts.

Chapter 6. Preserving Biological Diversity on Arid Western Landscapes.

Professor Donahue presents her strategy for preserving the native biodiversity on arid western rangelands. She discusses biodiversity as it relates to edge effect, reserve size and configuration, habitat type and quality, landscape level needs, and man-

aging arid rangelands. She uses literature to justify her proposed strategy of removing livestock grazing from large contiguous blocks of BLM lands with under 12 inches of annual precipitation. She outlines her plan and shares her motive:

Biological diversity also has moral value, just as the individual components of biodiversity do. That value may be deemed intrinsic or derivative from one's religious or theological views. The 'fundamental value assumption that biodiversity is good and ought to be preserved' is an essential underpinning of conservation biology—and of this book.

I am automatically skeptical when someone says they are doing something for moral values. And I have found it does little good to argue religion. But this chapter raises important questions for range professionals.

Is there an SRM religion that reflects our core values? If so, what are these values? What is it meant to glorify: God of Cows and Grass, Goddess of Open Spaces, Goddess of Western Way of Life.? Do our gods get in the way of our science?

In previous chapters, Professor Donahue alleges range managers are goal oriented and pragmatic. They accept manipulation of nature to reach their goals. Those goals are usually for perceived betterment of human welfare.

On the other hand, she sees conservation biologists as preserving nature, a goal that has value in and of itself. Assuming I have not done too much damage to her concepts, the differences boil down to the old "man in nature" vs. "man against nature" arguments.

I use "man" deliberately because she points out that most rangeland abusers from early cowboys to modern corporate ranchers were male.

If we are motivated by human need, does our "religion" permit sacrifice of natural communities to alleviate human pain in the short run? Where do we draw the line?

Also implied in this chapter is a belief that pre-settlement range conditions represent an ideal on which future conditions can be based.

It is further implied that removal of livestock from grazed areas and prevention of livestock from reaching now ungrazed areas will give a basis for understanding, and perhaps reaching, those pre-settlement conditions.

Is it possible to know what pre-settlement conditions were? Are there sizable areas in the West that have never been grazed by livestock? If the majority of the West is in some alternate stable (or unstable) stage caused by livestock grazing, can pre-settlement conditions ever be approximated by removing livestock? What is SRM's role in answering those questions?

Chapter 7. The Current Legal Landscape.

Professor Donahue reviews major laws, court cases, and administrative authority dealing with public rangelands. She makes a compelling case that current laws and administrative authority of the Secretary of Interior support the removal of livestock grazing for biodiversity conservation.

If she is correct, is that a matter of concern for SRM? Why? Why not?

Chapter 8. the Socioeconomic Landscape.

Professor Donahue discusses the value of public rangelands, the early post-Taylor Grazing Act years, and modern evidence of the value of rangelands. The second part is devoted to the economic value of public lands ranching today, the people who use public land for grazing, and the asserted merits and benefits of public land grazing. She concludes:

Eliminating grazing in arid regions of the West would offer tremendous benefits while imposing few costs. The economic impacts would be minor, even at the local level; and cultural concerns—whose authenticity as a matter of both history and federal land policy is suspect, anyway—are overblown.

This statement will infuriate many in SRM. But do we have either data or a mandate to disprove it? Is our indignation because of our science or our religion? Should SRM only defend the land, or does its purpose include defending user industries?

Professor Donahue's final chapter, titled Conclusion, is like a closing statement at a trial. She argues that the lands in question are public lands. She asserts that there is no private property rights in grazing permits. There are adequate laws to remove livestock. Livestock grazing is bad for public lands. The majority of the public wants livestock removed. Continued livestock will have further significant adverse environmental consequences on arid western rangelands. She concludes:

"It is time to make hard decisions about traditional, time-honored uses of land. I invite readers to judge livestock grazing on arid public lands by Leopold's straightforward standard: 'Examine each question in terms of what is ethically right as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends to do otherwise'."

I embrace Aldo Leopold's beautiful statement. But I would argue that the beauty of the biotic community includes *Homo sapiens*; morals and ethics of land use cannot be determined by excluding wants, needs, and values of modern humans.

I just tipped my hand on how I feel about people and nature. I have tried not to give my opinion on removing livestock. My opinion, strong as it may be, would only muddle our examination of the significance of this book to SRM. I want us to think about what this book proposes for our profession.

We have a number of committees that address rangeland issues. We publish our benchmark series. We hold symposia and distribute proceedings. We contribute panel members to CAST and NAS/NRC studies.

There has been no lack of professional opinions, yet they are often ignored, or even worse, called unprofessional.

We have had our greatest successes when we stick to scientific issues. It was range people that first questioned the adequacy of the Clementsian model. It was range people who developed the alternative state and transition model. It was range people who developed new knowledge about carbohydrate storage in plants, and range people are on the cutting edge of grazing behavior. It would certainly be safer to stick to sci-

ence, but would we be doing what SRM should do?

We have lost credibility because we have been too close to the livestock industry. Can we give responsible, credible opinions from the standpoint of land health regardless of use? What would happen to range management if all livestock were removed from our public ranges? Would we be less effective, or less a champion of public rangelands if they were managed for another use?

We have argued that range is a kind of land, not a use. But did we really believe it? Why did we tolerate public land agencies lumping range in with timber, water, wildlife, and other commodities?

SRM objectives, and the strategy outlined in Professor Donahue's book, both imply a goal of sustainable uses. Should sustainability be the primary criteria for our endorsement of any use? How can we be sure we are keeping options open for uses not yet imagined?

SRM maintains a contact in Washington and we often comment on pending legislation. Should we be involved in politics? Few decisions of SRM Directors have been as divisive as the endorsement of the Domenici grazing bill. Should we give opinions on legislation and regulations?

If so, should our opinion be limited only to the effect of the decision on the land?

The public rangelands by any measure contribute but a small amount of meat and fiber to our national economy. And even less to the world. If livestock were removed from public lands with less than 12 inches of rainfall, would it force us to concentrate on higher rainfall, private lands for food? Would managing Florida ranges for beef and arid public rangelands for biodiversity make SRM invalid? Would there be more, or fewer, hungry children if we concentrated our efforts on private land?

How would removal of livestock from American public lands affect range manager's ability to restore arid lands of other nations?

Professor Donahue's book can provide a turning point in our profession. Although many of us may disagree with some of what she wrote, she has challenged us to look at ourselves critically. This may not have been her primary goal, but it may be her major contribution.

Range management, as a profession, is at a crossroads. Enrollment in range curricula in public land states is declining. SRM membership is declining. The credibility of range managers is questioned. We are accused of being captive of a single use—livestock grazing.

If we can determine why we think keeping livestock grazing on marginal lands is, or is not, important to SRM, we can have a rebirth that will allow us to reach our objectives.

Author a Past President and is a long-time SRM member from Logan, Utah.

Editors Comments:

A review of the book *The Western Range Revisited: Removing Livestock from Public Lands to Conserve Native Biodiversity*, by Debra L. Donahue, was published in *Journal of Range Management* in January. Because of the high degree of interest generated by the book, then President Kendall Johnson invited additional reviews and comments from other SRM members. This paper by Dr. Box is one of those reviews.

Science: Perspectives for Natural Resource Managers

Claudia E. Kelley

The Annual Society for Range Management meeting was held February 2000 in Boise, Idaho. This week-long event was comprised of presentations ranging from technical sessions on vegetation management and ecosystem restoration to a symposium on range management education in the 21st century. Of particular interest was the symposium "Science: Perspectives for Natural Resource Managers" which defined science, provided examples of the different contexts in which science is used, and evaluated appropriate and inappropriate uses of science.

The Western Coordinating Committee-40, a Land Grant University research committee, created this symposium as a forum to provide a perspective of science from research, management and public interest communities who are involved with modern, complex land use decisions. Following the symposium there was a general request from those attending, for publication of the presentations in their entirety. It was agreed that the Society for Range Management would publish the proceedings in *Rangelands* and the authors were given an opportunity to develop their presentations for publication.

The June issue of *Rangelands* contained the first paper in the series. The paper entitled "Junk or Science in the Court System: You May Be Surprised" was written by W. Alan Schroeder. In his paper, Schroeder discussed the different standards used by the court system to weigh evidence. He illustrated how the outcome may well depend upon the venue of the complaint since the venue determines the type of standard to be applied in reviewing the method employed by the land manager. He proposed that the ultimate gate keeper of junk or science in the field of range management, should not be the court system but instead the commitment to only apply methods to decision-making processes that conform to high standards. With the exception of the paper presented by Barbara Allen-Diaz and Kenneth W. Tate, entitled "Science, Dogma, or Fact: Grazing the Sierra Nevada", the other symposium papers are presented following this introduction.

Rangeland management developed as a discipline integrating the art of management with the use of science. However, in recent years, intense public input and laws requiring the use of science in the decision-making process, have required managers to have more support from scientific research in their decisions. With the pressure to provide scientific documentation to support decisions, managers need to find appropriate information that will allow them to operate from a scientific perspective using results from scientific research as a base of

reference. However, because scientists and managers have interchanged information from science and art for decades, the literature used by natural resource professionals includes a mix of scientific reports and knowledge derived from experience. The frequency with which this information has been interchanged and treated as if it had uniform applicability has made it nearly impossible to differentiate between scientific and experiential reports making it difficult to determine the actual use of science in land management, particularly in the natural resources field. While each type of knowledge is valuable, each also has a specific area of utility. Thus it is important to be able to distinguish between the types of knowledge. One of the consequences of this process is that public natural resource documents are often criticized for misusing science.

Contributing to the misapplication of science is the fact that not all professionals are operating from a common definition of science. Science has a wide array of definitions from a general understanding of nature and how nature operates to specific information gathered under rigorous and controlled experimental conditions. The definitions of science used by natural resource professionals, and even between disciplines within the scientific community, are often quite different. However, the benefits of bringing natural resource managers together with individuals from different scientific disciplines are immeasurable. Ultimately, this bringing together of new views and perspectives should lead to a more comprehensive understanding of systems and issues. But without an appropriate use of information and a common baseline to work from, it is not any wonder that controversy surrounds implementation of science in management.

The symposium was intended to clarify many of the issues involved in this controversy and to help professionals determine how they could effectively use science to support the art of management. It is the hope of the participants in the symposium that this is just the first step in directing attention to these issues and that a commonly accepted view of the appropriate use of science and art in rangeland management will evolve from future discourses. At a time when the general public's confidence in science and scientists in general, and the natural resources field in particular, is declining it is critical that the scientific community lead the way in ensuring the accuracy and quality of the work they produce.

In what follows a brief synopsis is provided for each of the papers. For additional information on "Science, Dogma, or Fact: Grazing the Sierra Nevada" contact authors Barbara

Allen-Diaz and Kenneth W. Tate who may be reached at the University of California campuses, Berkeley and Davis respectively.

◆ **Science, Myth, and the Management of Natural Resources** by Frederick D. Provenza.

This paper compares reductionist science that emphasizes parts with systems science that emphasizes wholes. Provenza suggests that both approaches are deeply interrelated, and that both are integral to solving current problems. Science can be used to seek innovative solutions to these problems. He points out that at its best, scientific method "is the study of the processes of nature, which involves a journey into the unknown, to discover the ongoing workings of nature." At the completion of each journey we are offered truth, but science is always silent on how to use that truth wisely.

◆ **Describing and Categorizing Natural Resources Literature** by William C. Krueger and Claudia E. Kelley.

Current literature citations do not clearly state if the references used are scientific or experiential reports, making it difficult to determine the use of science in management. Krueger and Kelley have developed a protocol to classify the literature, and a system of reporting the classifications, so it is clear if information is derived from scientific studies or professional resource knowledge. They suggest published reports should be classified and referenced as either professional resource knowledge or science. Science should be further classified as to whether it is experimental research, a documented case history or a scientific synthesis, according to established criteria.

◆ **From Equations to Understanding** by Linda Joyce.

The objective of science is to create understanding. Scientific research is the process of building that body of understanding and involves the development of theories to explain observations. Some of the problems associated with developing theories can be overcome through the use of models, which are expressions of theory. Joyce points out that they can be used to represent and simplify reality and are useful in "showing the relationships between objects of a theory, the causal interactions, and the states of the systems." The focus of this paper is the use of analytical models to generate understanding of complex issues in range science and management.

◆ **Science, Politics, and Land Management** by Jack Ward Thomas and James Burchfield.

The increase in intensity of debates concerning land use assessments and planning has resulted in an increasing demand for the application of "good science" in the process. While this new reliance on science may be true in principle, it is increasingly confused in application. Thomas and Burchfield believe the current situation is due to a lack of understanding by politicians and the public as to what scientists are and what science is. They conclude that several shortcomings "must be recognized and addressed before science and scientists can play as useful a role as possible in land-use planning and management processes."

◆ **Management of Rangeland Grazing-Determination of Stocking Rates: Introducing Reliability by Appropriate Applications of Scientific Sampling Principles** by Michael A. Smith.

Determination of appropriate stocking rates is essential. The desire for improved resource conditions, more efficient grazing use and improved animal performance has driven the need for scientifically derived determinations of stocking levels. In this paper Smith describes the essential elements of using annual animal use indicators and trend in condition of the resource to manage stocking levels.

◆ **The Need for Science in the Range Livestock Industry: How Ranchers Evaluate and Use Science in Land Management** by Cassie Cady.

In recent years the U.S. Forest Service began using an ecosystems data gathering and management approach, called Ecodata, to make management decisions on the Lewis and Clark National Forest in Montana. Ecodata is a sampling method developed for analysis and classification of natural resources. This paper describes the implementation of the Ecodata methodology and asks readers to determine the validity of the science used in the process.

◆ **Perspectives: Science in Rangeland Management** by Clayton B. Marlow.

Marlow concludes the series with his perspective on the issues presented and a discussion on the role of science in the protection and management of natural resources.

Throughout the symposium two issues predominated. First, that the development of an objective and factual knowledge base is best achieved through the use of the scientific method. This process is enhanced when followed by a thorough review of pre-published manuscripts by qualified reviewers. Second, scientists, managers, policy makers, and the general public must constantly re-examine their knowledge base and landscape expectations, in response to the ongoing dynamics of natural systems. He suggested that "many of the conflicts over rangeland use may be the result of out-dated and unrealistic expectations of what rangelands can provide."

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Science, Myth, and the Mangement of Natural Resources

Frederick D. Provenza

In what follows, I draw a distinction between reductionist science that accents parts and systems science that accents wholes. I conclude that both views are deeply interrelated, and that neither position alone will solve the problems we face today. Science provides understanding of processes, but it can only provide likelihoods of behaviors of systems, given sets of conditions, none of which are known absolutely. Moreover, science only elucidates what is, not what ought to be.

In the preface to his book *The Marriage of Sense and Soul: Integrating Science and Religion*, Ken Wilber (1999) points out that "There is a strange and curious thing about scientific truth. As its own proponents constantly explain, science is basically value-free. It tells us what is, not what should be or ought to be. An electron isn't good or bad, it just is; the cell's nucleus is not good or bad, it just is; a solar system isn't good or bad, it just is. Consequently science, in elucidating or describing these basic facts about the universe, has virtually nothing to tell us about good or bad, wise or unwise, desirable and undesirable. Science might offer us truth, but how to use that truth wisely: on this science is, and always has been, utterly silent."

Only people can reconcile science with different values—cultural, economic, and ecological—to manage systems. We must seek innovative solutions, through science and empathy for others, to the problems that arise when peoples with different values attempt to use land. Our strength, and only hope, is for peoples of disparate beliefs to work together. That doesn't mean giving up individual views—our differences are our strength. Rather, it means building shared visions by opening up to one another from the heart. Ultimately, creativity comes from unions of opposites.

Reductionist Science

Modern science uses experimentation, replication of results, analysis of cause and effect, and factual documentation to test hypotheses. The scientific method is a belief not in any specific theory or body of facts but in a process through which we conduct the search for truth. At its best, it is the study of processes of nature, which involves a journey into the unknown to discover the ongoing workings of nature.

Three interrelated "methods" are used repeatedly in the quest for truth (Romesburg 1981). Individual research programs, as well as disciplines, are built on these three pillars. Induction involves discovering what is happening. It is based on observation—the keener the better—of events and patterns in nature. Retroduction involves hypothesizing how and why events and patterns happen. The more insightful the hypothe-

ses, and the more of them, the better. Hypothetico-deduction involves experimentation to test alternative hypotheses concerning the workings of nature. The experiments consist of tests of predictions that stem from hypotheses about nature—if nature works in this way, then I expect such and such to happen. Experiments determine if "such and such" actually happens given particular sets of circumstances. The "cleaner" the experiments—the more variables controlled—the better.

Unfortunately, even the best experiments are merely snapshots in time of an ongoing dynamic. To conduct a "good" experiment, we must attempt to stop the clock—hold everything constant. In fact, no experiment has ever controlled all the variables. In any study of behavior, for example, both the lack of experience and the presence of experience influence the outcome of the experiment. Thus, whether or not a creature has experience isn't the issue. The real issue is understanding how experience influences the outcome of the experiment, and putting the study into a broader context. In fact, the more one learns about behavior, the more one sees that everything is connected to everything else in time and space (Provenza et al. 1998).

Reductionist science stands out as one of the millennium's most powerful belief systems. The knowledge that has accumulated from understanding parts has led to revolutions in all facets of life from biology (e.g., modern medicine) to technology (e.g., man on the moon). Our understanding of nature had been a direct result of continually attempting to understand how parts of systems work—from *differentiating*.

"All natural and healthy growth proceeds," as Ken Wilber (1999) suggests, "by differentiation-and-integration. The clearest example of this is the growth of a complex organism from a single-celled egg: the zygote divides into two cells, then four, then eight, then sixteen, then thirty-two...into literally millions of cells. And while this extraordinary *differentiation* is occurring, the different cells are simultaneously being *integrated* into coherent tissues and systems in the overall organism. This differentiation-and-integration process allows a single cell to evolve into a multicellular organism and complex system of exquisite unity and functional integrity."

Differentiation is both the strength and the weakness of reductionist science. Differentiation carried to an extreme results in fragmentation of information and knowledge. Disciplines become dissociated, isolated empires unto themselves. This has drawn the criticism that reductionist science provides ever more information about less and less until we know everything about nothing. But differentiation is only a weakness when we fail to integrate across ever more narrowly defined sub-disciplines. Differentiation is a strength—the fabric wove of parts and mechanisms—when we understand in-

terrelationships across space and time. Thus, the age-old debate between holism and reductionism is misguided because it fails to discriminate differentiation from integration. The problem today is lack of *integration*, not lack of differentiation. Systems views in science and management accent *integration*.

Systems Views

Systems thinking is an attempt to integrate parts to reveal the workings of wholes. According to a systems view, seemingly distinct components of systems—each described by the term "holon" (Hollick, 1993)—interact to create global behavior without comprehensive or global knowledge by any of the component parts. A holon is an autonomous entity when viewed from its constituent subsystems—an individual from the perspective of an organ or cell—but from another perspective, it is merely a component of a larger system—an individual as a member of a social group or as a component of a physical landscape. A holon's behavior influences behavior at larger scales, which in turn influences behavior at smaller scales. Parts create wholes which recreate parts which recreate wholes.....and everything is a holon.

Scientific understanding of behavior and its application to management is an exercise in comprehending relationships among parts and wholes (Provenza et al. 1998). Behavior is an integration of the circle of life—gametes create cells create organs create individuals create social groups all of which influence environments influence social groups influence individuals influence organs influence cells influence gametes. Individuals are strands in the web of society, but at the same time they are societies of cells variously arranged "internally" into organs and organ systems that interact with one another and the "external" social and physical environments, to the extent that it is difficult to clearly define an individual. At all levels of organization, behavior depends on consequences that involve ongoing integration of information across levels of resolution from cells and organs to social and physical environments. In that sense, the notion of cause-and-effect is replaced with functional relationships between behaviors and consequences. Simply put, as the world changes, being gives way to becoming and the illusion of arriving yields to the experience of the journey.

Dynamic complexity arises from endless interactions among holons—self-balancing and self-reinforcing feedback loops—that are non-linear and difficult to predict (Provenza et al. 1998). Climate, soils, plants, herbivores, and people, for example, are interrelated facets of systems that change constantly. Ongoing change requires each component of the system to continually adapt.

Systems thinking focuses on understanding systemic processes—systems archetypes—that result in emergent patterns over time and space (Senge 1994). In so doing, it seeks longer-term solutions to underlying problems, as opposed to shorter-term fixes that mainly consider symptoms. Systems views emphasize circles and non-linear interconnections as ways of understanding, as opposed to linear ways of thinking. One comes to realize that everything involves circular arrangements of influence in play over time and space.

Behavioral escalations - such as marriage quarrels, the arms race, and arguments over natural resources - are one example.

Viewed from only one perspective, the relationship appears to be linear:

My view: your aggression → threat to me → I counter

Your view: my aggression → threat to you → you counter

But in fact, it is a self-reinforcing circle, with players on both sides involved.

Systems thinking complicates ethical issues over responsibility. It is impossible to assign strictly linear cause-and-effect relationships to anything or anyone in the conventional sense. Every act is influenced by so many factors in play over time and space that we can't really assign cause. Who is to blame for the arms race or fights over land? In mastering systems thinking, we give up the assumption that there is an individual, or an individual agent, responsible. The feedback perspective suggests everyone shares responsibility for problems generated by a system, be that interrelationships in marriages, on rangelands, or among nations (Senge 1994).

Some of the oldest belief systems on the planet have embraced the notion of interconnectedness implicit in systems views. These sentiments are tacit in the Eastern world view, as Lama Anagarika Govinda observes, "The Buddhist does not believe in an independent or separately existing external world, into whose dynamic forces he could insert himself. The external world and his inner world are for him only two sides of the same fabric, in which the threads of all forces and of all events, of all forms of consciousness and of their objects, are woven into an inseparable net of endless, mutually conditioned relations." (from Capra 1991). These same views reverberate in the words of Chief Seattle to the "Great Chief in Washington" in 1854, "This we know: The earth does not belong to man; man belongs to the earth. This we know. All things are connected like the blood that unites one family. All things are connected. Whatever befalls the earth befalls the sons of the earth. Man did not weave the web of life; he is merely a strand in it. Whatever he does to the web, he does to himself."

Age-old philosophies also underscore the dynamics of life. Eastern mystics see the universe as an inseparable web, whose interconnections are dynamic, moving, changing constantly. In Chinese philosophy, the flowing and ever-changing reality is called the *Tao* and is seen as a cosmic process in which all things are involved. Taoists say one should adapt one's actions to the flow of life. Buddhists call this world of ceaseless change *samsara*, which means 'incessantly in motion'. They, too, strive to move with the flow of life. "The central idea of Kegan," as

D.T. Suzuki suggests, "is to grasp the universe dynamically whose characteristic is always to move onward, to be forever in the mood of moving, which is life." (from Capra 1991).

The same sentiments—interconnectedness and change—are echoed from a scientific view by the eminent physicist John Archibald Wheeler, "Nothing is more important about the quantum principle than this, that it destroys the concept of the world as 'sitting out there,' with the observer safely separated from it by a 20 centimeter slab of plate glass. Even to observe so minuscule an object as an electron, he must shatter the glass. He must reach in. He must install his chosen measuring equipment... Moreover, the measurement changes the state of the electron. The universe will never afterwards be the same. To describe what has happened, one has to cross out that old word 'observer' and put in its place the new word 'participator'. In some strange sense the universe is a participatory universe." (from Capra 1991).

The German philosopher Arthur Schopenhauer accents these truths for the individual in an essay titled *On an Apparent Intention in the Fate of the Individual*. He points out that "when you reach an advanced age and look back over your lifetime, it can seem to have had a consistent order and plan, as though composed by some novelist. Events that when they had occurred had seemed accidental and of little moment turn out to have been indispensable factors in the composition of a consistent plot. So who composed that plot? Schopenhauer suggests that just as your dreams are composed by an aspect of yourself of which your consciousness is unaware, so, too, your whole life.... And just as people whom you will have met apparently by mere chance became leading agents in the structuring of your life, so, too, will you have served unknowingly as an agent, giving meaning to the lives of others. The whole thing gears together like one big symphony, with everything unconsciously structuring everything else. And Schopenhauer concludes that it is as though our lives were the features of the one great dream of a single dreamer in which all the dream characters dream, too; so that everything links to everything else, moved by the one will to life which is the universal will in nature." (quoted from a summary of Schopenhauer's essay by Joseph Campbell in *The Power of Myth* - Campbell and Moyers 1988).

Implications

Interconnectedness and dynamism—history, necessity, chance—influence system behavior over time and space, and they make the behavior of every holon unique and context dependent. Thus, it is impossible to generalize from time to time and place to place. Virtually anything is possible given different combinations of climate, soils, plants, animals, and people. As Ken Wilber (1999) points out, "...contexts are indeed boundless precisely because reality is composed of holons within holons within holons *indefinitely*, with no discernable bottom or top. Even the entire present universe is simply a part of the next moment's universe. Every whole is always a part, endlessly. And therefore every conceivable context is boundless."

That's why "controlled experiments" are not a good tool to investigate various management options, for example, to com-

pare landscape level manipulations such as different grazing systems. Monitoring the ongoing dynamic under different management scenarios is more important than "testing hypotheses" under supposedly controlled conditions to determine what causes what.

That doesn't mean that we can't discern patterns. Nor does it mean that we can't understand how nature works. The processes are knowable, and given particular contexts, certain patterns are more likely than others (Senge 1994). It implies, however, that we may never be able to predict outcomes due to the dynamism, complexity, and indeterminacy of the processes. As contingencies change, so too patterns and events. We will always make decisions in the face of uncertainty. Life is an ongoing series of choices in the face of varying degrees of uncertainty.

That notion was the realization at the turn of the 20th century when the views of physicists underwent radical transformations, from fairly rigid Newtonian beliefs that nature is knowable and predictable, if we can just discover the rules, to probabilistic notions of quantum mechanics, which illustrate that nature is knowable but not predictable even if we know the rules, to relativistic concepts of time and space that show the processes of nature are relative to the observer (Provenza et al. 1999). Just as physicists have been forced to relinquish their rigid Newtonian views, researchers and managers of natural resource systems must eventually abandon inflexible perspectives for ones that reflect the dynamics of life.

Twentieth-century physics has shown that there is no absolute truth in science, that all concepts and theories are limited and approximate. Science is a quest for understanding, for truth, an attempt to account for observable phenomena in the physical and biological worlds, but science can not be perceived as "true" or "final" in any absolute sense. It is merely a tentative organization of working hypotheses that, for the moment, best account for the facts concerning physical and biological processes whose interconnections are the fabric of a web characterized by change.

Twentieth-century managers confront a similar challenge: How does one manage ongoing interrelationships among facets of complex and poorly understood ecological, cultural, and economic systems, in light of a future not known and not necessarily predictable, in ways that won't diminish options for future generations?

Ongoing adaptation in the face of change is the essence of life for all creatures, including scientists and managers. In that sense, scientists and managers ought to accent understanding and adaptation—explore, implement, monitor, adapt...—rather than prediction. In the arena of constant transformation, virtually anything is possible if we dare to engage one another and the environment in ways that nurture creativity.

Creativity comes from venturing into the unknown. The familiar—typically comforting, orderly, and predictable—is at the same time often devoid of creative zeal. The unfamiliar—usually obscure, potentially dangerous, always unpredictable—is pregnant with creative opportunities. Creativity comes from unions of opposites, from compassion, from opening up to that which is different from oneself. The courage to love is the courage to transcend tradition. The contemporary world of natural resource management is filled with passion, but devoid of compassion. The challenge is to transcend the boundaries

we create. "All boundaries" as Peter Senge (1994) suggests, "are fundamentally arbitrary. We invent them and then, ironically, we find ourselves trapped within them." Compassion for others is the way to transcend boundaries, to find the center that lies beyond pairs of opposites.

Conclusion

Against a backdrop of ceaseless change, controversies over land—whose resources and for what use—remain steadfastly unchanged. The Buddha taught that "all compounded things are impermanent." All suffering arises from trying to cling to fixed forms—objects, people, ideas. The challenge is to accept the world as it moves and changes. The solution lies not in more science or better management—reductionist or holist. Rather, the solution lies in integrating ecological, cultural, and economic values and beliefs of peoples from vastly different backgrounds. To do so, we must all transcend boundaries - fears, desires, social duty - all the time.

Joseph Campbell (1988) concluded an essay on "*The Impact of Science on Myth*" with a Hindu legend that depicts how "gods" transcend the boundaries to cope with the challenges, dilemmas, and transformations of life. The myth tells "of a time at the very start of the history of the universe when the gods and their chief enemies, the anti-gods, were engaged in one of their eternal wars. They decided this time to conclude a truce and in cooperation to churn the Milky Ocean—the Universal Sea—for its butter of immortality. They took for their churning-spindle the Cosmic Mountain (the Vedic counterpart of Dante's Mountain of Purgatory), and for a twirling-cord they wrapped the Cosmic Serpent around it. Then, with the gods all pulling at the head end and the anti-gods at the tail, they caused that Cosmic Mountain to whirl. And they had been churning thus for a thousand years when a great black cloud of absolutely poisonous smoke came up out of the waters, and the churning had to stop. They had broken through to an unprecedented source of power, and what they were experiencing first were its negative, lethal effects. If the work were to continue, some one of them was going to have to swallow and absorb that poisonous cloud, and, as all knew, there was but one who would be capable of such an act; namely, the archetypal god of yoga, Shiva, a frightening demonic figure. He just took that entire poison cloud into his begging bowl and at one gulp drank it down, holding it by yoga at the level of his throat, where it turned the whole throat blue; and he has been known as Blue Throat, Nilakantha, ever since. Then, when that wonderful deed had been accomplished, all the other gods and the anti-gods returned to their common labor. And they churned and they churned and they went right on tirelessly churning, until lo! a number of wonderful benefits began coming up out of the Cosmic Sea: the moon, the sun, an elephant with eight trunks came up, a glorious steed, and certain medicines, and yes, at last! a great radiant vessel filled with the ambrosial butter."

Joseph Campbell offered this ancient Indian myth as a parable for our world today, as an exhortation to press on with the work, beyond fear. It is as relevant today as it was eons ago when the gods and anti-gods decided to conclude a truce and in cooperation churn the Milky Ocean for its butter of immor-

Fig. 1. Shiva, lord of the dance.

tality. For according to Hindu thinking, we are the gods and the anti-gods—pairs of opposites in the field of time and space. And through his dance, illustrated in Figure 1, the Indian god Shiva symbolizes the manifold phenomena in the world. He unifies all things by immersing them in his rhythm and making them participate in the dance, a magnificent image of the dynamic unity of the universe. In his right hand a drum, the tick, tick, tick of time. In his left hand a flame, existence in the process of becoming. His earrings, symbolic of the pairs of opposites, as the Greek gods Apollo and Dionysos symbolize light and dark. Apollo, the god of the light, represents the beauty of the moment and fixed forms. Dionysos, the god of the dark, destroys the old forms in order to bring forth new forms. Shiva, encircled by flames, is serene and still amidst the dynamism of creation and destruction. Everything contains its opposite, and at the center, all is still.

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Describing and Categorizing Natural Resources Literature

William C. Krueger and Claudia E. Kelley

All of us as natural resources professionals can benefit from classification of our literature into categories that reflect the nature of the information reported. Effective resource decision making requires input from a variety of sources, some science and some experience. We will describe our view of what information is science and what is not science but rather professional resource knowledge based on experience and observation.

Within the natural resource disciplines, science is typically understood to be information gathered according to specified protocols, commonly called the scientific method.

To define the characteristics of the categories we propose, we need to first define science as we use it in this paper. The term science has been used in many ways, from a general understanding of nature and how nature operates to very rigid definitions that define science within specific disciplines. Within the natural resource disciplines, science is typically understood to be information gathered according to specified protocols, commonly called the scientific method. Consequently we have accepted the following definition for science. Science is knowledge covering general truths or the operation of general laws, especially as obtained and tested through the scientific method (Merriam-Webster, 1985). It is objective, without imposed social values, and should be the foundation upon which decisions are built. To understand cause and effect or the relationships among variables is an important aspect of science based decision-making.

When any of us makes management decisions, we try to operate from a scientific perspective using results from scientific research as a base of reference. A manager does not apply science to the ground but rather applies an understanding of science to the decision made. It is our view, that a classification of literature will help each of us focus on the nature of the work we are evaluating and consequently increase our understanding of the work and its applicability to decisions that need to be made.

Sometimes science is the most useful information to assist decision making and sometimes the wisdom and experience within professional resource knowledge is the most useful information to assist decision making. Either way we need to know what we are using.

We are not inferring anything about the quality of information by our classification. There are both good and poor scientific experiments and reports as well as good and poor understanding of experience and observations. We have mechanisms to deal with quality but we do not have an accepted system of classifying literature. As resource professionals all of us have a strong scientific foundation, often with specialized training in a given aspect of resource management. Some professionals conduct fundamental or applied research to gather knowledge about basic relationships that exist among ecological processes, or study cause and effect relationships in nature. Other professionals blend this scientific information with social and political factors to formulate land use decisions. It is necessary to include non-scientific information in resource decisions, but science should be used as the foundation for making these decisions within the infrastructure of the complex field of land management. The literature used by scientists and managers includes a variety of reports. Some are scientific and others reflect knowledge derived primarily from experience. Currently scientific and experiential reports are frequently interchanged and treated like they have uniform applicability. We suggest that this is not appropriate and that each kind of literature has a specific area of utility. Using literature appropriately provides a strong foundation for making resource decisions that have predictable outcomes. We need to evaluate the specific attributes of each report we utilize. This study will increase our understanding of natural resources science and help us deal with the complexity of the driving factors in natural resources decisions. Because of the different contributions of research scientists and managers, success in the field of natural resources is contingent upon effective communication among them. Consequently each needs to understand the writings of

the other. The first step is to discern whether literature is based on a scientific or experiential design. The purpose of this paper is to define a classification system for literature in the natural resources field. We explain how to differentiate between types of literature, and describe a system of reporting the literature. We suggest published reports should be classified and referenced as either professional resource knowledge or science and further classified as to whether the science is experimental research, a documented case history or a scientific synthesis, according to established criteria.

...it is important to determine for yourself if the data and analysis presented support the author's conclusions.

Science

Experimental research and documented case histories comprise original research, which requires hypothesis formulation, experimental design, and statistical evaluation. Original research is information of verifiable technical quality. When the source is a peer reviewed journal you can be assured it has had intense review. Original research is sometimes published in documents where the level of the review is unknown. However, since the data and analysis are presented in the reports the reader can evaluate the quality of the work. Whether refereed or not, it is important to determine for yourself if the data and analysis presented support the author's conclusions. The strength of original research lies in the objectivity of the designs and the statistical analysis of the data collected.

Experimental research is characterized by replicated experiments and usually involves studies that allow definition of cause and effect. It can be used to generalize and predict cause and effect, as well as relationships, across a wide variety of environmental conditions. Conclusions from experimental research lead to generalizations that apply across varying ecological sites.

Documented case histories are non-replicated research. They involve either the study of cause and effect or relation-

Documented case histories, e.g. exclosure studies, often involve only extremes of land use and consequently they are only useful to compare across the extremes rather than within the norms of good management.

ships among parameters. Conclusions can only be drawn within the boundaries of the case. Interpretation of documented case histories is constrained by the conditions of the research. However, when a number of documented case histories have been completed across a wide variety of conditions, the ability to use this information to make more general predictions increases. When they include a variety of conditions, a series of documented case histories may be similar to experimental research. Evaluating documented case histories should be done from a different point of view than evaluating experimental research. To evaluate documented case histories you must understand the constraints of the case, as they are only directly applicable to areas that have the same environmental conditions. So, for the research to be of value, the constraints must be clearly identified in the paper. Documented case histories, e.g. exclosure studies, often involve only extremes of land use and consequently they are only useful to compare across the extremes rather than within the norms of good management. On the other hand they are often similar to management situations because they tend to involve studies of larger scales that are similar to management scales.

Both types of research are useful in providing a baseline to understand the resources being managed. However, research should not be a template for management but rather a basis to assist resource managers in improving the decisions they make. The reality is that management decisions involve a wider array of complexities than is dealt with in research. Managers need to use their skills as managers and not try to find mathematical models or constrained research predictions to replace the art of management.

Although not original research, scientific synthesis is an important type of science. Scientific synthesis is a specialized literature review that is based on original research with no technical dependency on non-researched hypotheses (viewpoints). A scientific synthesis integrates a broad spectrum of specific research to provide a holistic understanding of the area of science reviewed. They present a sufficiently representative body of data so that the reader can

independently evaluate the author's conclusions. Properly done a scientific synthesis can be an excellent scientific base to use in formulating management strategies and for developing scientific theories.

Scientific syntheses have strong advantages since they draw broadly on original research and contain sufficient data to allow for independent evaluation. Typically senior scientists who bring significant experience, insight and an extensive understanding of research and literature to the topic write scientific synthesis papers. This comprehensive examination of a topic by a qualified, objective scientist can bring new perspectives to current and old studies. In addition this approach allows the scientist to compare and contrast research methods, temporal and spatial scales, and conclusions. For example Coutant (1987, SS) in his scientific synthesis included interpretable data sets from eleven different studies. This allowed the reader to see the original data and evaluate the quality of Coutant's synthesis. Coutant provided additional analysis of these data sets to draw generalizations that are appropriate across multiple environments. He also pointed out how the literature should be used to make management interpretations. And how the literature can be used to prioritize decision-making and to maximize the beneficial impact of management practices in order to help deal with very large-scale problems.

Qualitative knowledge and experience of professional resource managers, scientists and others is widely reported through the natural resources literature.

Professional resource knowledge

Science is not the only information important for making valid natural resource decisions. Qualitative knowledge and experience of professional resource managers, scientists and others is widely reported through the natural resources literature. This literature base does not have experimental designs or statistical analysis of data, and is not science. It is not possible for the reader to look at the information presented and objectively determine if they would draw the same conclusions. This literature reports knowledge based on the skills and abilities of the authors. When coupled with a scientific foundation it can provide powerful insights to advise resource decision-makers. When interpreting professional resource knowledge, it is

important to understand the intent of the authors; their skill levels and if value systems have influenced the conclusions. Much of the resource management literature is professional resource knowledge. It is similar in some ways to documented case histories but does not have a scientific aspect. These case histories are not written in a way that the results can be verified, so they require substantial judgement in application to different areas. The information presented ranges from excellent and insightful views based on quality experiences to viewpoints based largely on philosophy.

Classification of riparian literature

Although, the literature used by natural resource professionals to make decisions or develop environmental assessments is generally presented as science, in reviewing over 1500 riparian and stream ecology publications from a variety of sources, the majority (66%) of the "scientific" papers would not qualify as science (Larsen, et. al. 1997, PRK). Since a literature citation alone does not clearly state if the references used are scientific reports, it is frequently difficult to determine the use of science in management. This is especially true for riparian related literature since the majority of the literature is professional resource knowledge.

When we classified the literature into science and professional resource knowledge by areas of investigation, it was apparent that there was wide variation in the designs used to study or evaluate specific phenomena (Figure 1). Studies relating to stream flow had the highest proportion of scientific reports, over 60%. Similarly, more than half of the hydrology and riparian bird studies were classified as scientific. The reports about watershed attributes, environmental impacts, and riparian restoration were all less than 20% science reports. It is clear that a professional needs to evaluate every paper individually to determine how it can be useful to the issues being addressed.

Values in natural resource decisions

Everyone has personal values, often strongly felt, regarding specific uses of natural resources. Some favor commodity production and others favor environmental preservation. This tendency to orient our views toward values is moderated by ecological objectives, financial constraints, laws, protocols, policies and regulations. Values are an appropriate driving force in management decisions and need to be in-

Fig. 1. Examples of the percentage of categories that were classified as science.

egrated into the decision-making process. These same factors have no place in science. Science must simply be the objective evaluation of cause and effect or other relationships. When research is oriented toward value system objectives it loses objectivity, violates the scientific method and is of little value to managers. Natural resource professionals need to be proficient at evaluating science and integrating it with other factors. As a society we trust science. To believe we are basing a decision on science when in fact we are not creates false confidence in the decisions made.

A system of reporting and using literature

To enhance the reader's understanding of natural resources literature and the use of each type of information, we have developed a system of reporting and referencing literature so that it is clear if information is derived from scientific research or professional resource knowledge. We suggest published reports should be classified and referenced as either professional resource knowledge or science and further classified as to whether the science is experimental research, a documented case history or a scientific synthesis, according to established criteria. Because papers published in scientific journals, like the *Journal of Range Management*, are usually science or defined as non-science (e.g.

viewpoint) by the editor, it would not be difficult to classify papers into appropriate categories. Likewise, reports that are professional resource knowledge can be readily identified. The greater challenge will be to accurately classify the articles in popular journals and magazines (like *Rangelands*), and publications from institutions or agencies many of which are not science manuscripts. To facilitate classification and referencing, authors of papers in popular journals or institutional formats would categorize their work and provide this information to the reader. Writers referencing these articles would include the classification with the traditional citation in the body of their paper and in the full citation in the literature cited section. For example, a paper would be referenced as Kelley (200X, DCH) to represent an original researched documented case history or Krueger (200X, PRK) to represent professional resource knowledge. ER would represent experimental research and SS would represent scientific synthesis. This establishes a format to provide information on the type of literature being written and referenced allowing the reader to gain greater insight into the literature and more completely evaluate the appropriate level of generalization the reference supports. As a result resource professionals will be better able to discern the nature of the information being presented.

Adoption of this system will require the cooperation of research scientists, professional resource managers, editors, and institution and agency leaders. Although implementation of this system will require additional work, we believe that all professionals in the natural resource field as well as the communities they serve will derive benefits from the additional information available in the references. Knowing the nature of the literature used, either directly or as references in reports, allows for more thoughtful use of the information, and provides us with a substantial opportunity to learn and improve our critical thinking about the resources being examined. This enhanced clarity or understanding should lead to the proper use of the natural resources literature. Recognizing the limits of information in terms of science or professional resource knowledge can help focus monitoring on poorly understood areas. Ultimately, this approach should result in the increased effectiveness of adaptive management strategies, through improved understanding of the literature and how it relates to site specific land use practices.

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From Equations to Understanding

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The purpose of science is to generate understanding. Scientific research is the process of building that body of understanding. It involves phases that are descriptive, experimental, and finally, theoretical and quantitative (Figure 1). Nature is first observed, as the early botanical expeditions of the West record, or as recent publications of new bird species report. In this phase, observations are documented. A more quantitative step is taken when measurements of the natural world are made. How much plant biomass is produced during a growing season? Observations and measurements generate hypotheses about how the natural world functions. Experiments are used to test these hypotheses. For example, an experiment could test the hypothesis that plant biomass production increases under specified amounts of nitrogen and water. These observations and experimental results build theory—a set of scientifically-accepted principles that explain the dynamics of the natural world. As this body of understanding increases, it is quantified using statistics, mathematics, systems analysis, and computer science. For example, the relationship between rainfall, nitrogen availability, and plant biomass production could be expressed as a mathematical equation. Quantifying the theory helps to extend our understanding. And as the theory is applied, new questions are asked and the cycle begins again.

The development of theory in range science is valuable because it provides a framework to generate and test hypotheses and leads to explanations for observations. Good ecological

theory is difficult to develop. Ecosystems have a diversity of organisms and processes that are difficult to model simply. Ecosystems are sensitive to what happened last year, or the year before, or maybe a hundred years ago. Theory may have unmeasurable concepts. Ethics or feasibility may limit field experimentation.

What do models have to do with theory? Models represent and simplify reality by showing the relationships between objects of a theory, the causal interactions, and the states of the systems (Pickett et al. 1994). Models help scientists cope with some of the problems of developing good theory. Models can be static, such as a diagram of a grass plant. Models can be system diagrams, with arrows indicating movement of nutrients or populations within a grassland. And, models can be analytical. The use of analytical models in generating understanding in range science is the focus of this paper.

Analytical Models

Analytical models are quantitative expressions of theory. They encompass numerical constants, a single equation, mathematical models (several equations), computer simulation models, and optimization models. In the broader arena of science, some examples of models are the speed of light in a vacuum (299,792,458 km per second), simulation models used to make short-term weather forecasts or annual wildlife population estimates, and perhaps the most famous single equation: $E = M \cdot C^2$.

Examples in range science include stocking rate equations and models predicting forage utilization based on leaf area index. More complicated, yet still relatively simple, are state-transition models of rangeland vegetation succession. Very complicated simulation models look at plant and animal productivity in grassland ecosystems as functions of many environmental variables.

Have models really helped to build the body of understanding we call range science? Some models, such as statistical models, have likely contributed significantly to range science. The *Journal of Range Management* is filled with many examples where statistical models have been used to identify significance or the lack of it in testable hypotheses. A recent example would be the study by Volesky et al (1999) where the authors use statistical models to conclude that neither leaf area index nor visual obstruction would be useful as direct predictors of total standing crop at individual sample locations on upland range sites in the Nebraska Sandhills. The controversy about the usefulness of models in range science seems to center more on simulation or computer models.

Simulation Models in Range Science

Early simulation models in range science were developed by scientists at Colorado State University, many of whom were a

Figure 1. The research cycle includes the phases of observation, experimentation, and the development of theory. The implementation of this theory often leads to new questions and another cycle through the research phases.

part of a large research project called the International Biological Program (IBP). Contributions were made by George VanDyne, Don Jameson, George Innis, the post docs, and other scientists associated with these early models. The scientists in the IBP Grassland Biome constructed a large simulation model of a grassland that was applied to several different grassland types; this family of models was called ELM (Innis 1978).

The emphasis of these initial simulation models was on the seasonal dynamics of vegetation and animal production in range ecosystems, under different environmental conditions. Why scientists turned to the use of computer models in ecology was described as:

"For many years, ecologists have sought to understand the temporal, spatial, and structural complexities of ecological systems. Because traditional methods of analysis proved inadequate for this task, the technology of computer science was applied in the 1960s to the study of ecological systems. Thus far, computer models have been used mainly to advance ecological science." (Holcomb Research Institute 1976, page 53)

Karplus (1977) placed ecological models close to the black box end of a spectrum of mathematical models (Figure 2). 'Black box' models are those where the behavior of the system is poorly understood, and in order to model the system, many assumptions are made. 'White box' models are those where the dynamics of the system are known quantitatively. Many systems encompass the gray area between these two extremes. Obviously the more physical or mechanical the system, the closer it lies to the white box end.

Figure 2. The spectrum of mathematical models from the 'black box' models where the system is not well-known, to the 'white box' models where the dynamics of the system have been well-quantified (after Karplus 1977).

Within this spectrum, he also proposed the utility of models. Utility ranged from gaining insight near the black box end to product design near the white box end. Karplus concluded in 1977 that ecological models would have utility for gaining insight and testing hypotheses (Figure 3). It was his sense that there would always be fuzziness in ecological models, and that it may be impossible to develop models that could predict

Figure 3. The utility of models along the black box to white box spectrum (after Karplus 1977).

performance, such as plant and animal production or stocking rates—just the type of objectives needed in the management of rangeland systems. Have simulation models in range science been able to predict performance of rangeland systems and improve our understanding?

Contributions of Simulation Models to Range Science

The use of simulation models in range science continued after the Grassland Biome. Examples include the Century model from scientists at Colorado State University (Parton et al. 1987), the SPUR model from the Agricultural Research Service scientists (Hanson et al. 1992), and Savanna from a scientist at Colorado State University (Coughenour 1992). The contributions to range science have been in 3 different areas.

The first area is whole system conceptualization. To quantify range ecosystem dynamics, scientists had to conceptualize how the ecosystem works as a unit. They had to tie together ecological processes such as how environmental factors influence plant productivity, how plant productivity influences decomposition, how environmental factors influence decomposition, and how productivity and decomposition influence the nutrient cycles of the range ecosystem. This whole-system conceptualization has allowed for research questions to be posed and to be tested. It has also facilitated comparisons of ecosystem dynamics across different systems: shortgrass to tallgrass, grassland to shrubland, or North American grasslands and Australian or Asian grasslands. And these comparisons have reframed the need for field data, that is consistently collected in the same way across sites to compare the same variables. The recent move to archive vegetation productivity data for the wider scientific community would not have happened if there had not been the recognition that such data are needed to validate models and to improve our theoretical understanding of ecosystem dynamics (Scurlock et al. 1999).

The second area is improved understanding of the internal processes of an ecosystem. Scientists working with the Century model, for instance, have made significant improvements in our understanding of soil organic matter dynamics, including the role of soil texture.

The third area is improved understanding of ecosystem dynamics under disturbance. Models have been used to quantify

the influence of disturbances such as grazing, drought, insects, and fire. Recent simulation experiments have shown that different models respond differently when water versus nutrients limit ecosystems (VEMAP members 1995) and that such differences have helped to contrast the theory underlying the models (Ryan et al. 1996, VEMAP members 1995).

As with any area of science, these contributions involved range scientists learning how to use simulation models as well as learning about the ecosystem. Many humorous stories abound about the first use of simulation models, such as a model experiment where grasshoppers gained more weight than cows. But these stories are similar to stories other scientists tell about the use of new tools in their area of research. Learning how to use the tools of simulation models has involved refining programming and mathematical skills, narrowing the scope of the models, and using rigorous experimental designs for model comparison. Over time, technological developments have also improved computer software and hardware.

Perhaps the most important contributions have resulted where modeling research has been linked with field research. Scientists associated with the Century model at Colorado State University and scientists associated with the Terrestrial Ecosystem Model at The Ecosystems Center (Massachusetts) have taken ideas and insights from their ecological models back to the field to be tested.

These contributions have value to range science. Models synthesize scientific understanding. Natural resource managers must often manipulate complicated ecological systems in highly variable climates. Could models have utility to natural resource management?

Contributions of Simulation Models to Range Management

The Holcomb Research Institute evaluated the utility of environmental models in decision-making by using a two-way classification that describes environmental models along a decision-making axis—day-to-day, short-term, and long-term—and along a complexity and predictability axis (Figure 4). This

Type of Decision	Type of System			
	Predictable		Unpredictable	
	Simple	Complex	Simple	Complex
Day-to-day	Traffic Light Models	Moon flight models	Personnel development	Economic response to tax changes
Short-term decision making	Highway design	Flood control models	System response to natural disasters	Urban planning
Long-term Planning Policy	N/A	Pollution control strategies	National budgets	Global environmental policy

Figure 4. *The environmental decision-making classification developed by the Holcomb Research Institute (1976).*

classification of models seems relevant here because range research is strongly oriented to understanding range ecosystems for the purpose of managing them more appropriately.

In this classification, day-to-day and short-term decision making encompass problem-specific types of technical decisions. The impact of the decision is local; examples include reservoir water release rates and insecticide spray schedules. Planning or policy making involves longer-range decisions, such as pollution standards, or the authorization of the use of a pesticide.

Predictability in their sense has two aspects: 1) the system is inherently unpredictable, or 2) the system is currently unpredictable but future additional scientific information may allow the response to be predicted.

Their examples of environmental modeling encompass physical, biological, and socio-economic models (Figure 4). Traffic models are simple systems relative to moon flight models, but as the physics is known, both are predictable systems. Unpredictable systems are characterized by personnel deployment, in this case police to fight crime. Crime is difficult to predict, but deploying personnel relatively simple, once the level of crime is known. Highway design or flood control models exemplify short-term decision-making while pollution control strategies and global environmental policy require longer-term planning.

When this classification is imposed on the types of systems and decision-making in range management today, it is apparent there are few simple and predictable models of range systems (Figure 5). There may be examples in intensive agricul-

Type of Decision	Type of System			
	Predictable		Unpredictable	
	Simple	Complex	Simple	Complex
Day-to-day		Fire Behavior Models		Invasive species dynamics
Short-term decisions	Productivity models based on weather	Weather forecasting models --short-term	Seasonal stocking rate decisions	Wildlife-livestock interactions
Long-term Planning	N/A	Grazing systems	State and transition successional models	Plant and animal productivity models

Figure 5. *Models in range science today as classified using the environmental decision-making classification of the Holcomb Research Institute.*

ture where day-to-day simple systems have been modeled, for example hog confinement operations, but few operations in range management are as tightly controlled and predictable. Ecological systems tend to be complex with a strong element of chaotic behavior.

Simulation models have been used to analyze a variety of site-specific range management problems: grazing management alternatives, climatic patterns on grassland production, cloud seeding for hail suppression, drought, strip-mine reclamation, grazing and fire management, grasshopper outbreaks

(Parton et al. 1994). As the technology and data became available to analyze larger geographic areas, simulation models have been used to look at regional issues such as climate change within the Great Plains (Parton et al. 1994).

The importance of linking ecological responses to economic decisions has long been recognized in range science. In the late 1970s, the Regional Economic Resource Simulation Model, an integrated social-economic-ecological model, examined the influence of investments (including ranching) on the regional economy. As quantitative information increased, opportunities to link this ecological information with social or economic models have improved (Conner 1994). Decision-making within ranch enterprises was the focus of the model developed by Stafford-Smith and Foran (1990). Economics was also included in the study to look at the potential impact of climatic change on plant and animal production (Hanson et al. 1992).

Over 20 years ago, the Holcomb Research Institute identified concerns about the use of ecological simulation models in natural resource issues: 1) too much detail in research models, and 2) the optimal solution not identified. They went on to describe institutional problems: Ecological theory is incomplete. Data are lacking for model validation. Models developed in research are often not appropriate for the applied problems. And lastly, the decision-makers are not familiar with ecological modeling and cannot make use of these tools. Have things changed since 1976?

Applying Simulation Models to Natural Resource Issues

Here are what I believe are today's institutional problems of applying models to natural resource problems.

First, managers are uneasy about ecological theory. Can a box and arrow diagram of an ecological model convey to decision-makers what scientists know and what they assume within these models? Can all of the relationships be tied back to field research studies? What are critical assumptions that influence the behavior of the models? Lack of good communication creates an unease about the underlying theory in the model.

Secondly, we still lack data for validation. The state-and-transition models appear to offer valuable insights with respect to the successional dynamics of rangeland ecosystems, particularly those that are subject to episodic events. By our own accounting however, we do not have sufficient data on rangeland ecosystems recovering from disturbance. We lack the field data to estimate transition parameters in these models and to evaluate model predictions.

Thirdly, decision-makers are still unfamiliar with ecological modeling. However, this problem is often the result of some significant differences (Table 1) between the research culture and the management culture (USDA Forest Service 1997). The time horizons are often long in research, whereas management decisions need to be made within specific (often short) timeframes. Research seeks to generalize, whereas decision-makers have a locally specific need. In research, critique is key—the nature of science is a running argument. In management, the answer is needed. Assumptions must be explicit in research to test hypotheses, whereas assumptions may not be entirely known by all parties in the decision-making

Table 1. Differences Between Research and Decision Making

Research Culture	Management Culture
Time horizons long	Time horizons short
Generalization	Locally specific
A running argument	The answer
Assumptions explicit	Assumptions not always known
Context is science	Science is one element in the decision space
Results given as probabilities	Results needed in the context of acceptable risks

process. Science is often only one element in the decision space for managers. In research, the context is science. And lastly, research draws conclusions in terms of probabilities whereas decision-makers look at options in terms of acceptable risks. These differences are critical in developing ways to apply simulation models in natural resource problems.

And fourthly, there is the aspect of 'uncertainty about uncertainty' in models. A model may reflect state-of-the-art theory in an area of range science, but may not yet contain a complete understanding of the ecological processes within a single ecosystem, or reflect the dynamics of the diversity of range ecosystems. This degree of uncertainty needs to be explicitly identified by the scientists and understood by the manager. Science, and models in particular, can guide policy makers as they make the tough policy choices that require balancing competing interests. The gap between the model results and the management decisions, the gap between science and management, needs to be negotiated carefully because it influences the credibility of models and science in natural resource management.

Models Likely to Remain Important in Improving our Understanding of Rangeland Ecosystems

Understanding is an objectively determined, empirical match between some set of confirmable, observable phenomena in the natural world and a conceptual construct (Pickett et al. 1994). Models offer that conceptual construct, and are likely to remain a very important aspect of improving our understanding of the dynamics of rangeland ecosystems.

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SCIENCE, POLITICS, AND LAND MANAGEMENT

Jack Ward Thomas and James Burchfield

As the intensity of the debates concerning land use assessments and planning inexorably increase, and the resultant allocation of increasingly scarce natural resources produces winners and losers, there is a parallel and increasing demand for the application of "good science" in the process. This demand is heard—and equally loudly—from those on each side of increasingly polarized issues related to public land management issues. In other words, the participation of scientists and the application of science are being increasingly demanded, in principal at least, and are increasingly confused in application.

The situation results, we believe, from confusion in the minds of the public and politicians as to what scientists are and science is. This relatively new reliance on science and scientists is the latest attempt to produce a sure-fire approach to making land management decisions that will be universally accepted by all parties "with a dog in the fight" and by the courts. These conflicts, after all, beg resolution, which seems increasingly unlikely, and what and who better to provide "final and irrefutable truth" than science and scientists?

Such blind faith in the application of "good science" as a panacea to gridlock is unjustified, and it presents several shortcomings that must be recognized and addressed before science and scientists can play as useful a role as possible in land-use planning and management processes. It is well to understand that the application of scientifically derived information and insights in management almost always requires a considerable degree of synthesis of such information from a myriad of sources that commonly span several disciplines. Large-scale efforts at synthesis often require both intradisciplinary and interdisciplinary team efforts. Understandably enough, intradisciplinary teams work better together and more efficiently than interdisciplinary teams.

The issue of bias has been widely acknowledged among the scientists themselves, it is only the observers of science that wish to uphold the myth of pure objectivity.

However, it is well to understand that scientists, by and large, see the world through lenses tinted and ground to differing calibration by virtue of their disciplinary backgrounds. Further, scientists are not free of bias. The scientific method is designed to help overcome investigator bias—but such always exists and the possibility, even probability, of bias creeping into analysis must be recognized and addressed.

Scientists must make choices about the variables that are worthy of concern and measure, and these decisions are commonly sorted by worldviews that are fundamentally human. Microbiologist Robert Pollack (1999) proposes that scientists respond to an "inner voice," an unconscious upwelling of val-

ues that drives creativity and motivates discovery. Lele and Norgaard (1996), a biologist and an economist respectively, observe that the nature of scientific thinking requires scientists to adopt broad images of reality to formulate analytical constructs, forcing a *priori* decisions on relevant factors, their interrelationships, and their boundaries. The issue of bias has been widely acknowledged among the scientists themselves, it is only the observers of science that wish to uphold the myth of pure objectivity.

Information pertinent to problem solution is commonly produced in a number of disciplines. This means that any appropriate approach to the use of science and scientists in planning or assessment requires cross-disciplinary efforts. Equally important, cross-disciplinary work requires a more complex, iterative peer review process, such that multiple specialists have occasion to examine and critique interactive effects. As of this moment, there are only a handful of such efforts that have produced results that have received even faint and conditional praise (Johnson et al., 1999). The good news is that these experiences have provided information useful in succeeding efforts—adaptive management in action. But even then there are still significant adjustments to be made following each iteration of experience.

These experiences have been sobering in that it has become clear that such efforts require the attention of highly trained and appropriately experienced scientists. Therefore, such efforts are expensive. With rare exceptions, appropriate personnel have had to be recruited from the ranks of agency research personnel or from counterparts in academia to fill key roles, including that of leadership. At present, most management personnel are not adequately trained nor experienced to carry out such highly technical leadership roles, nor do they have resources to employ consultants to lead such efforts and operate satisfactorily across disciplinary lines.

It is simply past time for federal and state land management agencies to seriously consider alternatives for assuring the existence of an adequately trained and experienced staff of scientists to carry out the increasing demands of science assess-

Clearly, the agencies must either recruit doctoral level specialists, "up-train" personnel (which we would recommend), or both, to carry out these increasingly demanding and difficult tasks. This, of course, opens up the necessity to pay these persons at the levels necessary to attract and retain qualified personnel. That means paying such specialists as much, or likely more, than their superiors in the bureaucratic hierarchy. This is not an easy thing to achieve in paramilitary governmental organizations—but it is very likely essential.

ment and evaluation. At present, agency research staffs are still repeatedly raided for qualified personnel to address one high priority job after another. This crisis-oriented response cannot be tolerated much longer. There is a dramatic need for these very same scientists to go to work on research questions that had surfaced in completed or ongoing assessments and evaluations.

Clearly, the agencies must either recruit doctoral level specialists, "up-train" personnel (which we would recommend), or both, to carry out these increasingly demanding and difficult tasks. This, of course, opens up the necessity to pay these persons at the levels necessary to attract and retain qualified personnel. That means paying such specialists as much, or likely more, than their superiors in the bureaucratic hierarchy. This is not an easy thing to achieve in paramilitary governmental organizations—but it is very likely essential.

These land management and regulatory agencies have "crossed the Rubicon" in terms of firmly establishing precedents for high quality assessment and analyses. There is, in our opinion, no going back. And, the new planning rules proposed for the national forest system assure that the bar for performance has been permanently raised. The agencies must hire, or train, the personnel that can deliver in a sustainable fashion at that enhanced level of performance. It is no longer, or should not be, possible or credible to pretend that these recurrent demands are merely aberrant crises that will likely not occur again. Let us face the fact that crises demanding assessment and evaluation of alternatives of very high quality are now routine in the federal land management business.

...too many scientists assume that the public and politicians understand what science is and scientists are.

That recognition should be coupled with full understanding that the increasingly litigious nature of the world of natural resources management—particularly on the public's lands—requires an increasingly demanding adherence to legally prescribed, intricate processes, including the appropriate and thorough consideration and application of science by qualified scientists. The rise of the "conflict industry," wherein advocates on the environmental and user-group sides bring the big guns of litigation, propaganda, fund raising, demonstrations, and opinions of various experts immediately to bear on any action or process undertaken by management agencies, assures challenge to many, if not most, assessments or proposals.

Commonly, at some point, each side in the conflict will produce experts and scientists to lay out alternative assessments of available information. They will argue that whatever scheme or assessment so far produced is "fatally flawed" (a favorite term in these spitting matches) in the synthesis or application of available information or in terms of perfect adherence to prescribed processes.

Such disagreements should not, of necessity, paint scientists involved in conflict in a bad light. Scientists are carefully conditioned over a prolonged period of education to challenge existing knowledge (hypotheses) about how the world works. And any synthesis of information within a discipline, or between disciplines, is subject to alternative interpretation.

Certainly, differences of opinion among scientists will occur over what pieces of information from the overall mass of information are pertinent to the questions at hand.

The chances for significant differences of opinion to arise increase rapidly when synthesis involves a multi-disciplinary effort. Scientists accept that—even more, they thrive on the "game." However, too many scientists assume that the public and politicians understand what science is and scientists are. Too frequently this includes a belief, or a leap of faith, that there is only one scientific "truth" that would emerge if the process of assessment and evaluation are appropriately conducted, using "qualified scientists" and confining considerations to "good science." We now understand that this belief is unfounded and, as Sheila Jasanoff (1990) observes, competing claims of truth in regulatory science lead us to a pragmatic "negotiated science" in which information and the public interest are carefully weighed in the balance.

The next highly naïve assumption that many politicians and the general public make is that when the "right" science, produced and certified by scientists, is on the table, there will be a decision made as to appropriate natural resource management that all concerned will consider acceptable. For, after all, such a decision is surely "scientifically sound." As the most sensitive nerve in the human body has been said to run from one's pocket book directly to the heart, such acceptance of a decision contrary to one's welfare is not likely. Decisions antithetical to the interests of any group of players in the natural resources management game will not be considered acceptable—regardless whether or not the decisions were based on "good science."

The only natural resources management decisions that will remain operative over any appreciable time frame will satisfy four factors. Kennedy and Thomas (1995) described this basic relationship in a Venn diagram (Figure 1a). Such management decisions are:

1. within legal bounds
2. within ecological capability
3. economically feasible
4. socially/politically acceptable

Whether or not the decision being made lies within the acceptable decision space accorded by the overlap of these factors can be determined in one of two ways. Initial assessment can evaluate compliance with the following factors. The legality of the proposed actions is evaluated by legal counsel. Ecological capability can be judged by an experienced interdisciplinary team with appropriate credentials. Economic ramifications are judged by economists. And, social acceptability and impacts are projected by social/political scientists. Obviously, the amount of decision space available to managers can be altered by manipulations of the assumptions related to each of these variables. This can be visualized as increased flexibility in any portion of the system pushing the circles toward the center and increasing decision space (Figure 1b). More constraints can be visualized as pulling the circles away from the center and decreasing decision space (Figure 1c). Obviously, the decision space is largely constrained by the most intractable variable. This allows managers to direct attention to what wildlife biologists refer to as Liebig's Law of the Minimum, i.e., the overall result will be limited by the

Fig. 1a. *The interactions of various systems bearing on decision space.*

Fig. 1b. *"Loosening" made in one or more of the decision variables pushes the systems inward, producing increases in both risk and management flexibility (decision space).*

Fig. 1c. *"Tightening" is one or more decision variables pulls the system apart and reduces both risk and management flexibility (decision space)..*

most constraining variable(s).

That in turn introduces the need for risk assessment, i.e., the likelihood of achieving projected outcomes in the alternatives under consideration. Risk assessments are constructed considering the variations in the individual factors by alternatives, and then considering the interactions of the four (or however many) operating systems. Such manipulations can produce many iterations of outcomes for consideration of decision-makers, and from which final alternatives for consideration are derived. It will always emerge that the greater the risk assumed, the greater the manager's decision space—and conversely, the most constraints accepted the less the risk.

As a general rule, managers in multiple-use land management agencies, given their mission, will opt for a bit more risk over a shorter time frame with a mid-course correction with the intent of enlarging decision space. Regulatory agency managers, given their mandates, will opt for little or no risk over a longer time frame. That will, in turn, dramatically reduce decision space. If there are threatened or endangered species involved, for example, the concerns of the regulatory agency will be the trump card in the gaming of risk.

The planning and assessment efforts are further complicated by the almost continuous emergence of new information—technical, political, economic, legal—that bears on land management decisions, even those of long-standing. The reaction to such a tattoo of new information creates pressure for a constant adjustment in plan execution and even revision of plans through amendment.

This new information derives from several sources. Included in this array are new laws (and the anticipated interactions with extant laws), results of court cases, new research findings, and management experience, including results from monitoring efforts—both formal and informal—leading to adjustments in a process of adaptive management.

This ebb and flow of information and subsequent adjustments in management activities including planning can be viewed as a reassuring corrective factor to the status quo, since it forces attention on those issues related to important public concerns. As we have acknowledged earlier, information is frequently amassed based on what may be interesting to scientists, but not necessarily relevant to the political questions at hand. And as political scientists such as A. D. Socolow (1987) have argued, analyses are often not about what is important, but what is easy to measure. As long as we concentrate on what may be attractive to scientists and readily measurable, we may be discounting other relevant contextual factors that affect policy concerns. Politics brings us back to the root of the issue.

This new information feeds back to guide changes in management action in a process of what has been called adaptive management. Conceptually at least, if such changes are anticipated and welcomed as clarifying agents, management changes will occur routinely through plan revision without the undue costs and culture shock associated with a routine resistance to inevitable alterations.

That is the theory. In reality, the current system of decision making and plan alteration—the process requirements—are simply too onerous, inflexible, and expensive to encourage, or even allow, timely adjustments. Oddly, a lack of plan adjustments made in a timely manner frequently leads to a manage-

Applied research is carried out to address identified gaps in knowledge or understanding necessary to address critical management problems.

ment "train wreck." In the end these train wrecks prove even more expensive in time, money, and consternation for the public and politicians. The old saying of "pay me now or pay me later" has a certain ring of truth in such situations.

Therefore, while science and scientists have a definite and growing role to play in natural resources management, they are only one of many players in the assessment and planning game. What is the appropriate role for scientists in this regard?

The traditional role of conducting research to provide the underpinning for informed management is, traditionally at least, the scientist's designated role in these affairs. Such research activities include basic research to provide knowledge for the sake of knowledge itself, but which in often surprising ways provide key understandings essential to clarification of a larger management picture. Cause and effect relationships are revealed, as well as unexpected intervening variables.

Applied research is carried out to address identified gaps in knowledge or understanding necessary to address critical management problems. More recently, interpretation of research findings in a form understandable to practitioners and interested publics is increasingly recognized as a significant

Clearly and most appropriately, scientists are but one set of players in the natural resources planning and assessment game.

role for scientists.

These research activities set the stage for the critical next step of bringing scientists and science appropriately to bear in land management. To that end scientists have been employed more and more frequently in the synthesis of scientifically derived information for application in assessment, planning, and management. Such synthesis ordinarily crosses disciplinary boundaries, and most commonly requires multi-disciplinary teams to accomplish satisfactorily.

It should be clearly realized that synthesis of applicable technical information and its application in assessments, planning, and evaluation is not "science" *per se*. Rather it is synthesis, assessment, planning, and evaluation done by scientists, and, the elevated educational level of the participants notwithstanding, is no more or less than that.

Scientists should not make decisions about the appropriate course of management action. That is the duty and prerogative of appointed decision-makers and elected officials. However, scientists can and do serve a valuable role in evaluating whether alternatives under consideration are compatible with the extant state of knowledge.

It is most definitely not the role of scientists to dictate the appropriate levels of risk in decision making. Scientists, however, should have responsibility to see that risks of alternative

management actions are described as accurately and completely as possible. Clearly and most appropriately, scientists are but one set of players in the natural resources planning and assessment game. But now that scientists have been so heavily involved in several high-profile assessment and planning efforts, it should be apparent that the rules of the game have changed. Application of an equivalent level of scientific expertise will be expected in future efforts.

If scientists play their appropriate role, it can be accurately said that resultant management decisions are science based. And it should be equally clear that management decisions, inevitably and appropriately in our view, will be value driven.

Science and scientists, playing a well-defined role in the assessment and planning process, can enhance natural resource management decisions by providing insights, information, risk assessments, and evaluated alternatives for consideration of appropriate decision makers. Scientists must guard against being misused, even inadvertently, in assessment and planning processes. And it should be the responsibility of scientists to educate others, with specific attention to managers, the public, and elected officials, as to their proper role in land management activities.

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Management of Rangeland and Grazing-Determination of Stocking Rates

Michael A. Smith

The determination of appropriate stocking rates for an area (animal unit months, AUMs, or animal numbers in units standardized by animal size times the length of grazing period; aka carrying capacity) for grazing animals is one of the most important tasks of rangeland managers (Holochek et al. 1999). Customarily, stocking rates have been assumed to be static for a particular land area, and in historical practice, permits to graze public lands were fixed at a presumed economically or ecologically sustainable level. Forage use and animal performance would have varied yearly in response to growing conditions.

In recent years, on private pastures and public grazing lands, concerns for more efficient grazing use, improved animal performance, or improving resource conditions have suggested the need for more scientifically based determinations of stocking level. Arguably, the most effective and defensible method of assessing the appropriateness of currently used stocking rates is to monitor condition and trends of pertinent resource attributes and adjust grazing practices including stocking rate accordingly. Condition and trends would be determined by reliable sampling techniques, an application of "good" science. In addition, the grazing animal manager must assume much more responsibility for monitoring and timely adjustment of grazing in response to monitoring results. I will attempt to describe the essential elements of using annual animal use indicators and trend in condition of the resource to manage stocking levels.

Concerns with Current Methods

Many land managers and critics of grazing have tended to ignore the opportunity to learn from the relatively long history of grazing impacts implicit on most rangeland areas. These people are adhering to outmoded paradigms for determining appropriate stocking levels. The traditional methods applied to currently grazed areas

result in unnecessary or misleading assessments of grazing levels.

Common problems with application of the traditional methods include inadequate sampling estimates of condition, utilization, annual fluctuations in weather effects, productivity, or animal distribution. Frequently no adjustment for seasons of grazing and training or herding of animals or other animal management practices of the permittee are made. Recent historic grazing levels and animal performance indicate at minimum that adequate forage is available to sustain the animals and resource condition problems if present are usually localized.

Traditional methods include the Natural Resources Conservation Services (NRCS) stocking rate guides. These guides require quantitative, rarely done, sampling of individual plant species productivity to determine condition class and assume continuous seasonal grazing with low intensity management practices. In their defense, NRCS guidelines are labeled suggested starting stocking rates and imply later adjustments. The U.S. Forest Service (USFS) manuals include production-utilization surveys that promote one-time stocking level adjustments based on usually limited data on annually variable utilization and production. These surveys adjust stocking level based on proportional differences in utilization from a predetermined allowable use level on key areas of the allotment. **The assumption of proportionality between utilization on small key areas and stocking levels usually lacks any verified relationship for the specific land area.**

Formulas that appear sophisticated have been proposed that assert that the appropriate stocking level should be based on livestock grazing characteristics described in the published literature (the text book approach, Holochek et al. 1989). The formula uses the distribution of grazing animals from other areas applied to the distances from water, slopes, species composition, and productivity of

the subject area to hypothesize a stocking rate that is represented as carrying capacity. This approach ignores many factors important to effective range use including habitat's arrangement in the landscape, seasonal and annual differences in forage availability and palatability, weather, animal training, and herding practices.

A recent USFS Environmental Impact Statement (EIS) on management of Great Plains grasslands proposes to allocate forage for livestock grazing in a process based on 4 characteristics known or estimated; management area acres X vegetation structural class percent X herbage production of site X allocated use level by structural class summed over all structural classes. This formula makes several arbitrary assumptions including plant growth allocations to plant health, wildlife, and livestock, presumed productivity, and, assignment of vegetation to structural (height) classes that appear to be derived from assessments with limited applicability or lack scientific literature verification. Grazing management practices, annual variability, and seasonal use patterns appear to be ignored.

These formula approaches may be an appropriate starting point on an area without a grazing history but they ignore many factors intrinsic to the area or controlled by the manager. In many examples, advocates of grazing practice reform point to these pseudo estimates of carrying capacity or reduced rangeland condition following past grazing practices to advocate reducing or eliminating grazing. An overwhelming deficiency in formula and one-size-fits-all stocking rate determinations is the implicit assumption that the number of animals using the area is the principle problem limiting resource condition. Critics often ignore or discount the numerous documented illustrations of improved conditions following the implementation of grazing practices that effectively control livestock distribution and use patterns.

An Alternative Stocking Rate Paradigm

In any situation where stocking levels are being assessed, management goals for production or condition for the area being managed must be clearly stated and translated into measurable objectives. Evaluation of stocking rate may be required when some objective of management is not being met. Animal performance such as weight gains may be below expectations. Erosion of riparian and stream habitats, loss of upland vegetation composition, or watershed values may require improvements. Enough forage for other herbivores may not currently be left after livestock grazing. Effectively correcting deficient management actions or stocking levels imply that some level of trend monitoring and inventory of the area should be available to verify the specific kind, location, and extent of the deficiency. Cost, labor, or technical tools frequently limit the availability of appropriate inventory and monitoring information.

Assessment

A common example problem for public land grazing permittees and managers is that allotment riparian zones need more or taller willows to satisfy structural habitat diversity. Stream bank erosion or unsatisfactory spawning gravels reduce fish habitat value. A common response of managers to these ailments has been to recommend reductions in stocking level without consideration of the stocking history or grazing management. The recommendations commonly require arbitrary standards of percent of stream bank disturbance without site specific evaluation of the stream bank disturbance imposed by the geomorphology of the subject stream. For livestock grazing, this response by managers ignores several well known characteristics of livestock behavior and of alternative grazing management systems that may have great potential to solve the problem. **The option of reducing numbers seems to surface just because it is simple to implement and managers know it was done on other areas.** Frequently, reduced stocking rate is recommended without the prerequisite identification of the specific nature and extent of the problem.

Inventory-Plan-Monitor-Replan

In circumstances where a history of stocking levels exists and an inventory or even cursory assessment such as a Standards and Guidelines check has indicated that existing resource conditions are not satisfactorily meeting management goals, a logical course of action from managers should be as follows: 1) to identify what aspects of the grazing program may have resulted in the unsatisfactory resource condition, 2) establish measurable objectives for the resource components that identify the desired change in resource condition, 3) examine the feasibility of one or a combinations of management options such as planned grazing systems, vegetation stubble heights or utilization levels appropriate to suggest pasture moves, herding, season of use changes, or animal species changes, 4) implement the preferred grazing management strategy, 5) establish monitoring of annual use and weather and long term monitoring of change in measurable resource components, and 6) make timely annual adjustments and/or longer interval changes in the grazing strategy based on the monitoring results.

Successful implementation of the above process requires the incorporation of procedures or processes that arguably might be categorized as sociological as well as biological science based adaptive management. **All stakeholders need an opportunity to participate and express their viewpoints in arriving at the management decisions.** Stakeholders and especially the animal owner or manager should understand the goals, resource management objectives, and responsibilities for implementation of management on the unit.

Ecological potential, management cost, and management skills may limit what can be accomplished. The management strategy must be implemented as planned. If full implementation is limited by the time line for implementation of facilitation practices such as fences, water, or training of animals to herding, interim resource trend objectives and use targets should be established and as much of the management program as possible implemented to insure public awareness of attention to the apparent problem. Goals and objectives must be realistically attainable within the capability of the resource and managers.

Science in This Process

The integration of management and monitoring into an adaptive management strategy where monitoring feeds back directly to timely management adjustment is where good science can and should be applied. My use of "science" in this context primarily refers to the use of data developed through sampling processes that insure reliable data. Reliable data, whether of productivity, composition or utilization should be collected without bias and with sample sizes that provide acceptably small variation.

Ecological potential must be verified as this establishes the array of choices available for management goals. Monitoring must provide a reliable data foundation for management adjustments. Reliability explicitly involves data being representative of values for the component of the system being measured. The variation in the values must be low enough to realistically indicate the central tendency of the data, and the sampling technique must be usable by novices and subject to little variation in measurements by repeated observers on the same point.

Statistical reliability is insured by random or unbiased systematic selection of sample points from within the population (area, type, or species) being sampled. Other schemes for locating sample points will bias the sample results in whatever direction the scheme dictates, but for a specific purpose and with knowledge of the bias, alternative schemes may serve adequately if only a subset of the population, indicated by the bias, is of interest. Natural temporal and spatial variation in measured material cannot be avoided but the sample size, frequency of sampling, and technique should insure that this natural variation is accurately represented. Larger sample sizes or more frequent measurement may be necessary to accurately describe variation. Appropriate sample sizes can be calculated based on variation in a preliminary sample. Annual variation in growing conditions suggests that many measurements must be repeated until the expected range of resource values has been established. The sample technique should introduce minimal variation by being a relatively uncomplicated measurement and not subject to different interpretation of the material measured with different values

obtained by a subsequent observer on a particular data point. A trend associated with management is indicated when the resource value changes over time are correlated with animal use and management and exceed the variation implicit in weather fluctuations over the period of record.

The animal manager would have primary responsibility for impacts of animals on the objective resource values. This manager must be able to make many of the measurements called for in the monitoring program in order to make timely management changes. The monitoring program must be based on enough simplicity in cost, sample size, location, and technique for the animal manager to quickly and reliably determine pertinent use impacts and trends in the resource being impacted. An ideal outcome of the implementation of grazing management predicated on annual and long term monitoring of use and resource conditions is that desired trends in resource conditions are accomplished and supported by reliable data open to scrutiny by resource managers or other stakeholders.

An Example

In one example of the implementation of the above process, a USFS allotment had concerns by Forest Service managers and other stakeholders of localized instances of excessive use exceeding forest plan standards on uplands, riparian zones, willows, and aspen. A coordinated resource management group was formed to address these problems. Key area, site specific objectives were established along with a grazing management plan to address these concerns in an allotment management plan. Monitoring was conducted for 4 years on various key areas included upland forage utilization percent, riparian species residual stubble height, percent grazed twigs on willows, and percent of grazed terminal buds on aspen, and willow and aspen height gain. In this period, use of willow by

elk and cattle was also determined seasonally. Relatively high aspen use levels resulted in a program of sequentially fencing stands during cattle grazing periods to allow regeneration to get taller than browsing height. Elk were shown to consume more willow than cattle. Cattle were moved to the next pasture in the rotation as stubble height or utilization level targets were reached. After the 4 years of monitoring, the permittee was authorized to use a variable season-variable number permit with continuation of the rotational grazing, herding, monitoring, and aspen fencing because of the success of these practices in meeting the utilization standards for cattle. The length of the grazing season was variable depending on the length of time to reach the annual use targets. Key to success for the permittee was accepting the responsibility for continual monitoring of use that allowed for timely livestock herding and movement between pastures.

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The need for science in the range livestock industry: How ranchers evaluate and use science in land management

Cassie Cady

I thank Clayton Marlow for inviting me to be a part of this SRM symposium. I am a rancher and student of ranching and have worked on the Checkerboard Cattle Company (CCC), where I'm co-manager, since 1976. The ranch is located on the North Fork of the Musselshell River, in the Castle and Little Belt Mountains, Montana. Headquarters are over 5200 feet in elevation and the terrain rises from there. We are surrounded on several sides by US Forest Service (FS) lands. The ranch has evolved with the use of these federal lands even in the late 1800's (before the FS existed) and continues to hold FS leases on 5 allotments with about 60% of our cattle grazing on FS allotments during summer months.

I tend to view science as an aid in our efforts to ranch sustainably. **Ideally, to be most useful to me, science should be easily understood, unbiased, and repeatable.** However, separating well designed, rigorously tested science from that which is opinion or observation can be difficult. We see information that has the appearance of science but seems to have been selected to bolster specific, preset agendas rather than presenting objective results that can be reproduced. Unlike information derived from conjecture, results from scientifically conducted studies can readily be seen. Performance of our AI calves, for example, is physical evidence that the science used to produce the technology is valid. It will take four years from the moment of successful AI conception until we can get carcass data on the first calf born to that heifer. Four years seems a long time to wait. But we'll take the time so that we can determine the quality of product we are raising. We'll use the data to make culling and bull selection decisions and to market our calves. Unlike livestock genetics, the validity of scientific premises in range and forestry is slow to reveal itself and more difficult to assess. In an effort to improve the grass resource we are raising on the ranch, we'll also take the time. We use range inventory data to help us in making range management decisions. We set goals, weigh what we learn from outside sources against our own experiences, and choose a course of action. We try one thing and if it doesn't work we try another. We monitor results to determine if and how our actions work toward our purposes and needs; and then we adjust as needed to respond to changing conditions. To evaluate the results of our range management on the ranch, we use grazing records, monitoring photo-points, and permanent transects. In addition, we have established permanent monitoring transects on some of our FS allotments. We have also relied on the historic range monitoring done in our allotments by Lewis and Clark National Forest personnel. However, in recent years, this Forest has begun to use an ecosystems approach, called Ecodata, to make management decisions. We are concerned that they are using this process as though there have not been livestock grazing on the allotments for decades.

I'd like to describe the implementation of the Ecodata methodology used by the Lewis and Clark National Forest and have you judge the validity of the science used in this example. That's *your* job. First I'll review the Ecodata process as it was implemented on our grazing allotments and identify several concerns that arose as Ecodata was implemented, citing examples that we documented. These examples raised questions about the quality of science used by the Forest Service. Finally, I'll draw some conclusions about our first hand experience and make some recommendations to this audience.

Timeline

In 1987, Region I of the USFS made a decision to use the Ecodata system it had developed for analysis and classification of natural resources. Ecodata is described as "A sampling method designed for multi-resource inventory and monitoring application that can be used in conjunction with other data collection procedures, such as range inventory. Ecodata sampling methods provide for description of vegetation types." (*Final EIS*, Chapter 8, p. 4) It was implemented in an attempt to establish a standardized method for vegetation inventory and monitoring and, secondarily, to "promote the integrated use of vegetative data by all types of resource managers" (Winslow, 1995). I don't understand all the complexities of the Ecodata system, but in this method plant communities are classified based on species composition by percent plant canopy cover; ecological status is described as floristic similarity of current vegetation to potential vegetation (climax).

Because the Lewis and Clark National Forest (LCNF) of Region I consists of widely-dispersed districts, this Forest elected first to combine allotments located closely to each other into "allotment groups" to facilitate Ecodata assessment. This would allow Forest Interdisciplinary Team (IDT) specialists to concentrate resources in assessing several allotments at once, rather than focusing on one allotment at a time.

In May of 1992 Forest Service (FS) personnel met with the 19 Castle Mountain permittees to let them know that the first allotment group to be studied by the new method would be the Castles. To facilitate information gathering and dispersion, and to deal with the FS as a group, permittees reinstated a defunct organization called the Castle Mountain Livestock Association (CMLA). As secretary/treasurer of the CMLA, I've been involved in the dealings between the CMLA and FS from the beginning. The CMLA position has been proactive in the process of trying to help the FS accomplish what it wants. We asked the FS for its goals and for the chance to be a part of the IDT. Initially, the FS had no goals to share and told us that the IDT would develop goals as it went along. In January of 1993, the CMLA was finally allowed to sit in on the IDT meetings as observers, not participants. The IDT meetings

were long but it was fascinating to observe from the inside the federal government at work. I came away with a much greater appreciation for the difficulties government employees wrestle with in dealing with policies and special interest groups. Permittees wrestled too—with learning about the NEPA process, Ecodata, seral states and with judgment about the value of the land management proposals presented within the IDT team. We asked that if we could not actually participate, could an independent, third-party range scientist sit in on the IDT as advisor and participant. We were told that a ranger or range con would be happy to meet with any experts to discuss their questions. We asked for the data generated by the Ecodata survey and were given the entire record. We also asked to be able to submit an alternative for evaluation and were given permission to do so. In September, 1993, we submitted an alternative in which costs of proposed structural improvements were \$1600 less than those proposed in the FS Preferred Alternative (Alt 10); in addition, we requested no reduction in AUMs. In a comparison of the ten alternatives evaluated in the Final EIS, the CMLA alternative (Alt 5) came in 9th - just above the No Action Alternative (Alt 1) in analysis of the categories of Upland Status (% use), Vegetation < DPC (desired plant community), Fisheries Trend (decline), Sensitive Fish (decline), and Wildlife Riparian (decline). The No Grazing alternative (Alt 2) showed the greatest resource improvement (more rapidly) over any of the other alternatives in all categories. Alt 10 (Preferred) called for a reduction in AUMs and was believed by the FS decision-maker to be a good compromise of cost of improvements, protection of resources, and livestock grazing. The CMLA questioned the justification of spending over \$164,000 on structural improvements and taking reductions in AUMs.

The CMLA began to ask for help from outside range experts early in our participation. In September of 1992, we hired Rangehands, Inc to do a cursory review of the Castles to point out the problems they saw. They described problems in livestock distribution (not numbers), and, in a few allotments, season-long grazing. At a range monitoring field-day in June of 1993, John Lacey and Robin Tierney, PhDs in range science from MSU, reread an old Parker three-step site and found the transect approaching maximum in forage density index and composition. The FS Ecodata classification of the polygon* (450+ acres total) in which this transect is located showed the polygon to be in low seral or “poor” condition. We also questioned outside experts about a livestock distribution formula developed by the FS—using 8% slope and .15 mile distance from water - to determine carrying capacity. In July of 1995, we again hired Rangehands, Inc.; this time to verify available forage production on some “key” polygons by harvesting and weighing samples. The analyses suggested that FS estimates of available forage were often too low, and sometimes extremely low. Consequently the CMLA requested a Section 8 process in 1994 and attempted to initiate a CRM process in 1996. Neither of these processes were successful. The FS released its Castle Mountain DEIS in August of 1995; the Record of Decision (ROD) / Final EIS—Castle Mountain Range Analysis (FEIS) was released in February of 1997.

* The Final EIS, (Chapter 3, p.2) describes the methodology of classification of plant communities by site type (productivity), community type (seral stage), etc. “Plant communities were assigned to the map *polygons* based on the similarity of the polygon field description to the classified plant community description.” (Italics added) A map showing *polygons* looks like a jigsaw puzzle, with each puzzle piece representing a community classification (grassland, riparian, conifer, broadleaf, etc.). Each polygon is numbered and the number is logged into Ecodata with specific information relative to habitat characteristics, size and so forth. Polygons may vary in size from one acre to over 500 acres.

Definitions

The following definitions used by the FS may differ somewhat from what is generally understood and accepted. They are taken directly from the Final EIS.

-potential natural community (PNC)-

The biotic community or composition of plant species that would naturally occur under minimally disturbed conditions (i.e. little occurrence of grazing, fire, mechanical disturbance or non-native plant invasion). (Chapter 8, p.9)

-key areas-

The areas or portions of the range that are preferred by livestock and are grazed to the allowable use first. For cattle, these areas are generally riparian areas of gentle gradient and near water. The Key area guides the management of the entire area of which it is a part. (Chapter 8, p.6)

-Allowable Use-

The amount of forage planned to be used to accelerate range improvements. (Chapter 8, p.1)

Is this audience familiar with these definitions? Are scientific data available to support these definitions?

In the first place, natural resources are dynamic and have *historically* received disturbance - in the form of fire, grazing, and mechanical impacts by millions of hooves, wind and water. Also, my concern as a rancher is that application of an allowable use standard may not move plant communities in key areas to a higher seral state as required by the FS. In his essay entitled The Illusion of Ecosystem Management, Allan K. Fitzsimmons describes ecosystems as being a fabrication of the human mind. He states “While the ecosystem concept may be helpful as a tool for researchers to better grasp the world around us, it is far too ambiguous to serve as an organizing principle for the application of federal law and policy. As spatial units, ecosystems represent a geographic free-for-all.” Range experts in this audience should be among those to debate the accuracy of these terms and the suitability of “ecosystems management”. As you do, please consider the following.

Agency Approach

Historically, data collected in the Castles included readings of 30 Parker three-step transects in the 1950s, ‘60s and ‘70s. In addition to the Parker data, records of numbers of livestock, on/off dates (total AUMs) and dates of moves through pastures within the allotments are kept annually. Paced transects describing range condition have been done in several areas over the years and those results are available, but few actual utilization measurements are available. All Parker transects

are located on upland sites. The majority of transects were rated in good condition, some in fair condition, a few in excellent, and none in poor. However, the fifty years of Parker three-step data have been dismissed by the LCNF as being unable to be integrated or correlated into Ecodata, and so are no longer used. None of the other historical data were used in the development of the following methodology.

Under the Ecodata process, estimates of allotment stocking rates are calculated based on four factors:

1. existing condition relative to desired condition,
2. actual use relative to allowable use,
3. maximum carrying capacity estimates, and
4. effective carrying capacity estimates.

1. Existing condition relative to desired condition.

The FS began in 1991 by mapping the allotments into polygons. The assessment of each polygon is based on a one-snap-shot-in-time estimate. For each polygon FS personnel do an ocular observation to determine:

- a. dominant species (determined by percent plant canopy cover)
- b. site type (ST) based on productivity on uplands or susceptibility to damage in riparians (where ST1=most productive, ST3=least productive)
- c. community type (CT) or % of floristic similarity to PNC (where CT1=PNC, CT2=high seral state, CT3=mid, and CT4= low)
- d. average slope of polygon.

The “desired future condition (DFC)” is plant communities in high or higher (PNC) ecological status with some exceptions. Exceptions include those polygons in low seral state which are not expected to improve because they contain large amounts (greater than 20%) of introduced species such as timothy, Kentucky bluegrass, and brome. Therefore, the emphasis is to move polygons that are determined to be in mid-seral state to high seral. The manner in which seral states will be improved is by applying allowable use standards.

2. Actual use relative to allowable use.

Historic use data and trend were not considered in the process of developing the new standards. Allowable use standards were developed based on published grazing studies and FS Handbook guidelines. Following are standards of allowable use for different plant community types and different grazing systems as listed in the Final EIS.

Desired

Plant Community	SL % Use	DR% Use	RR1% Use*	RR2% Use*
PNC	20	30	40	50
High Similarity	35	45	55	65
Mid Similarity	40	50	60	70
Low Similarity	45	55	65	75

* SL= season long; DR= deferred rotation; RR1= rest rotation 1; RR2= rest rotation 2.

The average use over the rotation cycle assumes a four-pasture, one year system for RR1 systems and a five-pasture, two year system for RR2 systems.
(Final EIS, Chapter I, p.11)

In his Plant Requirements for Prudent Grazing, Martyn Caldwell concluded that “proper use factors ... imply a level of precision and understanding of range plants and community dynamics that, for the most part, do not exist.” He went on to say that “...the traditional condition and trend analysis is probably the only suitable management alternative until a quantita-

tive understanding of range plant function permits a more refined basis for management.” Are scientific data available to verify that the above standards will move plant communities to a higher seral state? Will, in fact, 45% utilization move a FESIDA/AGRSPI community that is in mid-seral state (15% FESIDA, 5% AGRSPI) to high (20% both species)?

3. Maximum carrying capacity estimates.

The FS determined forage production by clipping plot samples using a Daubenmire quadrat of 1.4 sq ft. Most sampling was done by seasonal trainees. No permanent plots were established so sample sites cannot be accurately revisited. Nearly every sample was taken from a different polygon in several different allotments. Although data was collected at the end of a droughty period, weather records were reviewed by the FS to determine that precipitation was within a range of average conditions. From the clipping data forage production tables were developed for each of 94 plant community types. Results of clipping and weighing of 905 samples of forage taken from 1991 through 1995 (and augmented with published data from Mueggler and Stewart, 1980) were compiled into a publication (unique to the LCNF) to be used in mapping polygons. Very few historic clipping studies were available and so historic forage production records were not used in development of these tables. FS personnel can look at a polygon (in any of the mountain ranges within the LCNF), place it into a specific classification, and look it up in Range Vegetation Classification 1996 to find ecological status and forage production in pounds per acre for each site type/community type given in the respective tables.

Maximum carrying capacity may be determined by one of two ways, neither of which use long term historic grazing records. Note that, in each of these methods, grazed AUMs are calculated, not measured.

- a. production basis:

1. total usable forage (lbs/ac) = forage production (lbs/acre) * % allowable use
2. total pounds available = total usable forage * acres
3. maximum AUMs = $\frac{\text{total pounds available}}{780 \text{ lbs (forage required by a cow for a month)}}$

- b. utilization basis:

1. maximum AUMs = $\frac{\% \text{ weighted average allowable use} *}{\% \text{ actual use}}$
AUMs actually grazed in that year

4. Effective carrying capacity estimates.

“Effective carrying capacity” becomes the number of AUMs estimated to be able to be grazed by the time allowable use is reached on key (heavily used) areas and may be estimated by one of two methods.

- a. PAUT formula:

This distribution formula using the average slope of a polygon (determined in the field) and average distance from water (determined from maps) is applied to adjust from maximum capacity in an attempt to take into consideration uneven use within a pasture due to slope and distance from water. No consideration was given by the FS for historic grazing capacity based on allotment use records. The following formula was developed using data from 140 polygons in 14 pastures in 4 allotments and is unique to the LCNF:

1. predicted pasture utilization

$$PAUT = \{(-3.8 \frac{PASL * PAWA}{POSL * POWA} + 13.2) / 9.2\}^2$$

Where:

PAUT = predicted pasture utilization (in percent)

PASL = pasture weighted average slope (in percent)

PAWA = pasture weighted average distance to water (in miles)

POSL = key area polygon slope (in percent)

POWA = key area polygon distance from water (in miles)

POUT = key area polygon allowable use (in percent)

$$2. \text{ maximum carrying capacity} = \frac{(\# \text{ acres} * \text{ lbs/acre} * \% \text{ allowable use})}{780 \text{ lbs}}$$

$$3. \text{ effective capacity (AUMs)} = \frac{\text{max. carrying capacity} * \text{PAUT}}{\text{weighted pasture allowable use [ave. allowable use of all polygons in a past. (weighted for forage production)]}}$$

$$4. \text{ head months} = \frac{\text{AUMs}}{1.32} \quad [\text{the AU factor for cow/calf (c/c); or, .76 for yearlings}]$$

b. actual use by polygon

This is a method also used by the FS to adjust maximum capacity. Because few historic actual-use measurements are available, and those available are located primarily in key areas (very few available for more lightly used areas), a one-time utilization rating of "suitable" polygons is applied.

1. effective capacity (AUMs) =

$$\frac{\text{max carrying capacity (as figured above)} * \% \text{ actual use}}{(\text{where actual use is allowable use}) \quad 780 \text{ lb}}$$

2. effective capacity (AUMs) =

$$\frac{\text{max carrying capacity} * \% \text{ allowable use}}{(\text{where actual use is allowable use}) \quad 780 \text{ lb}}$$

$$3. \text{ head months} = \frac{\text{AUMs}}{1.32 \text{ (c/c)}}$$

Through application of this methodology AUMs in the Castles have been reduced 17%. These reductions occur in spite of building improvements (fencing and water developments) originally estimated to cost over \$164,600 (Table 1). The FS policy states that two years of consecutive applications of both old and new methodology would allow for a good transition into management based on the Ecodata process. However, this policy has not been followed. Therefore, it is difficult to tell if AUM reductions are a result of climate in the year of assessment, change in methodology, or what. In comparing Ecodata to the SCS Range Condition Analysis (RCA) sampling method, Susan Winslow found that a change from the old RCA method of range classification to Ecodata may result in a reduction of range condition score by 15–20%. She states: "Range inventories conducted with Ecodata methods may indicate that vegetation resources have declined when the change in methods alone could account for the lower score and results may not be related to management changes." (Winslow, 1995)

Winslow's observations appear to describe what has happened in the South Little Belt Allotment group. The South Little Belt allotment group (including CCC allotments) were assessed using Ecodata in the summer of 1997 during a very

Table 1

Allotment Group/ (post NEPA)	Document Date	% Reduction AUMs	Total Improvement Costs
Castle Mtn	EIS. 1997	17% (10)	\$194,400 (164,600***)
Sun Canyon	EA. 1997	4 ** (4)	108,000 (95,600***)
Belt Creek	EA. 1998	38 (29)	293,850 (82,800***)
N. Little Belts	EA. 1998	13 (22)	88,700
Judith (17)	EA. 1998	21 (3)	191,480

*These are total reductions summarized in NEPA documents as predicted by use of the formulas described above. For example, the formulas predicted that total NF reductions in the Castle Mountain group will be 17% in order to stay within allowable use guidelines, and their initial reduction in NF authorized use is 10%. The rest of the reduction may occur later based on monitoring standards. Initial reductions in authorized use (% AUMs) appear in parentheses and include administrative changes.

**This reflects large AUM reductions permittees already took in the 1930s.

***Without vegetation treatment (prescribed burn) costs.

The LCNF is divided into 12 allotment groups, including one sheep group. The five groups listed above show allotment numbers after NEPA. The remaining 7 allotment groups contain 144 total allotments, pre-NEPA, including Special Use and Administrative. Data has been collected on 4 of those left and NEPA work has begun. Three allotment groups remain to be assessed.

favorable growing season. We at CCC wondered what the effects of a drier year would have on forage production figures and so did our own forage production sampling. We clipped, dried, and weighed ten plots in each of six polygons in August and September of 1999. Our sampling quadrat was a hoop totaling 4.8 sq ft of area. Although precipitation for 1999 was lower than normal, we found actual production in those polygons to be higher than stated in the LCNF Range Vegetation Classification handbook. In both CMLA sampling done with Dr. Sindelar in 1995 in the Castles (1. below), and CCC sampling done in 1999 in the Little Belts (2. below) we have found FS production figures to be lower. We believe that the FS use of the small Daubenmire quadrats on a small number of sites to sample biomass is inappropriate from a scientific standpoint as well.

1. CMLA Forage Review - July, 1995

Polygon #	USFS Estimate (1992)	CMLA Estimate	Difference
813	1300	2050	+ 58%
252	1300	2130	+ 64%
907	1300	1490	+ 15%
781	900	2240	+ 149%
57	900	1740	+ 93%
879	800	1500	+ 88%
181	2000	1160 (post-grazing)	NA
357 (inside)	1600	1390	- 13%
357 (outside)	1600	1030 (post-grazing)	NA
84	2100	2360	+ 12%

Notes: CMLA figures shown are for grass only, in pounds/acre. The FS figures are for total standing forage.

CMLA harvest sampling occurred July 10–11 during a growing season which was characterized by normal precipitation and below-normal temperatures. Cool temperatures delayed vegetation development by approximately 2 weeks. Standing forage crop was not fully developed at the sampling.

2. Checkerboard Cattle Company (CCC) Forage Review - August / September, 1999

<u>Polygon #</u>	<u>USFS Estimate (1992)</u>	<u>CCC Estimate</u>	<u>Difference</u>
627	700	2690	+ 284%
634	1100	3770	+ 243%
592	1200	2180	+ 82%
312	1200	5030	+319%
371	1200	3470	+189%
1116	700	1540	+120%

Notes: CCC figures shown are for total standing biomass, in pounds/acre.

The 1999 season was characterized by a cold, late spring and hot, drier than normal growing season.

We have also found what appear to be mistakes in polygon classification for several polygons. For example polygons containing over 50% timothy were classified as being in mid-seral state. We feel that the application of an allowable use standard will not move the predominance of timothy out of these polygons. Instead, we fear that FS personnel rating these polygons in the future may very well conclude that the allowable use standard did not protect these polygons judged to be in mid-seral state in the original 1997 appraisal. The polygons will be found to be in low when they are reassessed, and the "decline" in seral state will necessitate further reductions in AUMs.

The FS underestimation of forage production translates into automatic, immediate cuts in carrying capacity and permit numbers. Forest Service errors in classification of polygons and reliance on utilization standards may result in future cuts as well. All cuts adversely affect those ranches whose economic stability is tied directly to the historic and customary use of the allotments.

Let's look at the subject of riparians briefly. It is true that years ago riparian areas were considered sacrifice areas. This biased position needed to be changed. Now the position is biased just as badly in the opposite direction. We see large areas of streams completely fenced out and AUMs in whole allotments eliminated or reduced to the carrying capacity of the riparian areas contained therein. When the FS told us at the beginning of this process that they were going to look at the big picture, I was tickled. I thought *finally*, and I had an image in my mind of all the players standing on the top of a hill looking out on all the resource and deciding what we wanted it to look like. As the process evolved, I realized that the position of the hill had changed. It had gotten flipped upside down and had landed with the tip resting (and the health of the entire resource balanced) in the 1-2% of the resource called riparian. I understand the importance of riparian areas. I also understand that the health of riparian areas is entwined with and dependent upon the health of the uplands, but let's ground our positions in reason and common sense. These resources *evolved with use*. Use does not automatically constitute abuse of our natural resources. I am confident that livestock utilization of rangeland can be beneficial. We *can* use our federal land resources *and* keep them healthy. I believe valid science and experience have verified this, and can provide means for us to overcome existing problems.

Conclusion

Fairly and accurately applied by skilled, knowledgeable personnel, Ecodata may become a useful tool. But it cannot be validated without historical trend data. Our participation in and close-up review of the LCNF Ecodata procedure as it was applied in the Castles and Little Belts leads us to conclude that it has serious flaws. It not only seriously underestimated the carrying capacity of our allotments, but evidenced poor quality control in field application as indicated by the lack of ability to relocate sample sites, and by having sample sites too small in size, too few in number, and taken in different polygons. We question the scientific validity of the outcomes and the management approach of a process that fails to set measurable goals early on or closely involve the permittees who have utilized the allotments for many decades.

We worry that using low forage production figures, throwing out historical data, and using utilization standards as goals rather than as management tools will set resource managers up for failure. Ranching is a rigorous business encompassing many crucial decisions and requiring application of a variety of disciplines. We look for practical, technological uses of the scientific knowledge that has been compiled to improve production, not hinder it.

Recommendations

SRM can help by:

- developing and using a consistent and understandable working vocabulary,
- continuing to educate land managers and others about the role of ungulate use in range resource management,
- helping to differentiate between valid, impartial science and opinion, and
- promoting the hiring of range people to do range work.

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Perspectives: Science in Rangeland Management

Clayton B. Marlow

It is appropriate that we begin a new century and a new millennium with a discussion of the role of science in the protection and management of natural resources. The timeliness of our discussion takes on greater meaning when we consider the growing public concern that the scientific community cannot move rapidly enough to protect our dwindling natural resources from over-exploitation or extinction. Aplet et al. (1992) pointed out that the American public has become "grimly aware" of the loss of biodiversity and is demanding that forests, rangelands and ocean resources be managed for more than market commodities. Until the last decade of the 20th Century foresters, range conservationists and wildlife managers would have simply turned to Federal and land grant university researchers to develop new strategies for dealing with such a problem. However, there is increasing skepticism that anything positive can happen fast enough (Thomas and Salwasser 1989) and, more dramatically, that a scientific or technological solution will only spawn a dozen new problems of equal or greater magnitude (Stanley 1995). These conflicting social conditions give rise to two questions, what is to be done about the lack of public confidence in science based management and what role will the Society for Range Management play in regaining their confidence?

The bitter irony of society's disenchantment with the role of science in protecting and managing natural resources should not be overlooked because it was public concern over deforestation, loss of wildlife and range degradation that carried the philosophies of J.W. Powell and G. Pinchot into national policy at the beginning of the 20th Century. More than anything else, it was the structured logic of scientific inquiry that led early conservationists and agency personnel like Powell and Pinchot, to believe that science based management would achieve conservation goals and protect the remaining natural resources from exploitation. Since its

earliest beginnings it has been the structure and rules of scientific inquiry that kept both researchers and managers from reaching unsubstantiated or erroneous conclusions about the outcome of a project or treatment. In the Society for Range Management symposium, *Science: Perspectives for Natural Resource Managers*, Provenza (2000), Krueger and Kelley (2000) and Frasier (2000) emphasized the procedures that are followed in scientific inquiry. Without such rules to guide investigations the reader/practitioner is left with little more than product advertising. In fact, it is the very structure of scientific inquiry and reporting that gives researchers the opportunity to predict the outcome or response of an organism or ecosystem to a given set of conditions. Even though some land managers may be skeptical of the results from predictive models, researchers can use them to test new ideas and identify information gaps for further study. Predictive models can also be used by managers and program leaders to assess the risk of a given action or policy. However, a subtle but critical point often overlooked when selecting models and information for management application is how the information base that was used to create the model was developed. While the information used in ecological model development often comes from natural resource management and ecological literature, managers must be aware that all literature isn't always scientific or objective.

Krueger and Kelley (2000) found that only one third of the 1,500 articles on riparian and stream ecology could be considered scientific.

Even though most of the literature used to formulate natural resource models and action plans is generally described as scientific in nature, careful examination of the procedures used to develop that information indicates that much of it may not actually be scientific or objective. Joyce

(2000) has noted that the development of an objective and factual knowledge base is achieved through a process involving description, experimentation and quantification. Using this process as a criterion Krueger and Kelley (2000) found that only one third of the 1500 articles on riparian and stream ecology could be considered scientific. Over two thirds of the literature was either a synthesis of previous studies or what the Krueger and Kelley (2000) termed professional resource knowledge. This latter category was largely personal opinion gained through field observation. While there was probably no "malice afore thought" on the part of those publishing professional resource knowledge and synthesis papers, both categories of literature can have serious shortcomings.

Professional resource knowledge grows out of the experience and observations of managers and specialists in a variety of fields. Giving full credit to the power of observation and long term memory of field personnel the very real drawback to professional resource knowledge is that few of us have experience over broad portions of the landscape and, more importantly, live long enough to see all of the natural variation that can occur within an ecosystem. Thus, our understanding of the full range of ecosystem response is incomplete. Because professional resource knowledge is based on individual experience it would seem that such information would only be incorporated into models and management plans at the local level. However, a thorough review of the literature sources used in a West Coast National Forest Plan revealed that articles and reports based on professional resource knowledge had taken on the appearance of scientific literature by simply being cited in other publications (Allen-Diaz 2000). While the professional resource information may have been applicable in the local area it is unlikely that the same may hold true in other regions or under different climatic conditions or in different management scenarios. The scientific community has developed a procedure

(Frasier 2000) to avoid such a situation by alerting its readers to the limitations of the information in a published paper. This procedure involves the review of the manuscript by qualified individuals *outside the writer's agency or institution*. Input from such reviews ensures that future readers can both understand the results of a study or model and be reasonably assured of the validity of the results. Professional resource knowledge based articles escape this scrutiny because they are often published as agency reports or included in general interest publications that require little or no outside review. Thus, use of professional resource knowledge based information, while instructive, may lead to unrealistic expectations on the part of managers and the general public. Furthermore, difficulties and controversy arise when professional resource knowledge articles gain the appearance of scientific credibility through citation in other reports or publications.

While it may appear that we could regain some level of credibility with the public at large and with other scientific and professional disciplines by clearly identifying when professional resource knowledge is and has been used in reports and publications, it is equally important to remember that the broad applicability of a scientific study is derived from the question or questions addressed by the study itself. Much of the distrust or impatience with the scientific community's ability to address environmental issues arises from two fundamental sources. First, the slow pace of inquiry required by the scientific process frustrates those concerned with the rapid loss of species and entire ecosystems. George Schaller, the well-published naturalist, has argued that the preservation of African and Asiatic wildlife is failing because scientists are reluctant to recommend any action "until more information can be gathered." Second, those dedicated to the preservation of a species or ecosystem are alarmed by the potential for bias in scientific studies. For example, environmental organizations, such as the Sierra Club, have warned range scientists that they are skeptical of results that seem to be "paid for" by a particular agency or interest group. This attitude is

Furthermore, difficulties and controversy arise when professional resource knowledge articles gain the appearance of scientific credibility through citation in other reports or publications.

not confined to the environmental movement. Many livestock producers (Cady 2000) and a segment of gulf coast fisherman (Weeks et al. 1997) base their acceptance of science-based management on their perception of the scientist's background and experience. Thus, scientists who fail to win the acceptance of these natural resources users will have difficulty in getting their recommendations accepted, regardless of how thorough their research has been. While such issues appear to be directed at individual scientists, the broader scientific community faces the same condemnation because of the philosophical underpinning of western science.

The basic approach to problem solving used by American, Canadian, Mexican and European scientists has been, and continues to be based on reductionist methods. Any problem, whether it is the effect of livestock grazing on salmon habitat or how non-native plants invade apparently healthy native plant communities, will be reduced to its simplest parts for investigation. This enables the scientist to control all factors thought to effect the question so that he/she can ultimately identify cause and effect relationships. While extremely effective in developing factual and unbiased information the reductionist approach takes a prodigious amount of time to reach an answer and often as not the research indicates other areas where our knowledge is limited or lacking. Such results have created skepticism and distrust among environmental organizations and natural resource commodity groups because scientists appear to be "creating more work for themselves." In addition to this problem, a certain amount of bias can creep into a scientific study because of the manner in which the initial question to be investigated is developed.

A research question too broadly framed may fail to identify the subtle but powerful effects of a secondary plant metabolite on the competitive ability of

other plants or the effect of a small shift in temperature on salmon egg survival. A question too narrowly focused may fail to identify the larger issue of coastal fishing pressure on salmon recruitment or the role of increased all terrain vehicle use on weed seed dispersal. Lastly, the question

being researched may fail to meet the needs of the public at large because it is dictated by the agency or organization providing the research funding. In the United States the lion's share of research funds are awarded on a competitive basis and successful proposals tend to address concerns at the national level rather than those of local or regional importance. This drives research into arenas that may not have direct application to the problems a range conservationist is facing on the local district. Furthermore, funding guidelines and administrative rules rarely allow studies of sufficient duration to include the variety of climatic conditions that shape so many range and riparian ecosystems. Taken in total, these sideboards often limit the application of research results to such small areas that more research is needed to address the problem on a broader scale. When the "politics of science" are viewed in this light it should come as no surprise that land managers and the public have grown skeptical of scientists' ability to provide solutions for difficult environmental issues. If this skepticism is ignored by the research community, including members of the Society for Range Management, through "academic snobbery" (Thomas and Salwasser 1989), we as a Nation stand to lose a great deal. As greater and greater demands are placed on the world's natural resources by our insatiable desire for bigger homes, faster cars and more exotic vacations the creation of more roadless areas and national parks will be little more than a band-aid. Objective, reliable information must be used to create both interim management policies and long-term educational programs if we are to achieve a balance between human demands and the sustainability of the world's ecosystems.

To regain the trust and confidence of land management personnel and the general public in science-based management we as a professional society and as individuals must re-examine our own attitude

about the role of science in rangeland management. It is critical that resource managers stop and ask if the professional resource knowledge we've gained over the years is as infallible and unchangeable as we'd like to believe. Those concerned with the preservation of a species or an ecosystem must honestly appraise their expectations, are the population levels or acreages desired based in reality or a dream of "what it was like before the white man got here"? The scientific community must shake of its elitism and allow discussion of policy, economics and nature reserve design in professional publications like the *Journal of Range Management*, *Forestry Science*, *Journal of Forestry* and the *Journal of Wildlife Management* (Aplet et al 1992). Hopefully, through this introspection each of us will come to that same realization that Plato's character Socrates shares in the *Apology*; "Each of them believed himself to be extremely wise in matters of the greatest importance because he was skillful in his own art: and this presumption of theirs obscured their real wisdom." Like the Athenians of Plato's time we may have "obscured our real wisdom" by becoming lackadaisical in what we call scientific based management and by being too confident in what we think we know about or what we can expect from nature.

If we are realistic about what we truly know about nature, we must admit that natural systems are both temporally and spatially dynamic. Provenza (2000) has noted that the dynamic complexity of nature makes it difficult to predict outcomes or reactions across space and time and, yet, managers and scientists alike proceed with programs and modeling as if we can fully predict everything that can and will happen. This occurs in spite of evidence that many of the changes in nature take place at such a small scale and over such a long period of time that we humans rarely notice them. Nonetheless it is these small changes which shape great rivers and mountains and the very genetic code of our bodies. If this principle of steady, incremental change was not true then our pre-occupation with plant community succession and species evolution has been a flirtation rather than a science. I will suggest that our "real wisdom" about nature is that change is inevitable and that we as managers and scientists must be willing

to accept the fact that with new information and experience some time honored principles and management practices may no longer be valid. Thus, each of us has a responsibility as a member of the Society for Range Management and as a "citizen of the world" to regularly re-examine what we think we know and to seek out the best of science and technology to fill in our knowledge gaps. We should never reach the point where we believe we know all there is to know or that a single management action will always conserve a resource. We must also be aware of the evolution of society. Because societies change and evolve the type and level of demand they place on a resource or ecosystem will also change. Restrictive game laws and conservation practices on the Northern Great Plains were unnecessary when there was no market for beaver pelts or buffalo robes.

It is critical that resource managers stop and ask if the professional resource knowledge we've gained over the years is as infallible and unchangeable as we'd like to believe.

In closing, I want to emphasize two points that ran through all the presentations in the *Science: Perspectives for Natural Resource Managers* symposium. First, science is observation, development of concepts, testing of those concepts and thorough review of pre-published manuscripts by qualified reviewers. Simply being cited in a report or publication does not make a body of work science and therefore valid. Second, because natural systems are constantly changing we as managers, policy makers and the general public must be committed to re-examining our own knowledge base and "landscape" expectations on a regular basis. Things that once appeared to be facts may be found to be biased or inadequate today. Thus, many of the conflicts over rangeland use may be the result of out-dated and unrealistic expectations of what rangelands can provide. Carl Taylor, author and rural economist, once stated that conservation was both a social and a moral problem and as such could not be addressed by science alone (Taylor 1951). Even though we have concentrated on

the scientific side of the equation all morning, I would like to conclude this session with a quote from Dr. Taylor, "The need is not only for scientific knowledge but conscience, not only for reason but for sentiment." To this I would add, science can only tell us what can be done, we, alone, must decide if it should be done.

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Sneek a Peek

at the upcoming
issue of
*Journal of Range
Management*

Rotational Stocking and Production of Italian Ryegrass on Argentinian Rangelands

E.J. Jacobo, A.M. Rodriguez, J.L. Rossi, L.P. Salgado, and
V.A. Deregibus

The decreased carrying capacity of Argentinian Flooding Pampa rangelands may be partially attributed to continuous stocking practice, which drastically reduces C_3 grasses as Italian ryegrass. Seedling establishment, tillering and winter forage production of Italian ryegrass was evaluated under rotational vs. continuous grazing regimes during 2 years. Ryegrass seedlings established 2 months earlier in the fall and tiller density was 3 times greater with a corresponding increase in net primary production in the winter under rotational stocking compared to continuous stocking. The increase in winter productivity allowed almost a doubling in animal stocking rate.

Comparison of Three Techniques for Monitoring Use of Western Wheatgrass

Lacey E. Halstead, Larry D. Howery and George B. Ruyle

Managers need to know if forage use techniques that are commonly used to estimate ungulate herbivory under field conditions produce comparable results. A 2-year study compared forage use estimates obtained via the paired-plot method and 2 height-weight methods. On-site height-weight curves and the USFS gauge produced similar use estimates that were consistently lower than estimates obtained with the paired-plot method. Managers should ensure that chosen monitoring techniques provide an appropriate evaluation of management goals and objectives.

Grassland Biomass Dynamics Along an Altitudinal Gradient in the Argentina Pampas

Carolina A. Perez and Jorge L. Frangi

Within a general climatic region there can be significant changes in the grassland structure over relatively short distances. A study in Argentina evaluated differences in dry matter structure, mycorrhizae infection, net primary productivity partitioning to above- and below-ground tissues, senescence and litter fall, and seasonal patterns of dry matter fluxes with altitude. Several factors changed with altitude but water holding capacity of soils and temperature related to several observed trends in structure and function. The similar mean annual aboveground biomass at all sierra grassland sites suggests that a common threshold carrying capacity of green tissues has been attained.

Seed Production in Sideoats Grama Populations with Different Livestock Grazing Histories

Steven E. Smith, Rebecca Mosher, and Debra Fendenheim

Plants from "grazing morphotypes" exhibit vegetative traits associated with grazing resistance, but little is known regarding seed production in these populations. Our goal was to compare components of seed production in two populations of sideoats grama from two sites in southern Arizona with different histories of livestock grazing. Genotypes from the population exposed to livestock grazing showed a genetically based decrease in seed production relative to those of the ungrazed population under conditions of infrequent defoliation. Lower seed production potential in populations of sideoats grama intensively grazed by livestock may lead to reduced potential for seedling colonization.

Germination and Early Establishment of Douglas-Fir and Ponderosa Pine in Relation to Grassland Seedbed Conditions

Yuguang Bai, Don Thompson, and Klaas Broersma

Encroachment of woody plants into grasslands is a major threat to range resources in many areas. A study in interior British Columbia evaluated the effect of forest and grassland seedbeds on Douglas-fir and ponderosa pine seedling emergence and early establishment. The seedling emergence of the 2 species were related more to structural than chemical characteristics of seedbeds. Establishment of the 2 species in grasslands in the study area relied on the ability of the seeds to germinate early in the growing season on seedbeds in which soil moisture was conserved.

Flow Processes in a Rangeland Catchment in California

Rohit Salve and Tetsu K. Tokunaga

A common omission in rangeland hydrology studies has been a rigorous treatment of the subsurface component of the hydrologic cycle. Soil moisture and associated energy levels in a California Rangeland watershed are used to develop a water balance for a catchment dominated by annual grasses. A simple water balance assessment for the catchment showed significant variability in the amount of water lost to evapotranspiration and deep seepage. Over a 16 month period evaporation and deep seepage losses compared to the rainfall showed a substantial decrease in the amount of water stored in the soil profile.

A Method for Estimating Cattle Fecal Loading on Rangeland Watersheds

Kenneth W. Tate, Edward R. Atwill, Neil K. McDougald, Melvin
R. George, and David Witt

Water quality contamination by pathogens and nutrients from cattle fecal deposits is a concern on rangeland watersheds. A comparative technique using ocularly ranked fecal deposits was developed to estimate cattle fecal loading across a watershed through time. There was no significant difference between the weighed fecal load estimate and the estimates of observers using the comparative method. This method provides a rapid, simple technique for estimating spatial and temporal livestock fecal loading on rangeland watersheds.

Grazing Impacts on Selected Soil Parameters Under Short-Term Forage Sequences

E. Mapfuo, D.S. Chanasyk, V.S. Baron, and M.A. Naeth

Long-term cultivation is known to change soil physical and chemical properties, but little is known if short-term agricultural practices such as rotational grazing can initiate such changes. We evaluated the impact of 3 grazing treatments and 4 forages on selected soil physical and chemical parameters at Lacombe, Alberta. In general, neither grazing intensity nor the type of foraged grazed had any significant effect on the measured soil parameters after 3 years. The minimal effects of grazing and plant species on soil parameters may have been due to the resilient intrinsic properties of the soil and the short study length.

Effects of Roundups on Behavior and Reproduction of Feral Horses

Kyle V. Hansen and Jeffrey C. Mosley

Roundups are used to maintain feral horse populations in balance with rangeland grazing capacity, but little is known about short-term and long-term effects of roundups on horses. The effects of roundups on behavior and reproduction of feral horses were studied in 1994–1995 in Idaho and 1995–1996 in Wyoming. Foraging and social behavior, percentages of mares with live foals, and foaling success rates were not affected by roundups in either study area. There was no evidence that roundups had deleterious effects on behavior or reproduction of feral horses.

Vegetation Response to Stocking Rate in Southern Mixed-Grass Prairie

Robert L. Gillen, John A. Eckroat, and F. Ted McCollum III

Stocking rates directly influence the frequency and intensity of defoliation of individual plants which in turn, impacts energy flow and plant succession in grazed ecosystems. We evaluated the effect of stocking rate on standing crop dynamics and plant species composition of a southern mixed-grass prairie over a 7-year period. The vegetation showed little response to stocking rate over the study period. This may have been a result of the vegetation being in equilibrium with previous heavy stocking rates and increases in grazing sensitive species at lighter stocking rates may occur over longer time intervals.

Hoary Cress Reproduction in a Sagebrush Ecosystem

Larry Larson, Gary Kiemnec, and Teresa Smergut

Hoary cress is a perennial weed that is invading the sagebrush ecosystem of the Northern Great Basin. Field studies evaluated germination, emergence and shoot density to the contribution of vegetative and seed reproduction of hoary cress in a sagebrush ecosystem. Seed reproduction (2 out of 8 years) did not increase plant density but established populations relied upon vegetative reproduction to sequester resources and increase plant density. The spread of hoary cress, controlled by environmental conditions, is occurring at a relatively slow rate.

Seed Biology of Rush Skeletonweed in Sagebrush Steppe

Julia D. Liao, Stephen B. Monsen, Val Jo Anderson and Nancy L. Shaw

Rush skeletonweed is an invasive, herbaceous, long-lived perennial species of Eurasian origin which is spreading into rangelands of the Western United States. Seed germination characteristics of 2 populations in Idaho were evaluated. Without pretreatment and regardless of germination conditions, seeds germinated quickly (<12 days), had high germination rates (>60%), and some seeds also showed dormancy and afterripening effects. Germination characteristics of rush skeletonweed are consistent with those of other invasive alien species and favor rapid population growth leading to community dominance.

Estimating Grazing Index Values for Plants from Arid Regions

Pire C.V. du Toit

The ecological index method of rating range condition is based on classical succession theory which does not adequately represent agronomic values of plants. Two models were developed to estimate grazing index values of shrubs and grasses which included plant size, animal available dry matter production and chemical properties of the plant species. Index values estimated by these models were used to compute range condition scores and predict grazing capacities for different areas in South Africa closely approximating long-term grazing capacity norms. The grazing index value method is an improved approach for determining range condition and grazing capacities.

Tiller Recruitment Patterns and Biennial Tiller Production in Prairie Sandreed

J.R. Hendrickson, L.E. Moser and P.E. Reece

Prairie sandreed is critical in stabilization of the Nebraska Sandhills and is also an important forage grass but its tiller recruitment patterns must be identified to develop effective management practices. Tiller recruitment patterns and the contribution of biennial and new tillers to biomass production were evaluated at 2 locations in Nebraska. Short- and long-term precipitation patterns did not affect the rate or numbers of emerging tillers and new tillers made a larger contribution to biomass than did biennial tillers. This research provides information useful in developing grazing systems.

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 publisher or senior author (addresses shown in parentheses). Suggestions are welcomed and encouraged for items to include in the future issues of *Rangelands*.

Animal Ecology

Effects of social facilitation for locating feeding sites by cattle in an eight-arm radial maze. D.W. Bailey, L.D. Howery, and D.L. Boss. 2000. *Applied Animal Behaviour Science* 68:93-105. (Northern Agr. Res. Ctr., Montana State Univ., Star Route 36, Box 43, Havre, MT 59501). Cattle can learn feeding site locations from other cattle.

Grazing behavior and diet selection by Dorper sheep. T.S. Brand. 2000. *Small Ruminant Research* 36:147-158. (Elsenburg Agr. Research Center, Private Bag X1, ZA-7607 Elsenburg, South Africa). Dorper sheep graze less selectively and eat less grass than Merino sheep.

Least-effort pathways?: A GIS analysis of livestock trails in rugged terrain. D. Ganskopp, R. Cruz, and D.E. Johnson. 2000. *Applied Animal Behaviour Science* 68:179-190. (USDA-ARS, HC-71, 4-51 Hwy. 205, Burns, OR 97720). "These data support the hypothesis that cattle establish least-effort routes between distant points in rugged terrain and suggest that GIS software may be useful in designing systems of livestock trails in extensive settings."

Recent progress in the assessment of mineral requirements of goats. F. Meschy. 2000. *Livestock Production Science* 64:9-14. (Laboratory Nutrition Alimentat., 16 Rue Claude Bernard, F-75231, Paris 05, France). Reviews current knowledge of mineral requirements for goats.

Summer-autumn rainfall effects on wool staple strength and position of break. I. Small-scale field simulations of rainfall onto sheep grazing dry pasture in February and April. R.G. Woodgate, H.M. Chapman, I.D. Robertson, and K.J. Bell. 2000. *Australian Journal of Agricultural Research* 51:523-530. (P.O.B. 54, N. Beach, WA 6020, Australia). Sheep grazed more selectively after simulated rainfall was applied to dry pasture.

Grazing Management

Grazing management practices for riparian areas. T. Colberg and Z. Abouguendia. 2000. (Marilyn Phillips, Grazing and Pasture Technology Program, Regina, SK, Canada, phone: 306-757-9499 or Email: ssga@sk.sympatico.ca). Summarizes important principles for designing livestock grazing strategies in riparian areas.

Winter-feeding options for maintaining healthy riparian areas and water quality. T. Colberg and Z. Abouguendia. 2000. (Marilyn Phillips, Grazing and Pasture Technology Program, Regina, SK, Canada, phone: 306-757-9499 or Email: ssga@sk.sympatico.ca). Highlights different ways that ranchers can modify or design winter feeding sites.

Hydrology

Using GIS to identify functionally significant wetlands in the northeastern United States. P.T. Cedfeldt, M.C. Watzin, and B.D. Richardson. 2000. *Environmental Management* 26:13-24. (School of Natural Resources, Univ. of Vermont, Burlington, VT 05405). Developed a GIS-based computer program that uses remotely sensed land use data to identify ecologically important wetlands.

Improvements

Biological control of leafy spurge. D. Hirsch, D. Nelson, and S. Merritt. 2000. (TEAM Leafy Spurge, phone: 406-433-2020 or <http://www.team.ars.usda.gov/>). A comprehensive, easy-to-read manual on how to use flea beetles to control leafy spurge.

Noxious brush and weed control research highlights—1999. D.B. Wester and C.M. Britton (eds.). 1999. (Dept. of Range, Wildlife and Fisheries Mgmt., Texas Tech Univ., Box 42125, Lubbock, TX 79409). Progress report describes 32 research projects in the Department of Range, Wildlife and Fisheries Management at Texas Tech University.

Management Planning

Balancing endangered species and ecosystems: A case study of adaptive management in Grand Canyon. V.J. Meretsky, D.L. Wegner, and L.E. Stevens. 2000. *Environmental Management* 25:579-586. (School of Public & Environmental Affairs, Indiana Univ., Bloomington, IN 47405). Describes a conflict resolution process that satisfied competing requirements of ecosystem management and the Endangered Species Act.

Habitat conservation plans under the U.S. Endangered Species Act: The legal perspective. D.E. Moser. 2000. *Environmental Management* 26(Suppl. 1):S7-S13. (McCutchen, Doyle, Brown & Enersen, Embarcadero Center 3, Suite 1800, San Francisco, CA 94111). Discusses how private landowners can use Habitat Conservation Plans to comply with the Endangered Species Act.

Healthy watersheds, healthy grazing-land resources. T. Colberg and Z. Abouguendia. 2000. (Marilyn Phillips, Grazing and Pasture Technology Program, Regina, SK, Canada, phone: 306-757-9499 or Email: ssga@sk.sympatico.ca). "...provides background information to help producers and communities manage their rangeland and pasture resources within a watershed framework."

Multiple species habitat conservation planning: Goals and strategies of local governments. B. Loew. 2000. *Environmental Management* 26(Suppl. 1):S15-S21. (Riverside City Regional Park & Open Space District, 4600 Crestmore Rd., Riverside, CA 92509). Multiple species Habitat Conservation Plans have been used to eliminate project-by-project negotiations with federal and state wildlife agencies and to coordinate obligations under several federal and state laws.

Measurements

Methodology for public monitoring of total coliforms, *Escherichia coli* and toxicity in waterways by Canadian high school students. J. Au, P. Bagchi, B. Chen, R. Martinez, S.A. Dudley, and G.J. Sorger. 2000. *Journal of Environmental Management* 58:213-230. (G.J. Sorger, Dept. of Biology, McMaster Univ., 1280 Main St. W., Hamilton, ON L8S 4K1, Canada). Coliform bacteria measurements made by high school students were comparable to measurements made by experts who used more expensive methodology.

Monitoring the vegetation resources in riparian areas. A.H. Winward. 2000. USDA For. Ser. Gen. Tech. Rep. RMRS-GTR-47. (Publications Distribution, Rocky Mountain Research Station, 240 West Prospect Road, Fort Collins, CO 80526). Describes three sampling methods used to inventory and monitor vegetation in riparian areas: vegetation cross-section method, greenline method, and woody species regeneration method.

Plant/Animal Interactions

Effects of cattle grazing on North American arid ecosystems: A quantitative review. A. Jones. 2000. *Western North American Naturalist* 60:155-164. (Wild Utah Project, 165 S. Main St., Suite 1, Salt Lake City, UT 84111). In arid, grazed ecosystems, soil variables should be used to assess rangeland health because soils are more sensitive to cattle grazing than vegetative variables.

How forage characteristics influence behaviour and intake in small ruminants: A review. R. Baumont, S. Prache, M. Meuret, and P. MorandFehr. 2000. *Livestock Production Science* 64:15-28. (INRA, Centre Clermont Fd. Theix., F-63122, St. Genes Champanelle, France). Discusses how forage palatability affects diet selection and intake.

The effect of the spatial distribution of plant species within the sward on the searching success of sheep when grazing. B. Dumont, J.F. Maillard, and M. Petit. 2000. *Grass and Forage Science* 55:138-145. (INRA, Centre Clermont Fd. Theix., F-63122 St. Genes Champanelle, France). When patches of preferred forage were grouped, sheep grazed the preferred forages more intensively than when the patches were isolated and distributed randomly.

Plant Ecology

Field guide: Identification of common riparian plants of Saskatchewan. T. Colberg and Z. Abouguendia. 2000. (Marilyn Phillips, Grazing and Pasture Technology Program, Regina, SK, Canada, phone: 306-757-9499 or Email: ssga@sk.sympatico.ca). Annotated diagrams describe 58 species of graminoids, forbs, trees and shrubs commonly found in riparian areas of Saskatchewan.

Invasive weeds in rangelands: Species, impacts, and management. J.M. TiTomaso. 2000. *Weed Science* 48:255-265. (Weed Science Program, Dept. of Vegetable Crops, Univ. of California-Davis, Davis, CA 95616). Recommends long-term, integrated management strategies be used to control noxious weeds on rangelands.

Water and nitrogen uptake patterns following moisture pulses in a cold desert community. R.L.E. Gebauer and J.R. Ehleringer. 2000. *Ecology* 81:1415-1424. (Dept. of Biology, Keene State College, Keene, NH 03435). Six dominant perennial plant species differed in their timing and depth of water and nitrogen uptake, suggesting that resource partitioning may contribute to the coexistence of species in highly variable environments.

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

Letters to the Editor:

Dear Editor:

What interesting contrasts in the two *Rangelands* articles appearing in the February 2000 issue.

Holechek, et al. in Short Duration Grazing: The Facts in 1999 use the terms short duration grazing, Savory grazing and holistic resource management synonymously to describe a grazing system. The authors use a 1988 citations as their most recent Savory reference.

C.J. Hadley in her article *The Wild Life of Allan Savory* describes holistic management as a unique goal-driven, decision-making process that integrates human values with economic and environmental concerns, resulting in management that is proactive and sound—socially, ecologically, and economically. The article describes the evolution of holistic management.

What different perceptions. Is Holistic Management a grazing system or a goal-driven, decision-making process?

Savory perfected the holistic management mode and has updated it in recent years to keep it useful and functional for practitioners.

In deciding what Holistic Management is, I opt to take my guidance from the man who developed, teaches and implements the concept rather than just the interpreters of the concept.

Sincerely,
Stephen M. Williams
Phoenix, Arizona

Dear Editor:

If our *Rangelands* magazine is to serve as a forum for the presentation and discussion of facts, ideas, and philosophies pertaining to the study, management and use of rangelands and their resources, I encourage you and other readers to re-read and discuss the presentation of "Expected-Use GIS Maps," (Guenther, Guenther, and Redick) published in the April 2000 issue of *Rangelands*.

Please, gentle readers, consider the appropriateness of the "cure-all" solution presented by the authors, prescribing a GIS map of merely two factors, slope and distance to water, for the modern rangeland manager's myriad of time-consuming little concerns, from estimating grazing capacity to locating salt grounds, identifying sensitive areas, and locating trend studies. The authors do not present this use of computer technology as a "tool," nor do they discuss possible problems of applying such technology without regard to the many other factors most of us know can have strong effects on grazing distribution, potential conflicts, forage utilization, and carrying capacity.

It is particularly disturbing that the authors claim their expected-use maps have been "effectively used to facilitate several planning and analysis tasks that are often time consuming." The Muddy Creek Allotment (McNinch Pasture is an illustration in the article) must be one of the areas where BLM applied this technology. Ah-ha! So that was how they did it! I am personally acquainted with this allotment, and have been following with some interest the continuing saga of decisions and appeals BLM is suffering concerning livestock grazing on Muddy Creek. I have the same feeling that Dorothy must

have had when her little dog, Toto, jerked back the curtain to reveal the Wizard of Oz was just an old humbug; finding BLM's analysis, to quote Shakespeare, "full of sound and fury, signifying nothing."

Let's take the cows out of the picture, just for fun! Suppose we want to determine the expected knowledge of rangeland resources among rangeland managers in a given area. We plan to assign pay grades and program budgets accordingly. "It is known" (we all agree, so no reference is necessary) that knowledge of rangeland resources is strongly affected by factors of road access and distance from the office. Further, we can characterize knowledge levels (high, moderate, low), and based on these factors, develop a detailed, multi-colored computerized map of expected-knowledge levels for any given area.

Those areas with good access and within 1 hour of the office would appear in red on our map, as "concentration areas" for rangeland knowledge, and we could estimate the knowledge level as "high" in these areas, 60% or higher. Areas with poor access, more than 3 hours from the office, would be colored green (low knowledge level, 20–30%). Areas more than 4 hours from the office, with no road access, would be "incidental knowledge areas," with a knowledge level less than 20%. At the touch of a button, we could ask the computer to tell us how many acres of each knowledge-level were in any given area. We could do this whole assessment without leaving the comfort of our office, in a few strokes of the computer keyboard.

Would this effort result in a useful assessment of the expected level of knowledge of rangeland resources? Would the pay grades and program budgets be appropriately distributed?

We could acknowledge (but not enumerate) other factors (more difficult to analyze) that might influence the level of rangeland knowledge in any particular area. We could do some field checking to see if we were anywhere accurate in our assessment (but it takes time and money, to do that, and we were wanting to save on those items). We could discuss the potential hazards of relying strictly on computer models, without actual field data of any kind (but how would that help sell this program?). What we really want to focus on is the great savings in time and money through computer technology (and with that and \$1.75 you might get a small latte at the local espresso shop in a formerly abandoned storefront in downtown Western USA).

GIS technology is a tool, and its use is only as valid as the data and assumptions we chose to operate within the computer environment. There is a danger in the use of this tool, as it gives the appearance of factual, scientific information, without actual data. Reference to a federal agency and use of official titles does not add credibility to the computer program. Alone, it is mere "pseudo-science," or, to quote Alan Schroeder, in the June 2000 issue of *Rangelands*, "junk". The authors nowhere stated this fact. In *Rangelands*, we should insist that it be included.

Sincerely,
Robert J. Bump
Dillon, Montana

Dear Editor:

I was amused at the letters defending short duration grazing that the Holechek et al., article in the February 2000 issue of

Rangelands (Short Duration Grazing: The Facts in 1999) evoked in the June issue. The responses varied from "...a vendetta by the authors against Holistic Resource Management..." to Mr. Savory's own rather weak defense. He discussed at length the only research trial he ever participated in and after 7 years (not 8 as he stated) it "...proved what I always advocated..." which was that with HRM he could increase stocking, increase profits, and improve the range. Actually results of this research, known as the Charter Trial, published in the *Zimbabwe Agricultural Journal*, (1984), 81(2):41-56, by Drs. J.N. Clatworthy and S.D. Parsons and Mr. D.K. Worthington did not substantiate Mr. Savory's claims. They showed very mixed results. Stocking was increased with HRM over conventional systems but profits were the same or lower per dollar invested. As one might expect with heavier stocking, return per acre was slightly higher under HRM but return per cow was much lower. There was no measurable change in plant composition or range condition.

Later in Mr. Savory's letter, he suggests that the Society for Range Management and all other institutions concerned with resource sustainability establish a national learning site at some place like the Rio Puerco basin and using the Holistic Management framework learn together. He proposed a similar program in Zimbabwe two years ago which was reviewed in the *Bulletin of the Grassland Society of Southern Africa*, (1998) 8(2):1-5, by rangeland faculty from the University of Natal, Pietermaritzburg, R.S.A. (his alma mater). They said in part "...however, this [a rigorous evaluation] is extremely difficult. Not only because of wide spread financial costs and reduced manpower but by the very inconsistency of the Holistic Management approach. It would be difficult to evaluate even a short term endeavor (5 to 10 years) as the approach taken by Holistic Management proponents would surely have changed by then, as it has in the past."

In a post script to the above review, the *Bulletin* Editor captioned a less than flattering illustration with, "In the long term however, the system may turn out to be nothing more than hot air!!"

Sincerely,
Jon Skovlin,
Cove, Oregon

Dear Editor:

I have a few comments to make regarding the Savory-Holechek debate. My qualifications are that I introduced Short Duration Grazing (SDG) to range managers throughout the range community through the *Journal of Range Management* in November of 1969 and I began to employ SDG on my ranch in New Mexico in 1970.

I met Allan Savory in Rhodesia in 1967 through a friend, Mr. Aubrey Mountain, a rancher and Nuffield Scholar from near Que Que. Mr. Robert Vaughn-Evans, with the Rhodesian Extension Service and Mr. Mountain took me to several ranches that were just beginning to employ SDG, suggested to them by Allan Savory. The "Charter Field Trials," mentioned by Mr. Savory in his letter to *Rangelands* (June 2000), were also about to begin. I was unable to follow the Charter research but did keep in touch for a while with some of the ranches using SDG.

When I returned to my ranch in New Mexico in April of

1969, I immediately began pasture division, not a cell configuration, but according to topography and water availability. Had the Internet been in existence or even satellite telephone communication, I might have done things a bit differently, but I had only the basic principles of SDG. I knew they were sound and a significant new approach to grazing management.

I could see positive results by the summer of 1971, so I began to try to find a way for Allan to bring his knowledge and experience to the U.S. In the mean time, Dr. Ensminger's Stockmen's School was able to involve Allan and Dr. Stan Parson in their Phoenix course in the early 1970's. They made a distinct impression on several ranchers at that school and were engaged by the Spurlock brothers of Navajo, AZ, to install what was then still called SDG. Allan soon moved to San Angelo, TX and then to Albuquerque, N.M. He and Mr. Parson worked together for several years and later Allan established the Center for Holistic Management, now called The Savory Center.

Short Duration Grazing has been given many names, much improvement and a great deal of examination by scholars and ranchers alike. I value properly conducted research, but I also realize its limitation on space, time and scope. I have followed SDG basic principles with what I consider adequate planning for thirty years now, and, as long as I keep it flexible, find that it has not failed. To the contrary, SDG has helped improve my range, increased calf weights, restored wildlife habitat and contributed to watershed rehabilitation. If holistic planned grazing is a better name, let's call it that, but I have always considered the planning process an integral part of SDG. Decision-making then becomes informal and practical.

My grazing charts go back almost to the beginning of SDG on Carrizo Valley Ranch and record animal days per acre (ADA's), grades of pasture at the end of grazing periods, effective rainfall and time and length of use. This was the input that strengthened the planning process. Backward planning and monitoring, as well as wildlife considerations, were all part of the SDG I brought to my ranch from Rhodesia. I fail to see the name for a play on names—I'll just call it "successful."

The different viewpoints expressed in *Rangelands* certainly increases our awareness of the importance of developing long-lasting grazing methods that work, but to witness agreement by Mr. Holechek and Mr. Savory that SDG is a failed grazing method doesn't agree with 30 years of "rancher research" done without restrictions on space, time and scope. Perhaps the Holechek-Savory debate has been a turf battle between scientists. My understanding of that level of professional competition may be lacking, but my experience with SDG practiced with "Cowboy Logic" is a gratifying one; one that has benefited all components of the Carrizo Valley Ranch ecosystem. I credit Allan Savory, not only for that, but also for causing landowners and managers worldwide to analyze the paradigms that got us into the sorry condition we were in, and move on to a more holistic level. I believe that SDG, or Holistic Planned Grazing, or whatever it may be termed has brought about a real rangeland revolution. There is a great deal more interest by ranchers in how the land is grazed now than there was 30 years ago and that, in itself, is a worthy result.

Sincerely,
Sid Goodloe
Capitan, New Mexico

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Moving?

Please make sure to send your change of address to the headquarters office for our records.

Society for Range Management
445 Union Blvd., Suite 230
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Fishes of the Gulf of Mexico. Texas, Louisiana, and adjacent waters. Second edition. By H. Dixon Hoese, and Richard H. Moore. Texas A&M University Press, College Station, Texas. 422 p. US\$34.95 cloth, US\$18.95 paper. ISBN 0-89096-737-7 cloth, ISBN 0-89096-767-9 paper.

*Everybody down here has a stuffed fish on the wall.
Where did they get 'em? There are no fish...*

Alfred Hitchcock's *Notorious*.

When the ever-gracious Production Editor of *Rangelands* received this book in February at the Society for Range Management office in Denver, and contacted me concerning its suitability and timeliness for review in *Rangelands*, we both had doubts. We sometimes receive marginally suitable or clearly unsuitable books from publishers. In this case, while a book on fish may seem far afield, much of range management science in the Pacific Northwest is designed around fisheries issues. Also, many range scientists and managers fish for recreation, and anyway, most of them have some interest in ecology. Moreover, I was then about to leave to visit my parents on the Gulf Coast of Florida, where I had spent many days surf fishing in the Gulf of Mexico, and could do so again on this trip. So I thought I could review it with some relevant perspective, and even find some free time to undertake a first-hand, rod-and-reel search for some fish, if I could actually find some that weren't hanging on walls.

For a number of reasons having to do with development and exploitation in one form or other, fishing on the Gulf Coast of Florida, at least surf fishing on Belleair and Indian Rocks Beaches where I have enjoyed it over the years, only vaguely resembles what it once was. Commercial fishing, and exploitative sport fishing have contributed to the decline, but the effects of coastal real estate development have likely been greater. In the early 1970's, I remember days when swimming in the surf on Belleair Beach, Florida, west of Tampa Bay, was like swimming in an aquarium. Some days you could hardly step in the surf without actually stepping on a fish: whiting, flounder, jacks, and many other species, some of which you could see through the clear, blue water. Rays were common too, including the terrors of the chamber of commerce, the stingrays, (*Dasyatis* spp.), which rarely bothered the few local residents of those days, but which could sting heavy-footed tourists on a short weekend before they were waist deep in the surf. Above the surface wasn't entirely safe either, because striped mullet (*Mugil cephalus*) would contin-

uously jump several feet out of the water, so that you had to watch for flying fish. Beginning in the early 1970's, condominiums and the seawalls to protect them were rapidly built along the coastal beaches, and the days of finding young octopuses and sea turtles were numbered. Meanwhile, back at the intracoastal waterway, other developers were tearing out shoreline mangroves faster than a school of bluefish (*Pomatomus saltatrix*) can clean out a tackle box, and the days of inadequate fish spawning habitat but comfortable living with all the conveniences of home for urban and suburban transplants had arrived. *Fishes of the Gulf of Mexico* deals not with the latter residents of this beach, but with some of the better swimmers among the former ones.

This book is a field guide and taxonomic key to 540 species of fishes found there. The first section of the book consists of a brief introduction to the ecology and zoogeography, conservation and management of fishes in the Gulf of Mexico. Next, following an introduction to the identification of fishes, is a section of small color plates of the individual species, one plate to a species, five to eight plates to a page, arranged and numbered by families. A key to the families and numbered, brief species descriptions of the different fish follow the plates. Eight appendices and a glossary complete the text. The bibliography is extensive. The index, apparently computer generated, is detailed, but challenging to use because some page numbers for an individual species refer to locations in the main text, some to listings in taxonomic keys, one to a plate, and others to appendix references without differentiation among

these index listings. The format of the book is, by showy modern standards, undistinguished, but the combination of the photographs with a taxonomic key allows more accurate identification of individual species than can most field guides. Information relevant to the sport fisherman is limited, but the book would certainly be useful to tourists and seasonal residents, many of whom are, based on some of the questions I've been asked while surf fishing, unfamiliar with the native fishes.

The book has nearly a dozen species of flounder pictured, including the Gulf flounder (*Paralichthys albigutta*), and its close relative the southern flounder (*Paralichthys lethostigma*), both relatives of the Pacific halibut. One morning of my trip I visited an open air flea market and noticed, among a number of smaller fish, a large southern flounder on ice for sale. The fish vendor was a young Vietnamese man, with his whole family there, and I thought I could find out where he

had caught the big flounder. His *Mossimo* t-shirt doing little to dim my expectations of his piscatorial skills, I asked him if he'd caught the flounder. "Ah no, man," he said, "fishing's *hard work*... I buy them at the docks." Before I could ask him which docks he meant, (he probably wouldn't have told me anyway), I noticed two men, pallid northerners, from Minnesota judging by the advertising on one's cap, staring intently at the flounder. "Strange looking fish," muttered the taller one, staring blankly at the large fish. He had two eyes on one side of his head. Of course, so did the *southern flounder*.

A few of the 540 small color plates in Hoese's and Moore's book do injustice to some fish in some respects. For example, the photo of the yellowtailed jack or jack crevalle, (*Caranx hippos*) is of a small, weak-looking fish rather than the frequently large, but always powerful fish that it is. Many who consider river flyfishing or even bonefishing from boats the greatest pleasure in fishing have probably never stood knee-deep in the Gulf with a hooked jack crevalle running through a warm surf at low tide. Some of the plates are photographs of live caught fish, some apparently are photographs of fish in aquariums, a few are drawings, and still others, some of the most impressive in fact, are of mounted fish hanging on a wall. Evidently the authors too experienced a *hitch* in finding live fish, and as for the mounted fish, I can't help but wonder where the people who caught them got them.

In my ten days in Florida I managed to get out fishing only once, a warm evening on Indian Rocks Beach, part of the same stretch of sand where I had done most of my surf fishing and swimming over the years. As I parked near the beach access, a middle-aged man was washing his car at the condominium next door, and I asked him about the fishing. "They catch all kinds of things out here," was the best he could do in a phrasing that made me doubt if he himself had ever actually caught anything. Like most of the residents here, he probably had never fished here. And like most of them, he probably had not lived here long enough to see a major hurricane or a time when fishing was good. So very few of the current residents here have actually *seen* this beach.

As I walked past the sea wall toward the surf, I felt like *Lawrence of Arabia*, and I later found out that Indian Rocks Beach had been "restored" the previous fall with an expansive (and yes, expensive) artificial beach of clean white sand following gradual beach erosion in recent years. Now I've seen photographs of Indian Rocks Beach from the early 1900's, and remember it when I first saw it about 1970, and it was a beautiful, narrow beach of sand and shell, with sea oats (*Uniola paniculata*) and *Sabal palmetto* trees above high tide, nothing like the lifeless, unnaturally wide band of sand that surely pleases the current tourists. Of course the imported

sand has little in it for beachcombers, and the chamber of commerce may not have considered that. I dug up some sand at the water line and could find no trace of *sand fleas*, favorite food of the Florida pompano (*Trachinotus carolinus*), no *coquinas*, (small burrowing bivalves), or the other signs of life that I would expect, that is, *hope* to see there as the water warmed toward summer. The beach had an unnatural slope, and the lack of shell and other signs of life reminded me that a beach is more than a blanket of clean sand.

In such a desert it was easy to see why the fish weren't biting. In the next two hours I caught a single sea catfish (*Arius felis*) also known, appropriately, as *tourist trout*, had several more light strikes that felt like catfish, and nothing else. I've caught gradually more catfish in these still warm but now turbid waters in recent years, and less of everything else. As darkness approached, I threw my remaining shrimp to a blue heron who evidently also had learned that it is easier to acquire bait than to catch fish.

As I gathered my gear I heard the increasingly loud noise of an engine gradually drowning out the soothing roar of the surf. Looking north into the dark I saw two bright headlights, *like two eyes*, moving down the beach toward me, a sight I had *never* seen on this beach before. It was a tractor, a *John Deere* tractor, dragging the Saharan sand at the high tide line to clean up any seagrass, crustacean shells, or any other icky or slimy traces of life that might spoil tomorrow's day at the beach. Now being currently from eastern Washington, wheat farming country, *it was just a taste of home*, and seeing all those condominiums on my

right, I realized the builders and these inhabitants had come here, to this formerly wild, marginally unsafe, spiny, slimy, *living* place, and brought all of their comforts, tools, and toys to make it just like home. And they were doing their best to keep it that way.

You might want to pick up a copy of *Fishes of the Gulf of Mexico*, if you are interested in fishing, in ecology, or just to remind you of some of the fish that are doing their best to live there. And if you get down to the beach west of Tampa Bay, be sure to stand in the surf, in the warm *Gulf of Mexico*, taste the salty water, and watch the sunset. Face out to sea, keep one eye on the surf, and the other eye on the sunset and let your imagination drift backward and forward in time. But unless your tastes run to wall-to-wall condominiums, reinforced concrete, and inexpensive, imported lawn furniture, you won't want to look *behind* you at the works of mankind. And that's why I'm sure that even though the fishing is a shadow of what it once was, you will still find a flounder or two swimming there; because it's still a great beach if you have two eyes, on one side of your head.—David L. Scarnecchia, Washington State University, Pullman, Washington.

Forest of Discord: Options for Governing Our National Forests and Federal Public Lands. By Donald W. Floyd. 1999. The Society of American Foresters, 5400 Grosvenor Lane Bethesda, Maryland 84p. US\$15.00 paper. ISBN 0-939970-78-3.

Within the past fifteen years federal public land management issues have escalated to a level not seen previously. The listing of the spotted owl as an endangered species, and events such as the roadless initiative have continued to bring about unprecedented focus upon management of these lands. Within *Forest of Discord*, Donald Floyd succinctly addresses future policy concerns, and attempts to provide means to properly consider variables necessary to implement future policy decisions. In order to accomplish this objective, he furnishes philosophical and qualitative approaches for consideration of interest group input to policy-making.

Throughout four chapters and numerous tables and figures, Floyd presents past, current, and possible future federal public land policy and regulations. In Chapter 1, *A Tradition of Discord*, he addresses the origins and historical trends concerning federal public land policy. Chapter 2, *Policy Issues*, deals with the viewpoints and issues concerning federal public land policy. *Evaluating Federal Forest Policy and Decisionmaking*, the subject of Chapter 3, concerns the actual implementation of the policy-making process. The final chapter, *Recommendations*, presents a number of suggestions dealing with policy-making and implementation. The overall emphasis of the book is not one of strict concrete applicability, but of an holistic approach, interlaced with concrete examples to demonstrate the usefulness of such an approach.

Chapter 1 begins with the early American view of the land's usefulness simply within its "tangible uses," with little or no concern for conservation. It continues through the utilitarian movement at the turn of the century to the evolution of today's ideology of multiple use. The chapter is split into four sections. The first two sections deal with the National Forest Service's and the Bureau of Land Management's allotment of responsibilities with respect to management of federally owned lands. The latter sections discuss public interests and values within the federal public land management system.

The second chapter incorporates the various viewpoints and variables concerning federal public land policy. The chapter begins by addressing conceptual problems within the policy-making process, such as potential interest group impact upon the eventual outcome. The intricacies of government agencies and administration within the framework of management of federal public lands surface he addressed in the latter part of the chapter. Here Floyd presents ways in which agencies can act most effectively: "Organizations that perform well have a clear sense of direction, and their managers have a strong vision of where they need to go and why."

Chapter 3, more or less a continuation of Chapter 2, is where Floyd incorporates decisionmaking into policy. He begins the chapter with the direct relationship and definitions of decision-making and policy: "Decision-making involves the choice of an alternative from among a series of competing alternatives. Policy-making typically involves a pattern of action, extending over time and involving many decisions." The decision-making involved is categorized into five steps, which are: identification of goals and objectives, development of alternatives, decisions and implementation, and monitoring the results. These five steps essentially summarize Floyd's view of the decision-making necessary to implement management policy for federal public lands.

The book concludes with Chapter 4 where Floyd provides thirteen pages aimed at recommendations for future federal public land management. The complete scale of his recommendations is too broad to be summarized, but many of his suggestions involve clarification of purpose, improving the planning process, and budget management. The chapter provides good ideas, but is relatively unfocused.

Forest of Discord is a good reference for anyone interested in public land management and policy issues, ranging from individuals directly impacted to those simply concerned with the aesthetic value of public lands. This book can increase the knowledge of citizens about the processes by which policy is implemented, and ultimately influence the political views of various stakeholders.—*Ryan D. Nauer*, Washington State University, Pullman, Washington.