# Rangeland Research: Strategies for Providing Sustainability and Stewardship to the Rangelands of America and the World

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**Edited and compiled by Martin Vavra**

The following document is a compilation of a symposium presented in 1993 at the 46th Annual Meeting of the Society for Range Management. The symposium was sponsored by the Research Affairs Committee of the Society. Following is a list of participants, topics presented, and contributing members of the Research Affairs Committee.

**Symposium speakers and topics:**

| | |
|---|---|
| Research needs to aid wise management of the most valuable product from the 21st century rangelands: Water | Thomas Thurow, Associate Professor, Rangeland Ecology and Management, Texas A&M University, College Station, Tex. |
| Range livestock research: Where have we come from, where should we go | John Walker, Range Scientist, USDA-ARS, U.S. Sheep Experiment Staton, Dubois, Ida. |
| Riparian research, then, now and tomorrow | Warren Clary, USDA, For. Serv., Intermountain Research Station, Boise, Ida.; and Wayne Leininger, Associate Professor, Colorado State University, Fort Collins, Colo. |
| Vegetation management | Darrell Ueckert, Professor, Agricultural Research and Extension Center, Texas A&M University, San Angelo, Tex.; and Steven Whisenant, Professor, Rangeland Ecology and Management, Texas A&M University, College Station, Tex. |
| Range - wildlife research: A new agenda for a changing society | John Kie, Wildlife Biologist, USDA, For. Serv. Pacific Southwest Research Station, Fresno, Calif. |
| A nontraditional perspective - Social science in range management | Mark Brunson, Assistant Professor, For. Resources, Utah State University, Logan, Utah |
| Symposium Summary | John Malechek, Professor and Head Dept. of Rangeland Resources, Utah State University, Logan, Utah |

**Research Affairs Committee, 1992 and 1993**

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## Rangelands...Our Newly Discovered Resource

At the beginning of this century, a new science began to evolve among a limited group of people in the western United States concerned with the overgrazing and lack of management on western lands. Most of these lands were too arid for crop production and too far from urban areas to be of concern to most of the American public. These range science pioneers blended the emerging science of ecology with animal husbandry, agronomy, and forestry to initiate grazing management based on ecological principles. The profession gained in importance in 1934 with the passage of the Taylor Grazing Act that created the Federal Grazing Service (later the Bureau of Land Management) and resulted in the first management plans for the unattached public lands of the West. In 1948, those few struggling pioneers of range management formed the American Society of Range Management.

Rangelands are complex landscapes influenced by geologic origin, climate, the vegetation past and present, and past and present management. About 43 percent of the United States land area can be considered rangeland. World wide some estimates place 70 percent of the total land area as rangelands. They are often defined as any lands that are not farmed but are capable of supporting life from the vegetation present. Therefore, science-based range management often combines ecology, agronomy, geology, hydrology, animal science, soil science, wildlife science and forestry.

### Today's rangelands

For years, rangelands of the United States were a neglected resource. Livestock production was thought to be the only viable economic use of these lands and was sanctioned by society from the time of settlement up through the 1970's. Until 1934, much of the western land was overused or suffered from incorrect use, often as a result of legislation designed to assist in settling the frontier. The degradation of the rangeland resource that occurred is evident even today. After 1934, range management was directed primarily toward sustainable livestock production. Other uses coexisted, but were not given equal status. Healing of the range occurred in some instances, but the results of earlier abuse, linked with new influences such as invading foreign weeds, prevented full recovery. In some cases soil losses were extensive enough to block full recovery.

Today's western rangelands are interspersed with highways, railroads, urban areas, farmlands, and other aspects of civilization, which in many instances have caused some fragmentation of ecosystems. However, large tracts of relatively undisturbed lands still exist. Wildlife and fish are im-

***Fig. 1.*** *Rangelands are complex landscapes that make up about 70 percent of the world-wide land area. Photograph, Douglas Johnson.*

*Fig. 2. An 1870 rangeland (left) and as it appeared in 1976 (right). Rangelands are dynamic and may change with climatic and/or management changes. Photographs, Kendall Johnson.*

portant and common components of rangelands, as are the rivers that pass through them. We are just beginning to understand the habitat requirements of many of the plant and animal species native to rangelands. Some of these species are at risk because of past and present mismanagement practices. The rangeland water resource aids in ecosystem maintenance and is an important product for off-site use. Rangelands are the source of most surface flow and aquifer recharge in the western United States. The fate of municipal, agricultural, and industrial sectors of society, therefore, is dependent on the quantity and quality of water derived from grazing land watersheds. The quality and quantity of water are largely dependent on the management the land receives.

Mineral resources found beneath our rangelands are necessary for the maintenance of society. The proper extraction and reclamation of affected lands is an on-going challenge to range managers. An important emerging use of rangelands is recreation, not only for pursuits such as camping, hiking, hunting, bird watching, fishing, rock hounding, and recreational vehicle use, but also for the urban population to experience open space and solitude. The potential and challenge for maintaining and improving this resource and all its allied components remains great. With proper stewardship such diverse entities are livestock, wildlife, fish, and solitude can have have a place on our rangelands.

## Tomorrow's rangelands

The various uses of rangelands oftentimes appear to be in conflict; in fact, management for a single product may create incompatibilities with other uses. In the past, grazing management was primarily designed to sustain livestock grazing and was not always compatible with wildlife, aesthetics, or water quality. However, given a solid base of scientific information, management practices can be formulated that minimize conflict or that optimize an array of uses. How we configure range research and subsequently utilize the knowledge generated in management of the resource will determine how rangelands will look in the future.

We need to give more attention to ecosystem reconstruction and restoration ecology. Range scientists have a long history of success in these areas, but the focus should change from commodity production goals to ecosystem integrity. Public land management agencies are now promoting ecosystem management, which will become a reality. The public is demanding that past damages be repaired, and there is a willingness to pay. Therefore, as we address research priorities, we should think in terms of both whole systems research as well as clearly defined, single-issue questions.

The public will be an important player in management decision-making on tomorrow's rangelands. This is already a reality. Future research, then, must include people and their social system, not just plants and animals. Public involvement in research, as well as in management, is time consuming and complicated. However, research becomes successful when it provides answers to questions that concern the lives of people as well as the health of rangelands. Education must become an integral part of the research process. New advances in range science must be passed on to both professional range managers and the public. Researchers must accept more of the responsibility for continuing education in tomorrow's world.

We already know isolationism will not be possible in tomorrow's world. There is a moral obligation to expand our research to aid range management in countries less devel-

***Fig. 3.*** *Early research often focused on rehabilitation of degraded rangelands with the intent of improving livestock production. Photograph, Doug A. Johnson.*

oped than our own. Presently, this work may include a stronger element of the agricultural paradigm than is appropriate for work in the USA, it will also need to confront the issue of sustainability head-on.

## A legacy of past research

Many of the concepts developed early in this century have stood the test of time because of the urgent need to do things better during a time of range abuse. Early research often focused on livestock-oriented topics, namely grazing management and reseeding. Important discoveries were made on how defoliation of plants by grazing animals affects the health of those plants and what times of year grazing could be safely carried out. The drought and dust bowl of the 1930's focused research and resulting management on the concept of sustainability for the first time. Farming areas that never should have been plowed, coupled with poor tillage practices, left former grasslands devastated. Reclamation and restoration ecology are rooted in the plow-ravaged grasslands of the western Great Plains. The founding fathers of plant ecology in the United States provided those that followed with many principles, descriptions, and processes that still hold today.

Successes in range research have provided a strong base from which to build new and better research programs. New research avenues are developed as our knowledge increases so that other questions on ecosystem management can be asked. We can also reevaluate past research, improve the paradigms that were developed, and, in some cases, develop new paradigms in areas that were simply missed or observed somewhat incorrectly. For example, early scientists neglected to detect the importance of riparian zones to overall ecosystem health. Plant communities, habitat types, and the progression of communities through time were charted for the uplands, but no one considered the vegetation complexes adjoining the rivers and streams or the importance of that vegetation to water quality and quantity. Although water has always been the primary limiting factor in the West, not until the 1960s did scientists begain work on riparian systems. Today, riparian zone management remains one of the primary challenges to range professionals.

Early in this century scientists studied and described the changes in plant community structure that occur through time on a given portion of land. This change from simple to more complex communities, which was termed succession, was described as linear. It was thought that disturbance (fire, overgrazing) caused dramatic change but that the change was reversible once the disturbance was removed. Recently, research and evaluation of ecosystem processes have revealed much more complexity than was previously believed. The new models have opened a whole new approach to addressing ecosystem management and restoration.

The foundation of excellence in range management through research has been effectively established. The improving condition of our ranges is evidence of that. However, the economic and social needs for functional landscapes and the awakening of management at the ecosystem level provide challenges to range management that can be met only through continued, strong, and active research programs.

## Rangelands: Research Goals into the Twenty-first Century

### Provide water for rangelands, agriculture, industry, and people

The health of rangeland watersheds is dependent on sustainable land use practices. A watershed, when properly functioning, provides for capture, storage, and slow release of water originating as precipitation. Western America is basically arid country; water is the primary limiting factor to natural vegetation development, urbanization, and agriculture. Fish and wildlife populations are also critically influenced by the quantity and quality of water available.

As the population of the West has grown, competition for available water resources has also intensified. Shortage of quality water may become a serious constraint to maintenance and/or growth of various sectors of a region's economy, as well as to fish and wildlife. Management of rangelands with the purpose of increasing the capacity of the land to capture, store, and release water is extremely critical to the human and natural resources of the West.

Comprehensive watershed research has not been widely conducted. Watershed studies require long-term commitments (three- to five-year minimum) and are relatively expensive. As a consequence, management strategies have sometimes been developed that lack sufficient validation. There needs to be a stronger institutional commitment to rangeland hydrology research.

The demand for simulation technology has increased as agencies are increasingly challenged and accountable for the results of their recommendations. The development of new technological capabilities, such as geographic information systems (GIS) and decision support systems (DSS), offer great potential. These technologies require extensive data

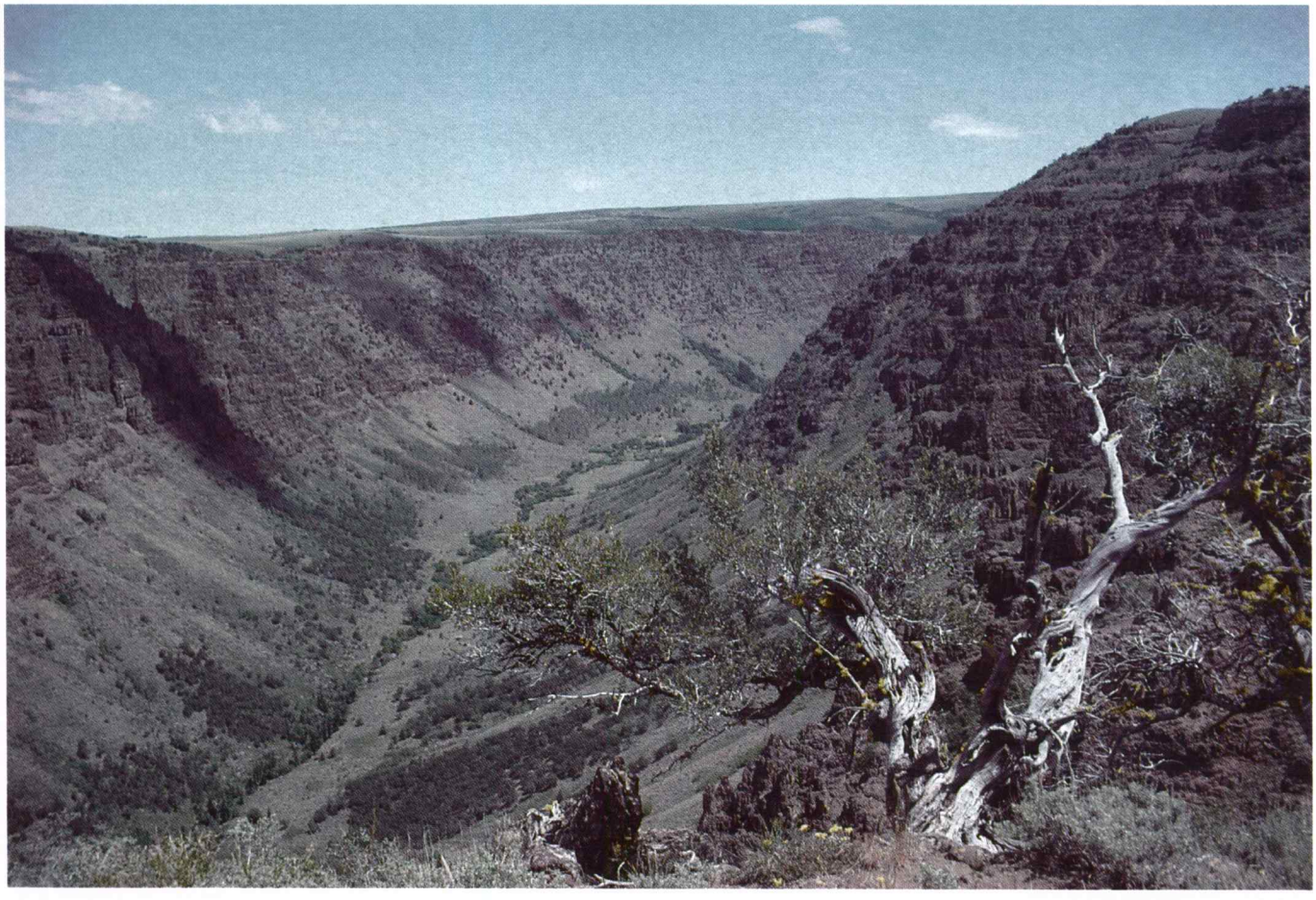


***Fig. 4.*** *Watersheds, when properly functioning, provide for the capture, storage, and slow release of the planet's most precious commodity: water. Photograph, Martin Vavra.*

sets, which address spatial and temporal parameters, for development and refinement. Comprehensive data collection and model development provide the key to successful watershed research.

- *Define temporal and spatial variability in the watershed landscape.*

  The complex interaction of soil, plant, and water through time and the massive scale of spatial resolution at which landscape processes need to be modeled require a focus of field research that has rarely been attempted. Simultaneous sampling of water/soil/plant variables at different levels of resolution for a sufficient period of time is needed to document changes resulting from various management actions.

- *Conduct validation and sensitivity analysis of existing and new water quality and quantity simulation models at different levels of landscape resolution.*

  Water quality and quantity concerns tied to land use are prime focal points for discussion of management alternatives. Without proper validation and sensitivity analysis, it is not possible to use a model reliably, nor is it possible to identify and improve the key areas within the model.

- *Develop decision support systems based on region-specific field data.*

  The complexity of modeling technology greatly exceeds the ability of most people who should be using the models. Decision support systems can help bridge this gap. These aids must be based on applicable field data, which generally are not available.

## Develop efficient and environmentally compatible livestock management systems

Range grazing research mainly involves two major approaches: grazing management and foraging behavior. Grazing management is the discipline of managing livestock and wild ungulate herbivores on rangelands. Foraging behavior is the study of selective grazing, which is demonstrated in all herbivores. Future research will hinge on these two disciplines.

Future research on range livestock systems must result in efficient and economically viable production; if livestock grazing is to be truly sustainable, it must also be profitable. However, future research will have as its cornerstone maintenance or enhancement of environmental quality. Grazing research must also have effective vegetation measurements to estimate forage availability and nutrient quality.

- *Manipulate diet selection and foraging efficiency.*

  Technologies are becoming available to alter what an animal prefers to eat and how that animal utilizes the food it eats. Through genetic manipulation and accepted breeding practices, animals with new grazing habits can be developed. Genetic manipulation may also provide detoxification mechanisms for naturally occurring plant poisons or provide rumen microorganisms tailored to specific foraging environments. Future progress will hinge upon development of techniques that monitor important processes of large numbers of individuals. Specifically, it will be necessary to measure botanical and nutrient composition of the diet, intake, and geographic location of the animal.

- *Develop grazing systems that result in desired plant communities.*

  The manipulation of plant communities through the use of grazing animals is an emerging research area. Successful examples are in plantation grazing to improve timber production and selective grazing for control of alien weed infestation.

- *Develop new technologies for livestock distribution.*

  Current methods of distribution control are those that have been used for more than 50 years. Fencing, water development, and salting have been the classical methods employed. New electronic technologies involving fenceless distribution control and monitoring composition and utilization of range vegetation may be possible.

- *Develop monitoring systems that identify impacts on the environment and the animal.*

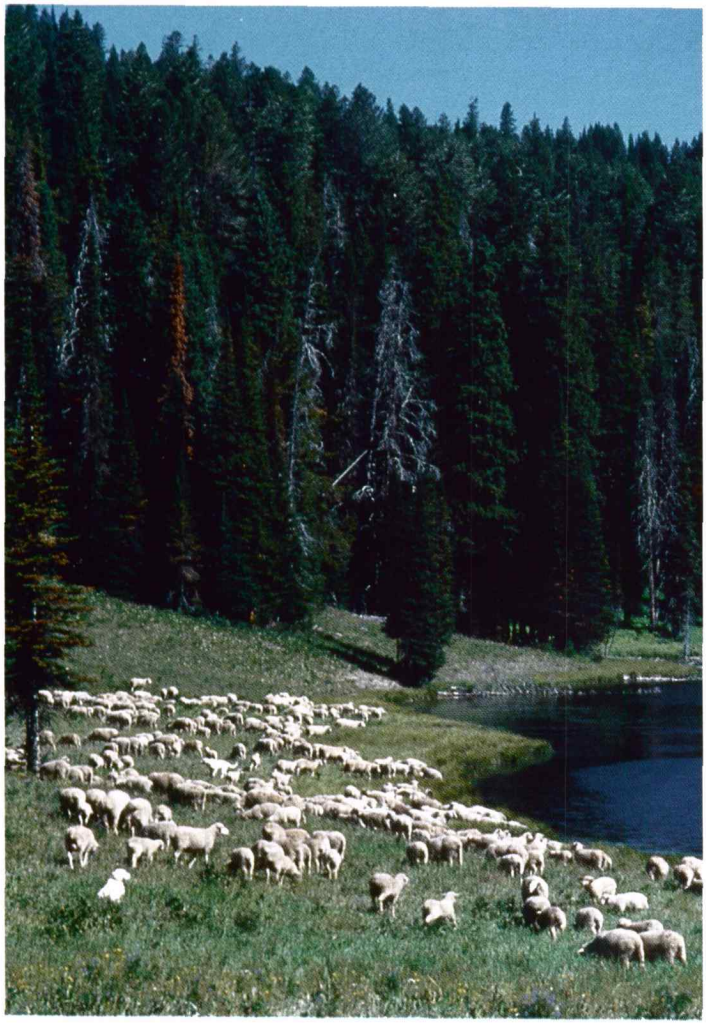
  Grazing by domestic or wild herbivores is a complex process that must be closely observed to detect possible adverse effects on the environment or other animal species. Techniques, including remote sensing, need to be developed to adequately assess herbivory.

  Decision support systems provide a planning tool that will greatly assist in the development of proper livestock and wildlife grazing systems. However, adequate background data need to be collected so that these systems represent real-world possibilities.

## Maintain and enhance the function of riparian and wetland systems

Riparian areas and wetlands provide productive fisheries and wildlife habitat, diversity of aesthetic scenery and recreation sites, sediment filtering and flood reduction, water of high quality for downstream users, points of recharge for ground water, commercial timber, and substantial forage for livestock and wildlife. These beneficial uses and values depend heavily on the health of riparian areas. Riparian conditions can also provide a good indication of the overall health of the surrounding watershed and its resources.

Riparian ecosystems are highly sensitive to uses that alter the flow regime or geomorphic character of the landscape. On the other hand, they are among the most vegetatively resilient ecosystems. We face a significant challenge in find-



***Figs. 5, 6.*** *Rangelands have provided forage for livestock world-wide since the beginnings of civilization. Photographs, Martin Vavra (top); Agricultural Research Service - USDA (bottom).*

ing cost-efficient and effective ways of restoring the many riparian areas that have been degraded through past misuse. The primary challenge for research and management is to discover and design approaches that can be employed in concert with natural processes to maintain healthy areas or restore damaged ones. Improving the productivity of these highly valuable riparian areas requires implementing wise and consistent resource management based on current and future technologies and research findings.

- *Define the processes responsible for past deterioration and thresholds necessary for rehabilitation.*

  Ecosystem damage entails the loss and then replacement of a particular plant community with different, often less-functional ones. One approach to recovery is to try to reverse the process. The ability to truly recover from degradation depends upon recovery of the hydrological function and floodplain water tables. The original or equivalent biotic communities cannot return in the absence of appropriate hydrological functioning. Knowledge of the dynamic repositioning of plant communities and the factors that initiate changes are not well understood.

- *Understand the various natural processes operating in the riparian system, including hydrological functioning and geomorphology.*

  Riparian zones, because of their location in relation to a dynamic, moving body of water (either a stream or variable shoreline), may be periodically destroyed and reformed naturally, oftentimes concomitantly at different locations within a specific stream or elevation along a shoreline. Geomorphological and hydrological processes in these zones are much more complex and dynamic than on surrounding uplands. Processes such as interception and absorption of nutrients, sediments, and toxins from ground and surface water, the relation of these processes to floodplains, and how they influence water quality need to be evaluated. An understanding of ecosystem processes will also allow the development of predictive models to compare the consequences of alternative management strategies on the functioning of riparian systems.

- *Define fish and wildlife values in conjunction with various natural and induced changes in plant communities, water tables, bank structure, and other aspects of structure and function.*

  Riparian areas are important habitat for wildlife and influence the aquatic habitat of fish. Although some research avenues have been explored, much needs to be learned about changes in fish and wildlife values as riparian communities change. The complexities of the food chain of both terrestrial and aquatic systems, as influenced by ecological condition, are unknown.

- *Identify the response of riparian areas to disturbance factors.*

  Alien weeds pose an impediment to the restoration of native vegetation upon many disturbed riparian areas. Weeds may also threaten communities in high ecological condition due to the dynamic nature of channel or shoreline changes. Fire is a natural phenomenon in many ecosystems, but the evolutionary role of fire in riparian zones is essentially unknown.

  Improper livestock grazing has been one of the greatest disturbance factors during the past 120 years. However, use of livestock grazing as a positive manipulation tool for riparian zone management has not been widely explored. Some riparian areas have been damaged by

***Fig. 7.*** *Vegetation response after eleven years of improved grazing mangement. Photographs, Wayne Elmore.*

wild ungulates as well. In the future this will become more of a problem if elk, moose, bison, deer, and antelope numbers continue to increase.

- *Define the economic benefits of riparian areas.*

  Fish and wildlife habitat, water quality, ground water recharge, reduced flood flow peaks, aesthetics, and forage are all important, economically quantifiable values of riparian areas. There is potential for accrual of vast economic, as well as ecological, benefits through improvement of degraded riparian systems. However, these values need to be quantified to demonstrate the economic benefits of investments in improvement measures.

## Develop vegetation management schemes that ensure ecosystem integrity

Major changes in the vegetative complex of rangelands have occurred globally since humans domesticated livestock and introduced plants and animals throughout the continents without understanding the natural laws of ecology or plant-animal interactions. Vegetation management research has often emphasized short-term objectives, such as killing undesirable plants or establishing forage species. While these are often essential objectives, the focus to achieve these goals has lessened efforts directed at longer-term objectives. The result is that we treat the symptoms rather than the causes of vegetation problems and emphasize treatment rather than maintenance or prevention. Success in dealing with these problems began when range scientists recognized that excessive grazing, droughts, reduced frequency and intensity of natural fires, climate, and interactions among these factors were the underlying causes in the decline of productivity and stability of global rangeland resources. Vegetation management research should be directed at increasing stability by initiating and directing--rather than combating--natural successional processes. This requires an understanding of structural and functional relationships among interacting landscape elements and their contribution to productivity, diversity, and stability.

***Fig. 8.*** *Rangeland scientists are now incorporating natural processes, such as fire, into vegetation management programs. Photograph, K.H. Asay.*

- *Improve our understanding of the application of new theories of successional dynamics.*

Recent major advances in successional thinking from the classic linear change in plant communities to that of steady states, transitions, and thresholds need to be validated and documented in the various rangeland ecosystems. This is perhaps the most important area of developing research in range management as change in plant communities, or the prevention thereof, is the basis of range management. Identifying how successional changes occur will help in understanding ecosystem function and provide insight into management practices from grazing to watershed protection.

From the first rudimentary single-treatment approaches to land rehabilitation, our knowledge of the complexity of natural ecosystems has expanded, and symptom-oriented land treatments have declined in use. Economically sound and ecologically based goals in vegetation management require research that focuses on utilizing and directing natural processes that are also consistent with societal concerns and needs.

- *Develop vegetation management strategies that address the causes of rangeland deterioration.*

Vegetation management techniques that utilize natural processes, such as fire and controlled grazing, need to be developed. Fire has the potential to be widely used, as it occurs naturally in almost all ecosystems. However, smoke management, precise fire control, and post-burn weed invasion are problems that need to be addressed.

Radical grazing management approaches, such as diet training, the use of nontraditional grazers, and goal-specific management systems, need to be evaluated. Herbicides and mechanical control are long-standing vegetation management practices that need reevaluation for a place in the future.

- *Develop rehabilitation and restoration strategies with more efficient and sustainable mixtures of species and landscape components.*

A primary goal of vegetation management is to use natural processes. Many degraded rangelands have en-

*Fig. 9. Improved grazing management that can maintain or allow restoration of rangelands to desirable conditions is an important goal.*

***Fig. 10.*** *Research on wildlife now focuses on habitat relationships and how various management practices may alter that habitat. Photograph, Martin Vavra.*

tered steady states of low ecological condition. Management practices should be developed that, while human induced, approach natural conditions. Ecological investigations into plant genetic resources, their synergisms, niche differentiation among species, and their role as landscape components are needed to develop these practices.

## Provide quality habitat to a wide array of native wildlife species

Wildlife management research has changed markedly in recent years. Most research was once directed toward "game" animals, those that were hunted, because license fees and taxes on hunting equipment were the primary source of wildlife research and management funding. In many cases the interplay between wildlife and vegetation management either was not considered or was given secondary status. In today's world, so-called non-game species are being recognized, and their niches in various ecosystems are being identified. Research on wildlife in regard to rangelands now focuses on habitat relationships and how various management practices may alter that habitat.

Traditional research has focused on habitat improvement techniques. Now research is answering questions about the spatial relationships of habitats and how wildlife species and communities respond to these spatial habitat arrangements.

In the past, wildlife researchers merely observed wildlife and formed hypotheses based on those observations. Today, scientists are developing hypotheses from basic theory and then designing manipulative experiments to test those hypotheses. This new research approach will aid in the development of manipulative practices on rangelands and will document wildlife response as a primary part of the study.

- *Identify the impacts of various vegetation management practices and livestock grazing practices on wildlife communities and biological diversity.*

  Livestock grazing has been a dominant force in shaping wildlife habitat in the United States for the past 120 years. Research needs to be conducted on particular communities and classes of wildlife. Birds, small mammals, and amphibians serve as examples of wildlife communities in which there is a dearth of knowledge.

  In recent years biological diversity has become an extremely politically sensitive issue. Research needs to be pursued concerning the correct identification and measurements of diversity as well as the effects of vegetation

***Fig. 11.*** *A wide array of wildlife species commonly termed "non-game" were once ignored by land managers. Photograph, Martin Vavra.*

manipulation and the impacts of grazing and various steady states on diversity.

- *Determine parameters of wildlife behavioral ecology on rangelands.*

  To fully understand the process of habitat selection by wildlife species, research is required that will aid in understanding how and why individuals make habitat choices and what they do in those habitats once they are there. Rangeland management practices commonly alter habitats. Habitat alteration can be positive for some identified wildlife species, once habitat requirements and preferences for habitat are known.

- *Identify population implications of habitat selection.*

  Wildlife select a wide variety of habitats. Little research has been done on how population characteristics vary among sub-populations in different habitats. The important questions relate to how reproduction mortality and other "fitness factors" vary between populations of the same species occupying quite diverse habitats and how these factors relate to persistence of those populations.

- *Explore the complexity of predation management and how it relates to rangelands.*

  One of the most controversial programs in wildlife management has been predator control for the benefit of livestock and game animals. Research is needed on the relationship of the predator to the prey populations and on the habitat effects of prey vulnerability and compensation. Non-lethal predator control methods should be explored concomitantly with other research because society is now less tolerant of lethal control.

## Understand the needs and direction of society in relation to rangelands

Social science has played a subdued role in range science throughout the twentieth century. However, as demands on rangelands become more complex, the need for social analyses increases. If researchers are to truly serve their manager clients, and ultimately the public, much closer attention must be paid to the social context of rangelands. The needs of society should govern how rangelands are used, but public participation in the governance process should be accompanied by an educational process that emphasizes

***Fig. 12.*** *Recreation has become an important, but not well understood, use of rangelands. Photograph, Quinton Skinner.*

***Fig. 13.*** *Today's public is demanding an active role in rangeland management. Photograph, Quinton Skinner.*

the complexities of management for multiple outputs. Research into the social science aspects of range management must include pathways to recognize society's needs and desires (which may be incompatible) and to develop educational processes to assist in balancing needs and desires. Society may want food, fiber, recreation, clean water, wildlife, wilderness, minerals, timber, etc., but society may not comprehend the complexities of managing for multiple products. For example, timber harvest and mineral extraction may not be compatible with wilderness on the same piece of land.

- *Define the social context of rangelands.*

  This category focuses on the basic unanswered questions about the changing context in which rangeland users, rangeland managers, and rangeland scientists must work. Specific areas that need resolution include the level of interest or apathy on the part of the general public regarding range issues; the extent of polarization of the public on such controversial issues as livestock grazing; and the characterization of the public regarding how they view other issues such as animal welfare, population control, etc., and how these views relate to their opinions of rangelands.

- *Identify the public perception of range environments.*

  In a rangeland environment there is an array of specific landscapes, which people may or may not enjoy looking at or being in, and which may or may not be preferred

***Fig. 14.*** *Healthy rangelands have meaning and purpose to a wide variety of people and, in turn, help provide healthy people.*

from one season to the next. The aspects of the environment that people notice when viewing a rangeland are unknown. Can the public perceive overgrazing impacts? Are good-condition ranges looked upon more favorably than fair- or poor-condition ranges? It is even unknown if people enjoy viewing traditional rangeland uses such as cattle or sheep grazing or people on horseback.

- *Identify the level of public knowledge of rangelands.*

The first step in an educational process is to identify the level of current knowledge. Urban and rural Americans may have formed opinions on uses and states of environmental health of private and public rangelands. Rangelands may be defined differently by the public than by range professionals. The public probably does not know the meaning of the traditional descriptors of range ecological health or the methods used to define them.

- *Develop rangeland educational efforts.*

Once research has been done in the previously mentioned categories, processes should be developed to provide education to the public. Programs to influence identified opinions and beliefs held by the public should be developed to increase public awareness while still meeting obligations to provide the optimum mix of goods and services. Certain aspects of range management are most important to get across to the public, based either on the extent to which current perceptions are scientifically false or the extent to which they induce polarization that intensifies, or impedes, resolution of rangeland conflicts.

- *Explore the complexity of uses and demands by rangeland visitors.*

By all accounts, rangeland recreational use has grown rapidly; however, little is known about the actual amount of visitation that occurs or its rate of growth. Range managers and owners need to understand how the anticipated demand for activities such as hunting, solitude-seeking, rock-hounding, or off-road vehicle use compares to the supply of opportunities. We need to identify whether range recreation is becoming a vacation choice or is largely an "acquired taste" of regional residents. How does this new clientele interact with the livestock that have traditionally been a central focus of range management?

## Rangelands: High-Priority Research for Healthy Ecosystems and People

Society in the western United States has changed in its ethnic and demographic makeup, but, most importantly, it has changed in its geographic distribution from a once-rural society to a predominantly urban one. As a result, we now have almost an entire generation removed from the land. Values and needs of contemporary society are markedly different from those of our parents and grandparents. Instead of valuing rangelands as places where important life-sustaining commodities such as meat, wool, and lumber are produced, people can now see rangelands as sources of other goods and values we loosely call amenities. These include open space for recreation and spiritual renewal; habitats for rare and endangered species of plants and animals that most people rarely, if ever see, and places recognized and valued for their natural beauty or inherent biological integrity, free of human influence.

As a result of these societal changes, range management has changed and will change even more in the future. If the science that supports range management is to be a viable contributor, it must also change. In reality, we are finally confronting a range management that is at once a biological, physical, and social science. Research answers need to be provided for management activities that are defined as the art and science of optimizing goods and services from the land in combinations needed and desired by society. Management of the land must be viewed as our common purpose and reason for being, with the commodities that it might produce viewed as the benefits of sustainable management.