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REVISIÓN CIENTÍFICA

NOTA DE LA DIRECCION

El Profesor Harold F. Heady comenzó sus experiencias sobre pastos naturales extensivos en 1932, a la edad de 16 años. Entre 1942 y 1984 fue profesor de ecología de pastos en cuatro universidades diferentes de Estados Unidos, permaneciendo los 33 últimos años en la de California, Berkeley. Fue uno de los fundadores de la "Society For Range Management", su primer Secretario y su Presidente en 1980. Fue Fundador y primer Presidente del "International Rangeland Congress". Tiene 178 publicaciones de las cuales 13 son libros.

Professor Harold F. Heady began his experiences on rageland in 1932 at the age of 16. Between 1942 and 1984 he was professor of rangeland ecology at four different universities, the last 33 years at the University of California, Berkeley. He was one on the founders of the Society For Range Management, its first Secretary, and its President in 1980. He started the International Rangeland Congress and was its first Chairman. His publications number 178 of which 13 are books.

PERSPECTIVES ON RANGELAND ECOLOGY AND MANAGEMENT

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SUMMARY

This paper reviews changes in rangeland ecology and management in the U.S.A. over the last 65 years and speculates on future changes. Emphasis has shifted from livestock management to ecological and environmental concerns, hence "rangeland ecology." The term "range management" may have outlived its usefulness and may also be detrimental to our image. The vision that we have of ourselves is not the same as others have of us. Many members of the Society for Range Management (SRM) and most of our interested non-member public believe that SRM emphasizes the livestock industry. However, the SRM objectives clearly focus on understanding ecosystem processes, environmental conservation, and above all care of rangeland resources. Other relatively small natural resources societies have similar identity problems. The time has arrived for a commission representing the natural resources specialities to examine the possibilities of present societies associating to enlarge memberships, reduce costs, and revise their approach to rangeland ecosystems.

In the 1930's range research concentrated on pasture size experiments with two objectives; testing the deferred rotation system to improve production and defining the carrying capacity in animal units. The experiments ended with World War II without finite answers to either objective, but with much learned about the effects of grazing on vegetation. Presently and in the future, pasture-size research will be restricted in favor of research on ecosystem processes, hopefully part of it in field settings.

In the university curricula, more emphasis is needed on education and less on the training of technicians. Graduates, in my mind, must be able to recognize and understand the field evidence of vegetational changes and processes. Reduction of field experience in university curricula is a mistake.

Rangeland analyses and practices have progressed during the 1900's. For example, rangeland inventory and analysis changed from a foot and compass survey to the use of aerial photographs and presently to Geographic Information techniques. First objectives of the inventories were to determine stocking rates. Evaluation of range condition and analysis of environmental impact became prominent after 1945. Survey of plant and range utilization have failed in attempts to determine proper use.

Crusades characterize rangeland practices. One is the march of seasonal grazing systems from deferred-rotation, to rest-rotation, to short-grazing/long-rest rotation, to the realization that good management can make any system work. Another crusade started with livestock as a single land use to the environmentalist jingle of "take all the cattle off." Along the way mechanical and chemical applications on shrublands nearly disappeared and exotic plants were replaced by native species in seeding mixtures.

Myths in rangeland professionalism are widely held generalities, that are not correct in all situations. Examples include good range management for livestock is good for wildlife, take half and leave half, native species are better than aliens, and rangeland improvements are permanent.

Our rich history of change in rangeland professionalism, research, and education raises questions about the future of three currently popular subjects of discussion, namely biodiversity, riparian zone restoration, and global temperature change.

Controversy characterizes most of the changes, crusades, and myths. Coordinated Resource Management is a collaborative participation process successfully used in conflict resolution of rangeland use problems. That process will continue and increase in effectiveness.

Key words: Grazing, history of science, natural resources, range management, rangeland ecosystem.

INTRODUCTION

Change characterizes the history of rangeland ecology and the practical management of rangelands from the beginning of the range management profession about 100 years ago. I review in this paper some of those changes and speculate on future trends. Several persons have been queried about their perspectives, but I take full responsibility for the comments and ideas expressed. Literature citations will be few or not given to avoid inferred acceptance or rejection of selected viewpoints. Since we are unable to investigate the future, this analysis is of the past, largely based on my 65 years of experience with rangelands. Unless otherwise stated, comments and perspectives are for rangeland ecology and management in the United States.

The beginning of rangeland concerns may have been centuries ago, but expanded interest in the early 1900's became a conservation movement that led to the formation of the National Forests, ecological studies in grasslands and forests of the western United States, and extensive surveys of the overused condition of rangelands. In the 1930's the U.S. government formed management districts of non-forested public domain lands. Attention to private lands by the Soil Erosion Service and state extension services expanded during the droughts and depression in the 1930's. At that time, university education and research programs increased in number and extended relationships from forestry to animal science, agronomy, economics, and biology. The emphases changed again when environmental preservation and correction of pollution problems became popular concerns in the 1960's.

Numerous countries, in addition to the United States, expanded rangeland activities, not everywhere called "range management," after World War II. I have worked on assignments and consulted in Australia, Brazil, Canada, Chile, China, France, India, Israel, Kenya, Kuwait, Malawi, Mexico, New Zealand, Russia, Saudi Arabia, South Africa, Tanzania, Turkmenistan, Uganda, and Zimbabwe. To some degree all have many of the rangeland problems mentioned in this paper, but none just alike; therefore, my reason for concentrating on the U.S.A.

OUR NAME

The term "range management" may have outlived its usefulness, because "management" no longer dominates in university curricula, research, environmental conservation, and many activities of professionals. The first major change substituted "rangeland" for range, giving terms like "rangeland management, rangeland resources" and "rangeland ecosystems," which tended to separate specific references to land from concerns such as political, cultural, environmental, economic, wildlife, and watershed. More than one university curriculum or department is now known as "Rangeland Ecology and Management" and a few have completely submerged "Range Management" into "Natural Resources." The term "ecosystem management" is now in common use by the governmental agencies. Environmentalists, in particular, dislike "management" and many do not want human manipulation of the natural resources in any form. That view is changing because most ranchers are conservationists, have resources to be good land stewards, and the alternatives, such as condominiums and ranches of a few acres, may do more damage than extensive livestock grazing.

Three usually wrong general statements about "management" of rangeland are frequently heard: (1) The land must be managed or it will deteriorate; but "deterioration" is a value judgement that depends on individual interpretation. (2) Without management there is no control over what happens; but in most rangeland situations climatic factors, especially unusual events, control what happens. (3) Management implies only domestic animal grazing and physical and chemical manipulation of the rangeland ecosystem; but use of rangeland is much more than grazing and seeding. A fourth (4) concept of "management" is more widely held; it includes variation from complete protection with no human inputs to intense manipulation of vegetation and controls over use and users. None of these four viewpoints is informative without definition of the terms. Management must be defined in each situation to have informative meaning. Discussion continues and "management" will probably remain a part of the professional name.

OUR CHANGING IMAGES

The image that we have of ourselves is not the same as others have of us. We do our best to change our attitudes and actions, to "keep up with the times", but the tendency is for others to hold with traditional, often incomplete evaluations of what we are. An important variable image of us is the emphasis that we and others place on livestock. The image problem appears early in this paper because it permeates the research we do, curricula in our universities, our writing and publications, and our talk with each other and to groups.

The 50-year-old Society for Range Management (SRM) unquestionably represents rangeland affairs and a look at its positions and policies is appropriate. SRM has changed its name twice, which may in itself indicate the ever-changing face of the profession and science concerned with rangeland. Frequently, members of SRM discuss the identity problem, a more profound problem than selecting a name. Selection of objectives and activities should provide the name. However, the struggle for adequate labeling will probably continue.

The objectives adopted by SRM at its beginning survived with few changes. Now they stipulate care of rangeland resources, understanding ecosystem processes, dissemination of knowledge, promotion of effective use, creation of public appreciation of the rangeland environment, and promotion of professional development of its members. Membership in SRM always has been open to anyone interested in any aspect of rangelands. For several decades the members were mostly professionals in the land management agencies, educators, students, ranchers, and not many others. Highly important at the time, the profession and formation of the Society were oriented toward poor rangeland condition caused by overgrazing. Emphasis on different ways of managing livestock to avoid overgrazing gave a lasting public impression that "SRM is a livestock society."

Times change; the membership has become interested in ecosystem processes, environmental conservation, fewer exotic plants, saving threatened species, wildlife, water quality, riparian habitats, and more. These to a large degree have replaced the original major emphasis on livestock in the minds of many members. Domestic livestock grazing on public lands has declined or has been eliminated in some places. The traditional livestock approach has been replaced with ecosystem management. But our non-member public still believes that "SRM is a livestock society."

Another complexity to our changing image comes from the United States Government's philosophy and public policy of reducing production of commodities (grazing, timber, minerals) from federal lands, and perhaps private lands. The Government has responded to pressures created in the environmental movement. One result is that the agencies hire fewer professionals in the commodity specialties, and give them less responsibility in planning and decision making activities than in the 1960's. Another result is that the prestige of the graduate in natural resources has suffered. I believe that fewer university students and decreased membership in SRM can be attributed in part to a view that commodity uses of the Nation's lands are unnatural, undesirably, and should be reduced.

The activities of rangeland professionals give a picture of compatibility with other interests and appreciation of ecosystem complexity. Here are four examples of the change in approach to rangeland rehabilitation mentioned in Whittekiend (1997). (1) The Red Canyon Ranch near Lander, Wyoming, supports a Nature Conservancy effort to demonstrate compatibility between ranching for profit and conservation of rare plants, care for wildlife habitat, riparian and wetland restoration, and other interests. (2) In the Gallatin Valley, Montana, high-intensity/short-duration grazing on seeded pastures is used to develop a unit separate from leased land for riparian care of potable water needed in the local community. (3) On another ranch, fish habitat improvement restores a high value creek for recreational purposes. (4) A nearby ranch has attained riparian improvement with livestock management that supports active fishing and waterfowl hunting programs. Many more examples are available of excellent rangeland management whereby domestic animal grazing will be compatible with other uses. The number will increase.

THE FUTURE

The crush of people on the public rangeland resources will increase as the World population expands. That will be evident by expanding urban sprawl, ranches subdivided for rural living on the land, increasing attention to quality and quantity of water from rangeland watersheds, and city dwellers seeking recreation and wilderness values. In developing countries, the conversion of land from natural resource emphasis to cultivation of food crops will continue. In developed countries, private rangelands in ranches will not be immune from pressures to sell the land or substitute other land uses for livestock grazing. As several have written in recent *Rangelands*, range professionals will be out of business if livestock grazing continues to be their primary target. Our every professional thought must be for the care of the land and water under whatever use society demands.

The vision and mission of SRM stipulates stewardship for productive, sustainable rangeland ecosystems based on sound scientific principles and policies, and support for economically, socially, and environmentally acceptable uses. That mission is commendable. One effort to meet the mission has been to take carefully written and published positions on issues. Forty of these appear in resolutions, statements on policies, and positions (SRM, 1997). SRM has a mixed membership of professionals in several government agencies, ranchers, university faculty, students, environmentalists, wildlife biologists, and others. The policy and position statements are as mixed as the membership, varying from statements on desertification, diversity, Directors' position on the Conservation Reserve Program, to a resolution on the 1995 Farm Bill in the U.S. Congress. Some of the statements have been controversial, which has resulted in loss of SRM members and raises questions about SRM management in controversial situations. A number of these policy statements take sides, thereby becoming outside the SRM mission of service to all members. Few of the position statements have had examination by the SRM membership. The whole process for addressing issues needs to be examined because too often the issues papers appear as favoring or disfavoring one or another of the SRM's membership groups and other groups in the public-at-large. This may be one of the reasons that SRM's total membership is considerably lower than a few years ago.

The Directors and Officers of SRM are concerned and discussing the rangeland image problems on the basis of three subjects, currently stated in the proposed SRM Strategic Plan (Buckhouse, 1997). First, public interest in rangelands is high, but support for professional rangeland managers, university education, and research is at an all-time low. Is it mistrust of the livestock connections by environmentalists and by the general public? Or is it that they do not know enough about SRM? Second, environmental and social non-market values have moved ahead of dollar values on rangeland forage for livestock on public land. Too often SRM is not heard or contributes little to the present mix of uses and values. Help could come from improved ability to resolve conflicts among its membership, clarify the role of domestic and wild herbivores, gain unity in rangeland assessment, and encourage development of useful databases. Third, static membership and dues but increasing costs provide insufficient funding for an SRM expansion program. Increased income can only come from better programs and a larger membership.

RESEARCH

Beginning with the budget squeeze caused by World War II, research into rangeland resource problems decreased, although some increases occurred in the 1950's. The U.S. Forest Service was at one time the lead research agency, but its emphasis has shifted to wildlife, environmental conservation, and recreational problems without reference to rangeland. Now a major Federal agency researching rangeland ecology is the Agricultural Research Service. The faculties of university rangeland and natural resources curricula are also major contributors to pertinent new knowledge. Here are a few perspectives on changes in rangeland research and dissemination of research results.

The page cost for publication in the *Journal of Range Management (JRM)* is higher than many journals. This and the lack of a basic science format fosters publication of rangeland ecological research results in other journals. A cursory review of ten rangeland ecology papers recently announced by U.S. Forest Service Research Stations shows that two were in the *JRM* and the eight were spread among seven journals, among which were *Oikos, Bioscience, Ecological Modelling, Biological Review, and American Journal of Botany.* "Browsing the Literature" in every issue of Rangelands cites a page or two of annotated rangeland publications. This is a valuable service, but why were those articles not published in *JRM*? The question is larger than cost. Could it be that SRM is not held as a science organization and the JRM not a science publication? Perhaps JRM has a too small or an inappropriate readership? Analysis of published sources of rangeland information does not answer the basic problem of size and resources. Answers could be found in a full analysis of who we are, what we stand for, and our relations with other natural resources groups. That analysis should be commissioned to avoid our talking to ourselves.

A means of changing our image would be for our research people to stop doing research that in some respects should be done in animal and wildlife sciences. Here are some examples in Volume 50 Number 4 of the JRM. Eight papers were specifically aimed at domestic animals, 7 were on some aspect of rangeland ecology, and several others were on viewpoints, methods, economics, etc.

Research and recommendations for land application should be concentrated on rangeland potentials, processes, and predictions. This would apply rangeland science to the land and hopefully give less advice to social and political movements. In other words, we need a less general or inter-net approach to research and more efforts on science, thinking, and theoretical framework. Another side of the issue is that we have been unsuccessful at changing our image from being livestock oriented to emphasis on rangeland ecosystems. Papers on studies such as restoration from pollution by pesticides and heavy metals, autogenic vegetation changes, environmental conservation, modelling of plant growth, responses to fire, and improvement of GIS mapping, are rangeland subjects that have been researched but not published in our publications.

EDUCATION

The most serious recent change in university education is the overall reduction and lack of student interest in field exercises. My belief is that our universities have seldom given undergraduate students sufficient experience in assessing vegetational changes, the mechanisms of succession, and restoration ecology (in contrast to rangeland improvement or reclamation) from visits to the field and laboratory exercises. In particular, the graduate rangeland resource professional needs to be able to "read" and understand the signs of ecosystem change, a basic of our profession. Most students, even those in Ph.D. programs, do poorly when observing vegetational changes in the field. The reduced field training gives people untrained in resource management an equal competitive advantage as practicing rangeland ecologists. To stand apart as rangeland ecologists, our university students need major emphasis on understanding landscape and ecosystem processes.

Studies of ecosystem change in a university education for range professionals should be deeper than understanding what is currently happening. Every plant and animal on our rangelands evolves a bit in a year or two but the creature itself evolved over eons of time. Our students need to know that organisms change or become extinct because of interaction with climatic variation, fire, competition, predation, and herbivory. I believe that students should study these interactions in an historical context. More importantly, they should understand that the sorting factors in evolution are the same ecological processes that rangeland professionals face on a daily basis in ecosystem management.

The information explosion made possible with computers, internet, CD's, and the multitude of software programs makes gathering of information and reproducing it highly efficient. Promotions might be based on the quality and number of CD's produced? Computer facilities will continue to enlarge, but we dare not forget that the tool to analyze data must not replace understanding the information.

I am not as concerned about other aspects of our university curricula. Yes, more English, public speaking and innumerable other subjects would be beneficial, but undergraduate students have little time for additional study units. Each student has a different set of interests and abilities that should be fostered and nurtured in the university. Put another way, more emphasis is needed on thoughtful education and not so much on training technicians. Students with degrees in law, anthropology, mathematics, languages, chemistry, or in any other field should be welcomed without penalty into rangeland ecology and management at the graduate level.

CHANGES, CRUSADES, AND MYTHS IN RANGELAND PROFESSIONALISM

This section will examine many types of changes that have occurred in research, education, and land management practices. The format is chronological following my understanding and experiences. The idea of crusades implies leadership by individuals, in some examples one idea leading to the next. Comments are not implied or intended to be critical, because rangeland recommendations have continually improved. Myths are mostly generalities that have not been proved for all situations, but remain as outdated images of rangeland professionalism. Most of the following subjects describe practices and ideas that have come and gone, often leaving behind images and myths.

Rangeland Resource Inventories

Survey of rangeland resources began as a part of forest inventories. They developed such terminology as range reconnaissance survey, proper-use factor, forage-acre factor, forage-acres, a few very broad vegetational types, square-foot density method, etc. The procedures required the surveyor to map vegetational types, estimate the forage production, determine a carrying capacity in animal-unit months, and make recommendations for range improvements. The surveyor did all this by walking or otherwise following compass lines, drawing vegetational boundary lines on a map, estimating botanical composition, and guessing the total forage production. Aerial photos became available after World War II and vegetational measurements (some of questionable accuracy) replaced the equally questionable ocular estimates in the earlier surveys.

Rangeland resource inventories became more quantitative after 1950 and were applied to specific areas for stated objectives, which might be wildlife winter range in one area or for range condition for ranch planning purposes in another. A large number of methodological studies published in the mid-1900's concentrated on accuracy and value of many methods used in determining attributes of vegetation such as cover, density, composition, and frequency.

The National Environmental Protection Act in 1969 required that all management practices applied to federal lands be subjected to environmental impact analysis. The Act changed the objectives and assessment procedures used in rangeland inventories. Its application actually began after court stipulated requirements were mandated in a suit won by the Natural Resources Defense Council against the Bureau of Land Management in 1975. Environmental Impact Statements (EIS), then and now, contain a number of alternative land management schedules and by thoughtful assessment evaluate the impact of rehabilitation practices on the land, biota, and water.

Quigley *et al.* (1997), after lengthy analysis by many people, found that no single EIS alternative reduced the risk to species and ecological integrity, or improved resiliency for social and economic systems. Fine-tuning of procedures in vegetation monitoring and appropriateness of EIS alternatives will continue to produce better decisions on natural resource problems.

A benchmark survey of ecosystem attributes is an inventory. Monitoring focuses on ecosystem changes resulting from application of rehabilitation and restoration procedures and from environmental causes. While vegetation monitoring requires an initial inventory, the monitoring objective and analysis now dominate. West *et al.* (1994) compared the monitoring systems used by eight different agencies and found their basic objectives similar. The eight use different field procedures to monitor different sorts of ecosystems, as they should, because one method cannot be efficient for all range sites and objectives. Elzinga and Evenden (1997) list 1406 papers with annotations on vegetation monitoring, that had been published in 162 different journals, 34 of them searched in depth.

Mapping is likely to continue with fully integrated digital data in the Geographic Information System (GIS). Decreasing the scale and increasing accuracy will increase GIS usefulness for small area attributes, analysis, and planning.

Evaluation of Range Condition

Evaluation of range condition began in the 1930's where grasses and shrubs dominated. Procedures used by agencies differed, but none emerged for widespread use until after World War II when the Soil Conservation Service put the Dyksterhuis system into effect throughout the prairies and plains in the Central U.S. This system, based largely on vegetational species composition according to range site and plant succession on those well-defined sites, remains in widespread use.

Attempts to make it apply to shrublands and mixed grass and shrubs in arid and semiarid areas of the Western mountains and Great Basin have not been widely accepted on either public or private lands. The basic field problem is attempted application of the traditional system beyond its appropriate specifications for the central U.S. grasslands.

Traditional theories of plant succession and climax have been questioned. Concepts have been suggested of "desired plant community" on an "ecological site" instead of "excellent condition on a range site"; "thresholds" for temporary pauses or "steady states" during plant succession; and "multiple steady states" through time and across landscapes. Models of "state-and-transition" (ST) are numerous in the literature for several vegetational types and in several countries. In many respects the ST terms appear as substitutes for the traditional terms of "range condition," "plant succession," and "site analysis." They do not constitute an alternate theory as they too are based on plant succession and site designation. The proposals constitute an excellent beginning for range condition analysis of shrublands and shrubs with a grass understory, types of vegetation not easily analyzed with the Dyksterhuis system. They need to be put into a form that is practical for range condition measurement and analysis acceptable to land management agencies. The outcome probably will be different systems for different types of vegetation. They should be ST models that include man-related causes of vegetational change and autogenic processes that also cause change. Further discussion and model analysis are given in Rodríguez Iglesias and Kothmann (1997).

It will remain a worldwide issue. The likelihood is that each country will develop particular procedures for rangeland condition evaluation because methods of sampling and analysis procedures for the central U.S. grassland do not necessarily apply to the dry regions, Mediterranean annual grassland, high-grass tropical grasslands, shrublands, and deserts. Considerable evaluation and testing lie ahead on range condition analysis.

Carrying Capacity and Stocking Rate

Rangelands in the Western half of the United States had been severely abused before 1900 by too many livestock and by little care given by the users. Deterioration of rangeland vegetation and soil in the U.S. reached its worst before the 1930 droughts. Numerous experiments and tests of practical recommendations before World War II attempted to determine a stocking rate that was the carrying capacity only for livestock and the degree of forage use that would assure recovery of vegetation, reduce soil erosion, and restore water quality and quantity.

Carrying capacity for livestock grazing and for herbivorous wildlife has not been successfully defined in research attempts because (1) forage resources and special needs in livestock operations vary from year to year and from place to place; (2) vegetational composition changes as a result of annual weather differences; (3) grazing effects are not equal over extensive rangelands; and (4) the producer's varying needs for different kinds and classes of animals in changing economic conditions. However, rangelands in general have more vegetative cover and less soil erosion than in 1900. These widely improved rangeland resources developed through the application of various stocking rates, use of seasonal grazing systems, and less complete utilization of forage plants. Past failures in research and practices to define a finite carrying capacity and stocking rate should deter major future efforts into research on carrying capacity and stocking rates. Too many economic, social, and managerial factors prevent adequate control treatments for effective research, especially in the face of biological and climatic variability. The major objective in decision making for rangeland grazing by either livestock or big-game wild species must be full ecosystem decision making and management that will rehabilitate, maintain, and protect the basic resources of vegetation, soil, and water.

Too much emphasis remains on carrying capacity for animal grazing, both of livestock and wildlife. Carrying capacity often implies natural regulation in a wildlife context, which allows numbers to build, followed by die-offs as habitat restrictions increase the effect of climatic catastrophe. Rather than management toward a given number of livestock, wild animals, and other users of natural resources, major emphasis on the world's natural rangeland resources must be on the conservation and restoration of those resources, not on carrying capacity for one or a few species. For large grazing animals, the manager needs to consider variable season of grazing, and variable numbers of animals on each grazing unit with the limits-to-use set by residual plant cover for ecosystem and succeeding user values.

Forage Plant and Range Utilization

Utilization measurements and interpretation of proper use presents a different situation than carrying capacity and stocking rate, although the three concepts are closely linked in non-destructive rangeland use. Forage utilization studies began as an effort to define proper use of key forage species. Four decades of trying (before the 1950's), failed to yield adequate measurements and to evaluate the percentages of the forage plants that were removed. Trampled removal was not considered. The rule of thumb, a myth, came to be known worldwide as "take half and leave half" of available forage, which was originally applied to year-long and season-long grazing. This myth does not apply to grazing in all seasons and areas.

Emphasis changed toward study of the effects of defoliation on individual plants, that is toward the proportion not eaten or trampled. That was a proper emphasis change because new plant growth builds from the living tissue remaining after defoliation. Individual plant response to varying degrees of defoliation at different times during the growing season has greater meaning. Vegetational responses in long-rest systems of grazing show that occasional heavy grazing can be tolerated. Some research has been reported on effects of defoliation in this context, but much more needs to be done. Useful guidelines must be for specific situations and include time of use in the growing season, and measurement specifications. A utilization percentage or category as an average for a pasture has little value.

Where the vegetation is annual grassland, as in Mediterranean climatic types, proper forage utilization cannot be the same as in perennial grasslands. The annuals only store food in the seed for germination and growth in another year. This fact has resulted in attention given to the quantities of plant materials left after grazing. It becomes the "mulch" that protects the germinating seedlings from frost and drought during the beginning of the growing season. In California, studies have shown that the annual grassland composition is directly related to the amount of mulch at the time the annuals germinate. The composition is also related to the patterns of rainfall and temperatures especially during the beginning and near the end of the wet season. The mulch is on the soil surface, water stays in the soil under it, seeds germinate under the mulch, and seedlings live or die there. The microenvironment between 5 centimeters above and 5 cm below the soil surface is key to the health of the annual grassland. It needs worldwide study in the annual-grass ecosystem.

Seasonal Grazing Systems

Research and recommendations on which grazing system to use have gone through a series of crusades. The first was wide-spread use of deferred-rotation grazing following the work A. W. Sampson began about the time of World War I. Following World War II, A. L. Hormay led the second crusade on rest-rotation grazing systems. The more recent third is a short-grazing/long-rest system which has been recommended for widely different vegetational types in several countries by A. Savory. Numerous publications describe practical application and research into the usefulness of all three to rehabilitate rangeland and to produce livestock. No single system has been shown to be best. There have been failures and outstanding results from all three types.

There are two major results. One is greatly improved rangelands because land managers have learned the importance of giving the vegetation opportunity to grow and remain healthy. The combination of successes and failures suggests the second, that good managers can make any grazing system successful. Additional research into comparing actual grazing systems probably is not needed. However, much remains to be learned about the effects of degree and seasonal timing of defoliation. Research procedures with controlled laboratory treatments are suggested.

Rangeland Improvements

Rangeland improvements, especially mechanical and chemical control of undesirable plant species, seeding of mostly alien species, fertilization, and construction of runoff water-control structures became widely accepted practices in the mid-1940's and tapered off after 1970. At first the objective was eradication and later, after failures and partial results, it changed to one of noxious or undesirable plant control. Herbicides caused environmental pollution and undesirable side effects to other than intended targets. Machines to control woody plants became too expensive. Prescribed fire to reduce brush and increase forage gained in popularity. The sequence on millions of acres started with brush reduced by fire, machines, or herbicides, followed by seeding of *Agropyron cristatum* and other introduced species. Fencing into pastures and grazing in a rotation sequence completed the process. The practices did not always produce either the expected forage or provide adequate soil protection, and brush regenerated in a few years. Costs of the conversion to grassland increased and environmental pollution further reduced use of the so-called "improvement" practices on public lands. On private lands prescribed fire for woody plant control is the principal practice, but burning time is regulated to control air pollution. Continued application of mechanical, chemical, and burning procedures appears questionable except for land rehabilitation after severe wildfire damage, soil loss through excessive erosion and sedimentation, and locally for special purposes.

Environmentalists who wanted native plants were able to force reduced brush control treatments and the inclusion of native plants in the seed mixtures on public land. Perhaps an extreme case is the inclusion of native *Artemisia tridentata*, which was the major reduced shrub, in seed mixtures after wild and prescribed fire. A myth emerged that *Agropyron cristatum* and other wheatgrasses did not deteriorate and *Artemisia tridentata* did not re-invade and increase. Both situations are false in a majority of seedings. This example also illustrates another myth, that rangeland improvements are permanent. Physical structures, shrub reduction, seeding, and other changes placed on rangeland will in time regress as the traditional natural successional processes and climatic variability continue.

Alien Species

Invasion by exotic plants that are mostly annual herbaceous species, a few shrubs, and intentionally seeded species is frowned upon by people primarily interested in native species. Claims that ecological resiliency is higher with the natives is not universally true and not all aliens are threats to the native ecosystems. Alien introductions, despite human efforts, have become permanent parts of the native succession and climax. Whether that throws the successional system into disorder or simply becomes a part of it, is a matter of opinion. When aliens do become permanently established, the term "new native" should be applied. For example, the abundance of new natives in the Mediterranean annual vegetation in California and *Bromus tectorum* in the Intermountain West of North America indicate they are permanent residents. They may be reduced but it is highly unlikely they will be eliminated. That leaves the rangeland manager with acceptance of the annuals and to use them accordingly, or destroy them and seed with natives, a costly and rarely successful procedure. Conversion by animal grazing alone seldom succeeds. Mediterranean annual grassland should be managed as such.

World-wide failed crusades include land treatments to control most alien invaders such as weeds of cultivation and rangelands, most insects, brush, and herbaceous species. Successful invasion, or establishment by any of these organisms requires a favorable environment and a safe site for the invader to collect needed resources. Creation of safe-sites occur more or less continuously in the natural landscape because of changes in vegetational composition resulting from weather events, fire, herbivores, and intentional and unintentional human-caused disturbances.

The Mediterranean annual grassland is especially well-known for presenting sites favorable to alien invaders. Generally, weed eradication and most control efforts have failed. Weed management, where the objective is partial or reasonable economic control, requires habitat analysis, estimate of costs and benefits, and determination of weed requirements; much more than selection and application of a pesticide. A good example of the problems in controlling aliens is the continued abundance of *Centaurea solstitialis* in California where over 500 other alien plant species grow without cultivation.

In crop agriculture, a complex of control procedures has become known as Integrated Pest Management. Rangeland rehabilitation or improvement and restoration needs to give more attention to this system concept. "Restoration," as used here, means to restore natural ecosystems to their historical conditions by reducing pollution, alien species, and applied practices. Restoration ecology is not the same as range rehabilitation, which usually implies change to attain a particular economic value.

"Take all the cattle off" is another crusade

Its supporters base their position on principles of restoration of ecosystems toward their historical characteristics. Another aspect of their belief is that livestock have and will continue to destroy the landscape. No livestock use of public rangeland is the target because domestic livestock are un-natural aliens that are perceived to destroy diversity. This controversy has become less violent in recent years because ranchers, the Nature Conservancy, and others are realizing that it is the ranchers who have the interest and principal means of conserving the natural rangeland ecosystems. I believe the campaign to "take all the cattle off" will continue to decrease as rangeland ecosystem information about herbivory and defoliation become known and accepted by people willing to coordinate their views.

"Good range management for livestock is good for wildlife" is another myth

A more reasonable statement is that wildlife and livestock can be managed simultaneously but populations of both cannot be maximized simultaneously. Maximum wildlife diversity is seldom attained when livestock are managed to attain maximum livestock production. On public land, if wildlife are given full consideration in the planning stages of rangeland rehabilitation and use, the management may be good for both types of animals. On private land wildlife are often attracted to areas with good livestock management. The private landowner struggles to attain a choice of objectives to meet living requirements. The complexities of decision making by private interests are based on dollar income, and with most ranchers, also on a substantial element of personal values. For public land management, the societal values outweigh the dollar income values. Ideally, these differences should be put aside in favor of rangeland resource conditions. Acceptance of this ideal has increased rapidly and will continue to become more important (Boyd *et al.* 1997).

Biodiversity

In recent years attention has increased in defining and establishing the value of biodiversity (BD) as a measurable parameter of ecosystems. The concept (perhaps not by the name "biodiversity") has been in long-time use by ecologists, paleontologists, and others who are interested in fluctuations in world climates and changes in ecosystems caused by human activities. The concept is as old as ecology itself, but standards for an acceptable degree of BD remain elusive. Biological diversity refers to the variety and variability of organisms and may be expressed in terms of kinds of organisms, their genetic variation, spatial distribution, community and ecosystem organization, and ecosystem processes.

Justification for maintaining high BD includes (1) reduction of species extinction and protection for threatened and endangered species; (2) maintenance of a broad spectrum of organisms such as those used for food, fibers, chemicals, energy, and medicines; (3) quality protection of watersheds, local climates, and atmosphere. Although seldom clearly stated, the goal in BD usually implies attaining natural levels rather than maximizing one of the many BD indexes. Neither definition nor measurement of BD have attained general agreement. The term is frequently misunderstood and meaningless to many people. Conservation and management of BD cannot be attained until a consensus is reached on decisive definitions. For example, a measure of the degree of grazing for a certain time and place that produces an ideal BD has not been suggested or agreed upon. The continually increasing pressures on the natural resources from the crunch of more and more people guarantees that the biodiversity of pre-human time will never be attained. Biological diversity is as variable and complex as "all outdoors," therefore likely to lose its current glamor. Greater importance must be placed on the preservation of ecosystem processes than on a certain species combination (West, 1993).

Riparian Zones

Riparian zones are transitions between free water, running or ponded, and uplands without standing water. On rangelands, these zones are a small portion of the total area but highly important habitats. They are the focal points of watersheds, and of a majority of wildlife species in the region. Abundant water and forage makes them the favorite habitats for livestock and big-game. The result has been overgrazing on the one hand, but on the other, adequate soil moisture provides favorable conditions for vegetational restoration. Changes in riparian systems began with the trapping of beaver, continued with livestock use, and became further impacted by recreational use. The environmental movement in the recent decades has resulted in definition of the impacts on specific areas and work to improve the structure of the stream, riparian zone and upland vegetation (Svejcar, 1997). Successes with riparian ecosystem management will continue because of the increasing need for high quality and quantity of water.

Global Temperature Change

The response of the Nation's rangelands to increasing atmospheric carbon remains essentially unknown, although effects on individual plants have been studied extensively. Global levels of CO_2 have increased from 280 ppm to 360 ppm in the last 200 years and most workers in this subject believe that the increase will continue. However, extending the effects on individual plants to the vegetation on rangeland is guesswork because vegetation changes primarily to variations in available water and nutrients. High costs prohibit in-the-field control of these factors for tests with variable CO_2 and temperature treatments. On natural landscapes, fire and grazing (herbivory) further complicate separate measurement of the CO_2 effects. Whether rangelands decrease or add to the global increase of CO_2 will be unknown until the various sources and sinks are documented (Polley, 1997). When that is accomplished, predicting possible climate changes and global warming will be more accurate. Research at 11 Agricultural Research Stations on this subject and by others will continue.

INTERAGENCY MEETINGS

During the last few years, announcements of interagency or multiple-sponsored meetings, and their summary publications cover a wide array of subjects. They indicate that "ecosystem management" is more than a bussword. It may have become a synonym that embraces people, social, economic, and biological factors in a system, and interagency meetings may be an attempt to meet that challenge. This objective is positive and warrants emphasis; however, attainment is yet to be achieved.

First, the complexity of natural resource problems has forced combined or coordinated attacks by several traditional interest groups. They generate and summarize large blocks of information. A recent example is the announcement of a "Specialty Conference on Rangeland Management and Water Resources" under the sponsorship of the Society for Range Management and the Soil and Water Conservation Society of America. The subject list in the agenda is impressive, including future trends in water resources, product assessment, diversity, riparian management and restoration, human impacts, water quality, role of local communities, wildlife impacts, predicting demographic trends and impacts, non-point pollution, impacts of climate variability, and others. The overall objective is a forum for the exchange of ideas and understanding related to water on rangeland ecosystems; a tall order. Most interdisciplinary symposia have more specific objectives such as "The Practice of Restoring Native Ecosystems" by The National Arbor Day Foundation in November 1997, and the "National Extension Natural Resources Conference" targeted toward Cooperative Extension people in May of 1998.

Second, broad leadership in cross-discipline interaction and understanding appears to be lacking. A particular symposium results, more often than not, from the effort of one or two persons, who have special interests and are able to obtain institutional, agency, and society support. This seems to indicate a broader need for inter-disciplinary information than is currently available within traditional societies such as those for range management and forestry. If this is true, the reasons may be small and static membership numbers, shortage of funds, and traditional approaches to subject matter. For the future of natural resources, the natural resource societies should examine and increase their role in interagency or inter-disciplinary information analysis.

Third, the symposia demonstrate leadership when the summary publications appear. Leaders in a broader context, beyond the publication, have not appeared. Loyalty to one's professional society appears to be down as indicated by declining membership in SRM and other groups. Other societies, especially those in conservation and the relatively recent emergence of environmental pursuits have increased in size. Some of the older natural resource societies may disappear or merge with a new emphasis. They are unlikely to dominate new arrangements.

COORDINATED RESOURCE MANAGEMENT

Coordinated Resource Management (CRM) is a collaborative participation process used in conflict resolution of rangeland use problems. The major players represent multiple competing disciplinary interests, such as market vs. non-market values, and private vs. public interests. It begins when a few local people get together for discussion of a local problem, such as a damaged watershed for a town water supply. Commonly, land ownerships are mixed. Recriminations may be high. The initial objective of CRM is patience among the group so that the problems are stated objectively and without blame. The next stage is people taking part in reasonable discussion with little emotion, public rhetoric, and advocation of personal points of view. It enables people in good faith to learn each other's viewpoints. A CRM team includes non-activist as well as activist people who marshal data, provide a course of action, and who have authority to take action. It is a continual action and discussion process that provides continuous feedback and planning flexibility. Often there is a sense of shared ownership in developed plans as well as shared authority and responsibility in the decisions (Moote and McClaran, 1997). The process is one of bottom-to-top in administrative jargon. There may be a tendency to change to top-to-bottom approach and in my opinion that will damage the process beyond repair. A full account of CRM including history, organization, and operation is given by Cleary and Phillippi (1993).

Ecosystem Resource Management and CRM go hand-in-hand. Management units should be for agreed-to specific objectives and for desired land and vegetation conditions. Different objectives for each ownership seldom do what is right for the land; hence the need to work with natural ecosystems. Animals and physical inputs are the tools. Monitoring allows objective evaluation of results. CRM has worked well when applied to specific area rangeland rehabilitation and management problems.

I ask and suggest that the CRM process be used in analysis for the future of SRM or what we have come to know as the Range Profession. In fact, it would be helpful to SRM if they could be represented on the CRM teams.

A PROPOSAL FOR ACTION

Can SRM be revised and transformed into a leading Natural Resources Society? Probably not. The time has arrived for a number of societies to appoint a joint commission to address social, economic, and scientific problems that relatively small, separate subject, natural resources societies have difficulty addressing. SRM should lead the way in the appointment of that commission with objectives to determine the possibilities of several of the present societies working together in one effort (perhaps a type of Coordinated Resource Management) . Combining and streamlining of operations could reduce costs and larger membership could make all of us more effective. These objectives can be accomplished, but first SRM needs to have a group (perhaps a few past presidents and some others) examine the idea, and if worthy, flesh-out the proposal.

ACKNOWLEDGMENTS

I thank and greatly appreciate the comments and corrections suggested by T. Bedell, D. Child, R. Cleary, Ruth Heady, W. Laycock, E. Redente, Q. Skinner, M. Smith, and M. Trlica. Their sincere and always positive suggestions have improved the manuscript.

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PERSPECTIVAS EN ECOLOGÍA Y GESTIÓN DE PASTOS NATURALES EXTENSIVOS

RESUMEN

En este artículo se revisan los cambios ocurridos en la ecología y gestión de los pastos en los EEUU durante los últimos 65 años y se especula sobre los cambios en el futuro. El énfasis se ha desplazado desde la gestión ganadera a una preocupación sobre aspectos ecológicos y ambientales, de ahí la expresión "ecología de los pastos". El término "gestión de pastos" puede haber sobrevivido a su utilidad y además puede ser negativo para nuestra imagen. La visión que tenemos de nosotros mismos no es la misma que tienen los demás. Muchos de los miembros de la Sociedad para la Gestión de los Pastos Naturales Extensivos (Society for Range Management, SRM) y la mayor parte del público interesado (no perteneciente a la Sociedad) creen que la SRM pone más énfasis en la industria ganadera. Sin embargo, los objetivos de la SRM se centran claramente en la comprensión de los procesos a nivel de ecosistema, en la conservación ambiental y, sobre todo, en el cuidado de los recursos pascícolas. Otras sociedades, relativamente pequeñas, dedicadas a los recursos naturales tienen problemas de identidad parecidos. Ha llegado el momento para que una comisión que represente a las especialidades en recursos naturales examine las posibilidades de que las sociedades actuales se agrupen para aumentar el número de socios, reducir los costes y revisar sus aproximaciones a los ecosistemas de pastos.

En los años 30 la investigación de pastos se concentraba en los experimentos sobre la superficie pastable con dos objetivos: probar los sistemas de rotación diferida del pastoreo para mejorar la producción y definir la capacidad de carga ganadera. Los experimentos finalizaron con la Segunda Guerra Mundial sin obtener respuestas concretas para ninguno de los dos objetivos, pero con un mayor conocimiento sobre los efectos del pastoreo sobre la vegetación. En la actualidad y en el futuro, la investigación sobre dimensiones de la superficie pastable será restringida a favor de la investigación sobre los procesos a nivel de ecosistema, esperemos que al menos en parte se lleven a cabo en condiciones de campo.

En los *currícula* universitarios se necesita más énfasis en la educación y menos en el entrenamiento de técnicos. Los estudiantes graduados, en mi opinión, deben ser capaces de reconocer y comprender las evidencias naturales de los cambios en la vegetación y los procesos que los determinan. La reducción de la experiencia de campo en los *currícula* universitarios es un error.

El análisis y las técnicas en el estudio de los pastos ha progresado durante este siglo. Por ejemplo, el inventario y análisis de los pastos ha cambiado desde las prospecciones a pie con brújula al uso de las fotografías aéreas y en la actualidad a las técnicas de Información Geográfica. Los primeros objetivos de los inventarios fueron determinar la carga ganadera. La evaluación del estado del pasto y el análisis del impacto ambiental se volvieron prominentes después de 1945. Las evaluaciones del nivel de utilización de las plantas y de los pastos no han tenido éxito en el intento de determinar su uso apropiado.

Ciertas cruzadas han caracterizado las prácticas de la gestión de pastos. Un ejemplo es el cambio en los sistemas de pastoreo estacional desde la rotación-diferida, al descanso-rotación y a la rotación de pastoreo-corto/descanso-largo, hasta reconocer que la buena gestión puede hacer que cualquier sistema funcione. Otra cruzada comenzó con el ganado como uso único de la tierra y ha terminado con el eslogan ambientalista de "quitar todas las vacas". Por el camino, casi han desaparecido el uso de técnicas mecánicas y químicas para eliminar los matorrales, y las plantas exóticas han sido sutituidas por especies autóctonas en las mezclas de semilla para mejorar los pastos.

Los mitos en la profesión de gestor de pastos son generalidades ampliamente difundidas, que no son correctas en todas las situaciones. Como ejemplo se pueden citar: la buena gestión de los pastos para el ganado también es buena para la fauna silvestre, toma la mitad y deja la mitad, las especies autóctonas son mejores que las introducidas, y las mejoras del pasto son permanentes.

Nuestra rica historia de cambios en la profesionalización, investigación y educación en la ecología y gestión de pastos naturales extensivos abre interrogantes sobre el futuro de tres temas de actualidad: la biodiversidad, la restauración de riberas y el cambio global de temperatura.

La controversia caracteriza a la mayor parte de los cambios, de las cruzadas y de los mitos. La Gestión Coordinada de los Recursos (Coordinated Resource Management) es un proceso de participación y colaboración que se ha empleado con éxito en la solución de conflictos en el uso de los pastos. Ese proceso continuará y su efectividad aumentará.

Palabras clave: Ecosistema pastoral, historia de la ciencia, pastoreo, recursos naturales.