Rangelands

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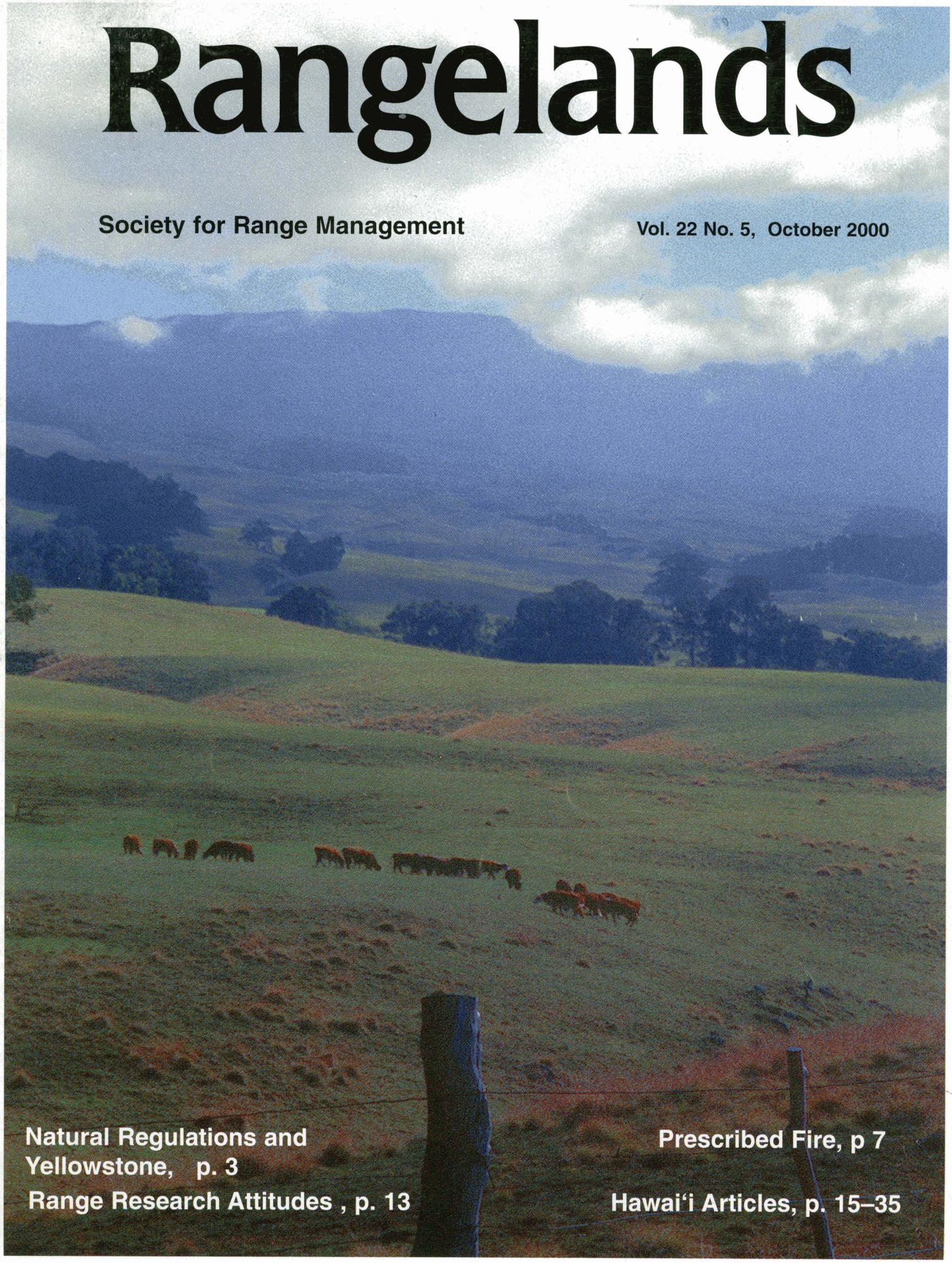

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Rangelands

FEATURE ARTICLES

DEPARTMENTS

Guest editor for the Hawaii articles: Lynn Huntsinger

COVER

COVER PHOTO: Front: Hawaii's rolling rangelands. Photo by Ayn Shlisky. **Back:** The Hawaii logo by Ayn Shlisky.

The Society for Range Management

The Society for Range Management founded in 1948 as the *American Society of Range Management*, is a nonprofit association incorporated under the laws of the State of Wyoming. It is recognized exempt from Federal income tax, as a scientific and educational organization, under the provisions of Section 501(c) (3) of the Internal Revenue Code, and also is classed as a public foundation as described in Section 509 (a) (2) of the Code. The name of the Society was changed in 1971 by amendment of the Articles of Incorporation.

The objectives for which the corporation is established are:

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

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

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

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

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

—to promote professional development of its members.

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

Rangelands

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

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Executive Vice-President's Comments

Autumn Potpourri

Reports and rumors on the demise of the Hawaii meeting were greatly exaggerated. Not only is our *Range Odyssey* alive and well, it has the potential to be one of our best meetings ever!

The setting will be unusual and spectacular, especially for us range managers. We will be living, eating, and meeting along beautiful beaches, tropical gardens, and magnificent views of the bay. Program planners report that the response for papers, poster sessions, symposia, and workshops has been outstanding. The opportunities for learning at this meeting will be as good as it gets. The timing couldn't be better with our renewed emphasis on continuing education. If you decide you need a break from all that technical stuff, the opportunity to snorkel, fish, swim, tour, view volcanoes, take a cruise for dinner, and much more is there waiting for you. There has never been a better opportunity for many of us to visit this paradise. Don't pass it up!

I'm sure you have noticed from Jeff Burwell's *Certification Corner* in the *Trail Boss News*, that our certification program has quickly become an important and valuable service to our members. In less than a year continuing education and professionalism have received some renewed emphasis with the Society culture. We have always had these values, but with the momentum created by our certification program, there has been a very noticeable increase in interest for training and education. I was undecided about the value of certification until it was put in place. Now I am a proponent. I think certification is an extremely valuable addition to SRM's program.

We continue to pursue opportunities to expand SRM's programs in ways that will benefit our members, the resource, and the profession. An example of that is our effort to provide meaningful recommendations for consideration in the 2002 Farm Bill. In August, we convened a cross-section of SRM members to develop input from a rangeland perspective, to this important legislative process. Our project was made possible by funding assistance from the Natural Resources Conservation Service, and is being coordinated by Jeff Burwell, our public affairs manager. Discussions have focused on how natural resources are impacted by current USDA programs, and we have attempted to identify both current and future issues surrounding rangeland resources. Preparation of a written report is in progress.

Another activity, which will be extremely important to SRM and the rangeland resource, will be the need to provide information to the new political administration and Congress. We are already engaged in the process, which we call the "transition plan". SRM will address the problem of a changeover in the departments and agencies important to natural resource management, as well as changes in Congress and congressional staffs. Section Presidents have been alerted by John McLain to be aware of possible appointees from their areas. The Board of Directors, staff, including Deen Boe, and committees, are working on specific points of emphasis for our communication effort. The National Capital Section will play a key role in putting these ideas into effect. The need for accurate information on rangeland resources has never been greater, and this is an important opportunity at a critical point in time.—**Craig Whittekiend**, Executive Vice-President, SRM

Elk feeding on mountain big sagebrush on big game winter range near Gardiner, Montana. Past ungulate browsing has resulted in very significant declines of sagebrush taxa on this important winter range. (photo by Carl Wambolt)

Natural Regulation and Yellowstone National Park—Unanswered Questions

Kurt Alt and Michael R Frisina

Natural regulation is the practice of allowing elk population size in Yellowstone National Park to be controlled by natural or non-human influenced processes. The concept has been controversial since it's development during the late 1960's and implementation in the 1970's. Much of the controversy has centered around the degree of impact natural regulation has had on vegetation inside the Park and on big game winter ranges adjacent to the Park. The effect of browsing, or impact, by ungulates on woody plant species has been interpreted in a variety of ways by different authors. In 1998, Congress directed the National Academy of Sciences (NAS) to review the National Park Service policy of natural regulation in Yellowstone Park. As a result, the NAS recently appointed a 13-member committee on Ungulate Management. Congress chartered the committee to conduct an unbiased science-based investigation that portrays both positive and negative aspects of natural regulation.

The popular press often defines controversial issues in a sensational vein. Individuals or organizations tend to define issues based on their view of the world. In this case, the "natural regulation" debate has been portrayed as a livestock industry or cowboy versus environmentalist debate. How can elk be allowed to "overgraze" the range; "if my cows did the same they would be removed from my Federal grazing allotment." Proponents of natural regulation often argue that it must be working, as the policy has been in place since 1967 and the elk population is doing fine. "**The policy is successful because the elk population has fluctuated in numbers as influenced by the environment yet has not dramatically declined during the years of natural regulation.**" In our view, these are not the correct parameters for measuring the effectiveness of natural regulation. In his oral testimony to the NAS Committee, Dr. Fred Wagner indicated that elk herd effects on the ecosystem under natural regulation policy poses questions of scientific fact, subject to tests of evidence. In our view it is this question of effect on the ecosystem that has not been fully explored or evaluated.

Yellowstone National Park is not a livestock grazing allotment managed under the Multiple Use concept, nor are elk the only resource of value associated with Yellowstone National Park. Using such limited or narrow parameters to judge the effectiveness of Yellowstone Park policy is not appropriate or acceptable.

We offer our viewpoint for consideration by groups like the National Academy of Science, as their effort will set the stage for future land management events in and around the boundaries of Yellowstone National Park. Findings of the National Academy of Science Committee may serve as the basis by which land managers evaluate the interaction of large ungulates with their habitats on all public lands throughout the western United States.

BIODIVERSITY

Yellowstone National Park is much more than its elk population. An approach that gauges the success or failure of National Park Service policy by how well the elk population sustains itself does a disservice to the citizens of our country and the ecological integrity of the lands they manage. A monitoring approach, without regard to the effects on the array of flora and fauna associated with Yellowstone National Park is not acceptable; it does not reflect what the Park's founders intended. The National Parks Organic Act passed in 1916, established the purpose of our National Parks to conserve natural and historic elements and wildlife of our nation for future generations to enjoy. We recognize the importance of the ongoing research efforts that take place in National Parks, but also believe it is important to recognize that our National Park System was not created just to provide experimental research areas for scientists to perform experiments. If Park policy is to be responsibly monitored, the effect of natural regulation on the array of potential plants and animals in the Park must be a key element of research. How the many years of natural regulation has affected the biodiversity of Yellowstone National Park is key to understanding if the policy has been effective. An understanding of effects on biodiversity is fundamental to determining if natural regulation has enhanced or degraded the values the Park was established to conserve.

A number of authors have published reports and articles describing changes in woody vegetation that have occurred due to intensive forage use by the "naturally" regulated elk population These changes are most noticeable for many woody or browse species, and raises the issue of how intensive browsing has affected the biotic community. The effect on Park biodiversity should be central to the National Academy of Science analysis of natural regulation.

Fig. 1. ***Lamar Exclosure YNP, established 1957. Photo at the top of the page was taken in 1958 shortly after the exclosure was established, protecting the area inside from browsing by large ungulates. The lower photo was taken in 1995. Note the recovery of woody species, especially aspen. Upper photo NPS, lower photo by Carl Wambolt.***

Aspen

What are the consequences on winter ranges in and around the Park where, due to browsing by elk, there are essentially only two aspen size classes contributing to stand structure? At many locations, on winter ranges in and around the Park, tall mature aspen and aspen stems 20 inches or shorter in height are all that exist (Figure 1). There are almost no aspen between 20 and 80 inches in height. Essentially, all young aspen are held within the 7 to 8 foot browse zone of elk and other large ungulates by browsing. If this trend continues, as tall aspen die, the stands may be converted to shrub type aspen. How does this altering of aspen stand structure effect the survival and species richness of neotropical migrant birds and small mammals that occur in such habitat types? Several different authors have described the negative effect of altered woody species stand structure, due to browsing, on birds. Measuring the effect of natural regulation on overall landscape biodiversity should be a fundamental component of any objective review of Park policy.

Willow

What are the consequences on winter ranges in and around the Park where, due to browsing by elk, the structur - al component of willow communities have been modified to varying degrees by herbivory ?

On portions of the Northern and Gallatin winter ranges, due to browsing, the only available willow is the current years growth. Over most of these winter ranges the tall willow component has been removed by browsing. The further one travels outside the Park on these winter ranges, into Montana, a more complex structural component of woody vegetation becomes discernible. On portions of the winter range outside of the Park, young woody stems within the browse zone are achieving a growth form that will allow them to develop to their typical stature. As with aspen, an important issue regarding loss of structural diversity is the effect on neotropical song birds and small mammals which can be expected to occur in such potentially diverse habitats. Where willow communities occur along stream courses, the effect on water quality and water-dependent wildlife species becomes an important consideration.

Shrub/gGassland Plant Communities

What are the consequences resulting from changes in shrub/grassland plant communities?

A decline of tree and shrub communities has caused an expansion of grassland communities. The shrub component has

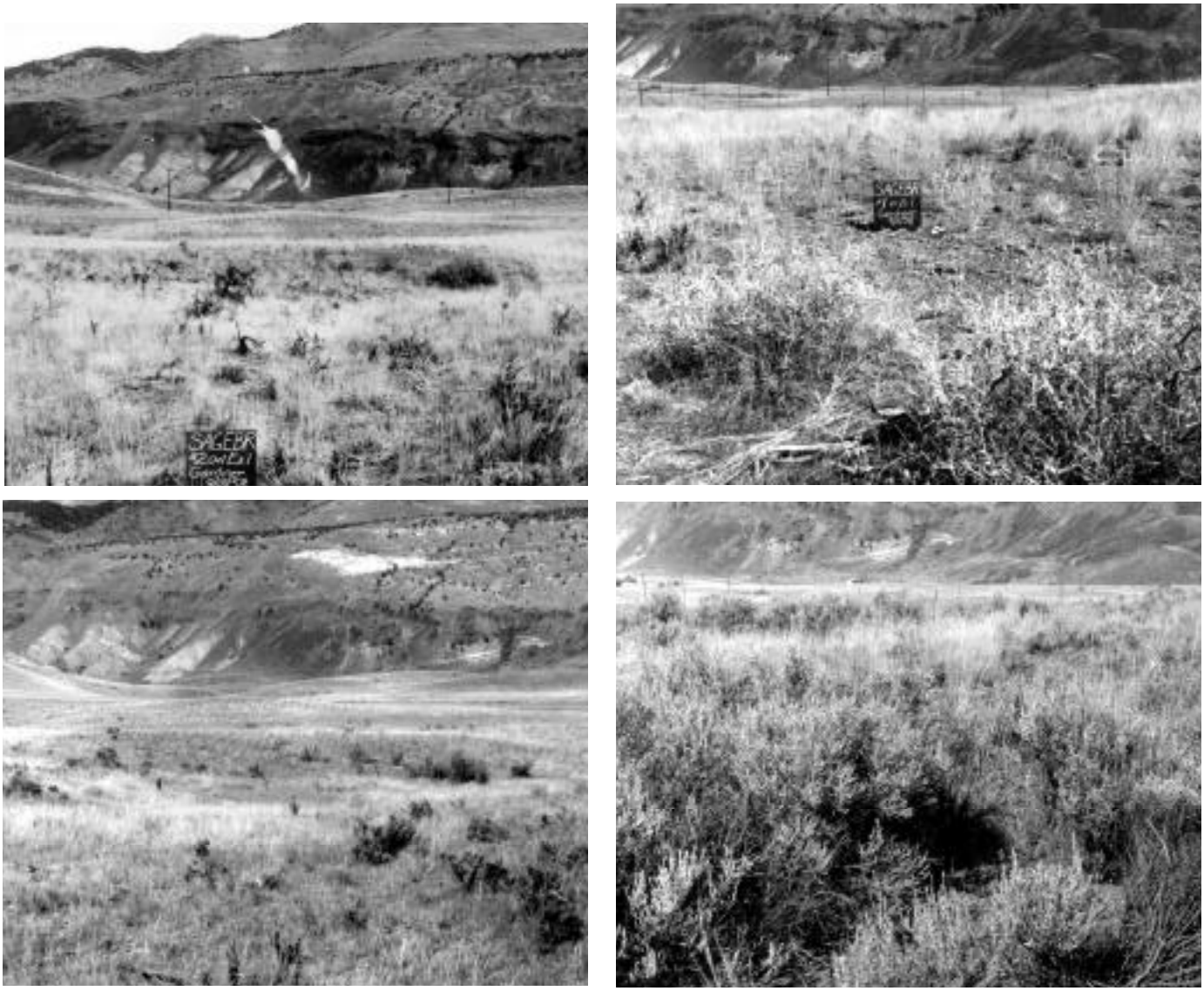

Fig. 2. ***Exclosure near Gardiner, MT, YNP. Photo in upper left was taken in 1958 outside of the exclosure, photo upper right was taken inside the exclosure in 1958 shortly after the exclosure was constructed. Notice the similarity. The lower left photo was taken in 1995 at the same location outside the exclosure; photo lower right was taken in 1995 inside the exclosure at the same location. Note the establishment of woody vegetation in the lower right photo as a result of protection from browsing. The photos may not fully reflect the site's potential as they only reflect 37-years of protection from browsing. Upper photos NPS, lower photos by Carl Wambolt.***

been removed or significantly altered, by browsing, in favor of grassland communities over large portions of the winter ranges associated with the Park (Figure 2.). The increase of woody species, within the exclosure, in Figure 2 may not fully reflect the potential of the site as the photos only reflect protection from browsing for a 37-year period. As with the aforementioned woody species, the effect on overall landscape level biodiversity becomes a key issue.

Other Ungulates

Elk are the dominant ungulate on rangelands associated with Yellowstone National Park. When it comes to using a variety of forage species and habitats, elk are the most adaptable of the large ungulates. As a result, elk may be the least sensitive indicator of environmental health. Other ungulates in the Park include bison, Rocky Mountain bighorn sheep, shiras moose, pronghorn antelope, Rocky Mountain goat, and mule deer. How natural regulation has affected the survival of ungulates other than elk within and adjacent to the Park is also central to considering issues related to biodiversity within the Yellowstone ecosystem.

SUMMARY

An objective analysis of natural regulation Policy must include a landscape level investigation, considering the effects on overall biodiversity. Yellowstone National Park is one of our largest National Parks and represents a significant portion of the largest intact natural area in the lower 48 states. Maintaining biodiversity in and around the Park as part of our cultural heritage assures Yellowstone Park will continue to fulfill its intended purpose for future generations. The findings of the NAS Committee may provide a series of guidelines for assessing the effect of grazing and browsing by large ungulates (both domestic and wild) on our public lands throughout the west.

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Prescribed Fire Costs on Juniper-Infested Rangeland

Rob Mitchell, Carlton Britton, Brent Racher, Ernest Fish, and Erin Atkinson

What are the true costs of prescribed fire on juniper infested rangelands? Redberry juniper is a basal sprouting, multi-stemmed evergreen tree growing on rocky slopes with shallow soils. Although several options are available for managing redberry juniper, prescribed fire is considered the least expensive. Many professionals recommend the application of prescribed fire without knowledge of the actual total costs. Individuals considering contract burning for producers have no guidelines for estimating costs. Factors such as total labor hours, miles driven, torch fuel, and food costs influence the actual cost of burning, but are often overlooked or difficult to estimate without experience. Texas Tech University has 30 years of experience conducting burns for producers in Texas, New Mexico, and Oklahoma. This experience is applied to 3 examples which illustrate the total costs for applying prescribed fire. The pastures used were infested by redberry juniper and burned in the spring 1998 (Fig. 1). These pastures represented a spectrum of pastures capable of being ignited from the ground with drip torches.

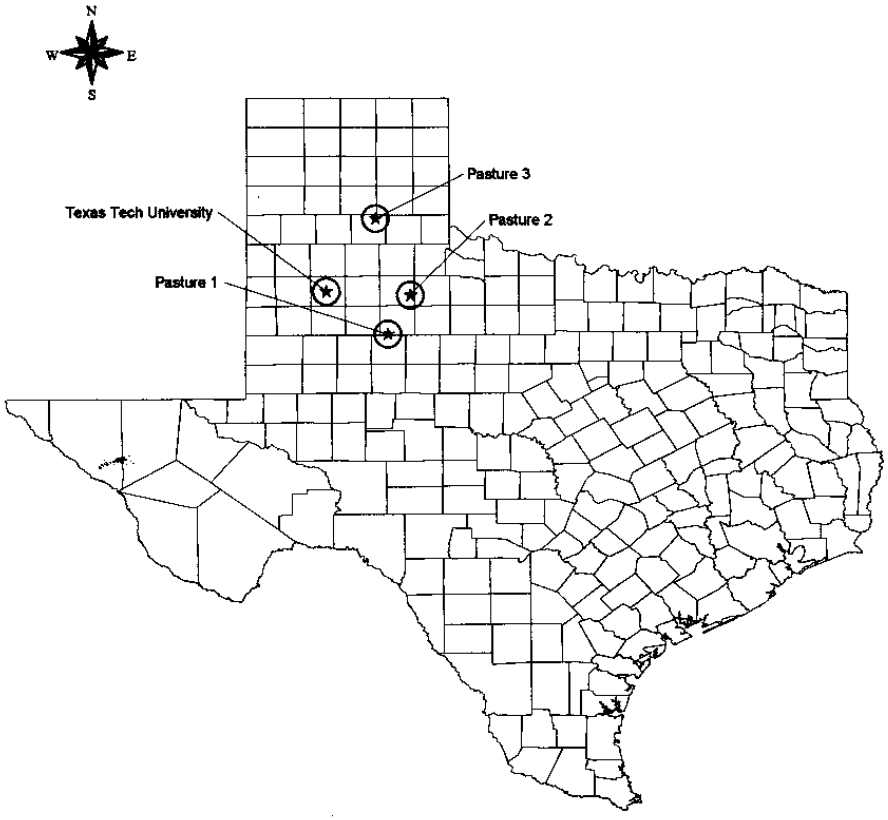


Fig. 1. ***Map of the pasture locations in Texas.***

Pasture 1 (1397 acres) is located 100 miles from the Texas Tech University campus, and had the least broken terrain with the smallest elevation changes across the pasture. We considered this a smooth terrain pasture. Pasture 2 (2,844 acres) is located 90 miles from the campus, with rugged terrain in the southwest half of the pasture, but was gently rolling in the northeast half of the pasture. We considered this a mixed terrain pasture. Pasture 3 (2,965 acres) is 140 miles from the campus, was uniformly rugged, and had rockier soil than Pasture 2. We considered this a mixed terrain pasture. The primary difference between Pastures 2 and 3 was the lack of smooth terrain on the north and east sides to apply blacklines in Pasture 3.

Costs recorded during burning included number of workers, total labor hours, miles traveled, torch fuel used, and food

Redberry juniper has invaded many areas in Texas.

Redberry juniper basal bud zone.

cost. Labor was calculated at $7.00 per hour, mileage at $0.27 per mile, and torch fuel at $1.02 per gallon. Torch fuel was mixed as 70% diesel and 30% unleaded gasoline. No cost was monitored for dozer work required for fireline preparation (but were estimated), grazing deferment for fine fuel accumulation, and no equipment costs were amortized for the burns. Equipment used to conduct burns at all locations included: a 1-ton, 4-wheel drive truck with a 200 gallon suppression unit and mobile radio, a 3/4-ton, 4-wheel drive truck with a 100 gallon suppression unit and mobile radio, a 12 passenger van, a 250cc, 4-wheeler with a 14-gallon rear-mounted sprayer, 14 drip torches, 12 hand-held radios, five backpack sprayers, four belt weather kits, four fire rakes, four McLeods, four swatters, two axes, two chainsaws, and matches. Dozed lines were installed around the perimeter of each pasture and an interior line was installed parallel to the perimeter line on the north and east sides of the burn units. The 500 to 1,000 foot area between the perimeter line and the interior dozed lines was burned to provide blacklines for safely igniting headfires with prevailing southwest winds. Crossover lines were installed in the blacklines at Ç to å mile intervals. The fenced acreage of the pasture containing the Pasture 2 burn unit exceeded 6,000 acres and the north dozed line was installed in a mesquite flat to simplify the burning of the remaining 2,844 acres. The terrain of Pasture 3 required installing many interior lines to facilitate burning the pasture in several units.

Pasture Comparison

The cost to burn the pastures ranged from $3.07 to $6.15/acre (Table 1). Cost to burn the pastures averaged $4.39/acre without any equipment amortization or dozed line construction costs. It is often assumed that as burn size increases, the cost per acre decreases. This was not the case for these pastures. The distance traveled, travel time, presence of suitable areas within the pasture to locate blacklines, and roughness of the pasture were the primary factors influencing costs. The distance of the pasture from campus also increased the difficulty of predicting weather at the site prior to leaving campus. The presence of a mesquite flat on the north side of Pasture 2 made installation of blacklines much easier than on Pasture 3. The rough, rocky terrain of Pasture 3 required more hours per day due to difficulty of ignition and suppression, and mop up time. The large crew size for Pasture 2 was a result of its close proximity to campus and the desire of students to participate on a burn at this particular ranch.

Table 1. Actual costs for prescribed fire application on three pastures in the Texas Rolling Plains during 1998.

Category	Pasture 1	Pasture 2	Pasture 3
Terrain	Smooth	Mixed	Mixed
Trips from TTU	5	7	13
Blackline	3	4	5
Headfire	2	3	8
No burning	1	1	1
Average number of workers	11	16	12
Average hours per day	12.6	10.8	17.2
Miles traveled	3,687	5,721	10,319
Torch fuel used (gal)	166	112	191
Food cost ($)	215	536	864
Actual burn cost/acre ($)	3.96	3.07	6.15
Dozed lines (miles)	13.1	19.3	26.0
Estimated dozed line cost/acre ($)[1]	0.61	0.88	1.14
Estimated burn cost/acre with lines ($)	4.57	3.95	7.29

[1]Assumes $65/hour of dozer time and installation of 1 mile of dozed line per hour on smooth terrain and å mile of dozed line per hour on mixed terrain.

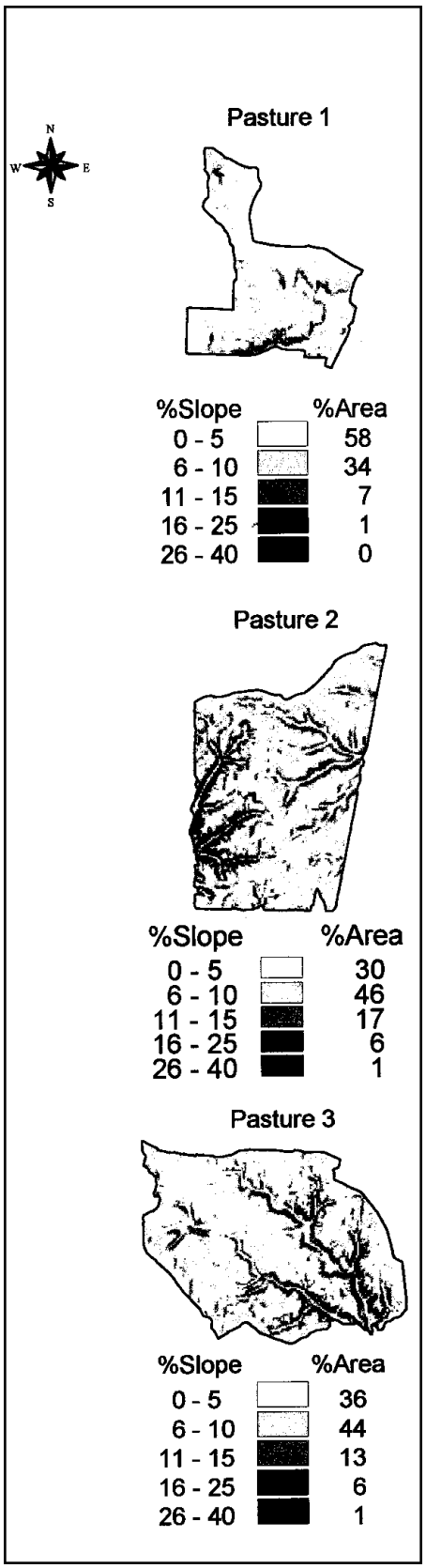


Fig. 2. ***Slope maps of the pastures generated from GPS evaluation and digital elevation models of the sites.***

Headfire ignition from horseback.

Total miles of dozed lines in each pasture was 13.1, 19.3, and 26.0 for Pastures 1, 2, and 3, respectively, and were estimated to range from 15 to 30% of the actual burn cost (Table 1). This high cost reinforces the need to plan firelines in less rough terrain. The ranchers for Pastures 1 and 2 owned dozers and employed operators, so installing lines was less costly in these pastures than in Pasture 3. Pasture 1 had the fewest miles of dozed lines due to the smooth terrain of the site, whereas Pasture 3 had the most miles of dozed lines due to the rugged terrain and the need to burn the pasture in seven headfire units (Fig. 2). Pastures 2 and 3 were similar sizes, but Pasture 2 had 147 acres per mile of dozed line, whereas Pasture 3 had 114 acres per mile of dozed line.

Burning juniper communities is hard work and requires many hours of site evaluation to prepare for burning. Additionally, training people to safely and effectively conduct prescribed fires in juniper communities takes time and experience. These results should be useful as guidelines to estimate the cost of prescribed fire application. However, it should be realized that contract burning cannot be conducted for the cost of application if the contractor expects to stay in business. Proper amortization of equipment as well as an adequate profit margin need to be considered in calcu-

Prescribed burning is inexpensive, but not free.

Burning blacklines in redberry juniper.

lating "full costs". Range professionals recommending prescribed burning to landowners need to remember that prescribed fire application is inexpensive, but not free.

Prescribed Burning Liability in Texas

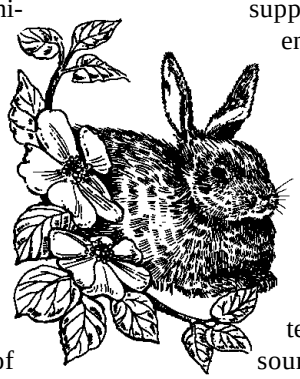
A major concern for Texas landowners considering using prescribed fire as a management tool is liability. Although most agricultural policies cover liability from accepted agricultural practices, it is a good idea to contact your insurance company to determine your coverage and the limits of liability under your policy. Legislation passed in the 76th Session of the Texas Legislature limits landowner liability for property damage, injury, or death caused by or resulting from prescribed burning if the prescribed burn is conducted under the supervision of a certified prescribed burn manager. This limitation does not apply unless the certified prescribed burn manager "has liability insurance coverage of at least $1 million for each single occurrence of bodily injury or death, or injury to or destruction of property." In the event of an accident, a detailed record of line preparation, notification of authorities and neighbors, permit acquisition (if necessary), and a detailed prescribed burn plan including smoke management will provide documentation of proper planning and prescriptions to determine if problems resulted from negligence or an act of God.

Authors are assistant professor, professor, research assistant, professor, and research associate, respectively, Department of Range, Wildlife, and Fisheries Management, Texas Tech University, Lubbock, Texas 79409. Fire Ecology Center Technical Paper 10. Visit the Fire Ecology Center web site at http://www.rw.ttu.edu/fec.

Viewpoint: Utilization & Ecosystem Function

Raymond D. Ratliff

What is a consumer of rangeland resources? It is bugs and beetles, cows and soil biota, bacteria and antelope. How do we balance production and use? One of a range manager's objectives is to assure that forage use is not so heavy as to impair the continuing supply of the needs of many consumers. The relation of forage use to ecosystem functioning is in most person's interest. Degree of use (utilization) is defined as "the proportion of current year's forage production that is consumed and/or destroyed by grazing animals"; which include rabbits, grasshoppers, and cows.



There are flaws in the current standards of utilization. Burkhardt and McKinney conclude that present utilization standards are useless as management tools. I agree, but this paper proposes answers to some basic questions about utilization.

How is the concept of forage utilization related to ecosystem function? How is the functioning of an ecosystem maintained by controlling use of vegetation? How does man fit into the utilization picture? Is the value of utilization measurements negated by management systems?

Concept of Utilization

The concept of forage utilization is related to ecosystem function through its dependence upon the resources left to maintain the system's cycle of production. A primary function of every part of an ecosystem is to produce resources for use by other parts of the ecosystem, thus cycling material. Simply put, the cycle runs from microbes, to primary producers, to primary consumers, to secondary consumers, and finally back to microbes. Producing too little of a resource at any stage will hinder completion of the cycle.

Maintenance and Utilization

Functioning of an ecosystem is maintained by controlling use of vegetation so that continued overuse is avoided. Using the resources available is a primary function of each producer, consumer, or decomposer. All are consumers of products available at some trophic level. Each consumer uses the resources available to it for producing resources needed by other consumers. If a consumer impairs the ability of a producer to provide the resources it needs, then production for the next level consumer is lowered. Overuse of any resource by any consumer—if continued—will eventually deplete the system and hinder its functioning.

Man and Utilization

Man fits into the utilization picture because he makes decisions that affect resources.

Under natural conditions (natural systems), the laws of supply and demand come into play. Consider simple predator/prey relationships. When the demand rises to and beyond the prey's ability to supply, the supply becomes depleted, the demand drops (predators fail to reproduce), and the supply is allowed to replenish. Under human influenced conditions this cycle can be interrupted.

Neither natural systems nor agricultural systems are sustainable if the resources (rain, soil fertility, etc.) that sustain them are not present. To man's short-term view, natural systems are sustainable, but over the geologic time since creation, many have failed. Production of some resource was not sustainable. To man's limited view agricultural systems may be sustainable, but given a lack of resource inputs (water and fertilizer for example) or the effects of other inputs on the system they too will fail.

Domestic livestock are a major primary consumer of rangeland resources—it is an agricultural system we recognize. Here man is a secondary consumer. Range science concentrates on estimating production, utilization, and assessing rangeland health. These tools help to judge whether the ecosystem function of producing resources to be consumed is sustainable.

Systems and Utilization

Man can control (within limits) the frequency, distribution, and season that his domestic animals graze, but he cannot control how an animal will use an individual plant. Thus, man cannot control the damage nor the benefit a plant receives from grazing. Because man can seldom afford to adequately measure vegetation production nor what remains on a given site, man cannot measure what is taken nor adequately measure utilization.

Properly designed, a grazing management system will largely negate any value from measures of utilization. Nevertheless, utilization measures (however inadequate) may be useful in adjusting distribution.

Along with stocking rate the mix of frequency (deferment or rest), distribution, and season of grazing largely dictate the design. Hormay and Talbot state that under rest-rotation grazing "degree of use of plants does not have the same importance as under continuous seasonal grazing, because grazing is limited to a comparatively short time and is always followed by rest

planned to be long enough to overcome the harmful effects of grazing."

Through **frequency of grazing,** man can control the growth and reproduction of given plant species. Given adequate time to regrow following a grazing event a plant will regain vigor,

produce a seed crop, and replenish reserve carbohydrates. A plant will call upon its reserves to make early growth; when production is sufficient to meet its needs the excess will be reserved.

Through **distribution of livestock grazing** man can control the use of each range site. Some sites and plants will always be more fully used than others and some will tolerate heavier use than others. Preferential grazing of plants will be a fact of life as long as one herbivore or omnivore remains; be that a cow, deer, gopher, grasshopper, or bear. Balancing use with a site's ability to produce, reproduce, and regrow is the key.

Through **season of grazing** man can control when his animals use an area. The overall season that an area can be grazed is under nature's control. But man can work within that season to control when grazing occurs in relation to plant phenology.

There is no one grazing management system applicable to all areas. Nevertheless, basic principles still hold: (1) Allow no more livestock to graze more frequently or at times other than an area can continually support. (2) Distribute livestock so that preferred areas do not receive continued overuse. (3) Monitor frequently to make sure 1 and 2 are being met. Attention to these three basic principles of management will assure continued utilization of all resources and that our ecosystems continue to function.

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Attitudes About Range Research

Research Affairs Committee[1]
Society for Range Management

Where has range research been recently and where should it go in the future? We asked a representative group of Society for Range Management (SRM) members these questions. You may be surprised at their answers.

This question is important because SRM has always been involved in helping to direct how some research dollars are spent. So, we need to know what is really important to the Society, not just to the persons writing the grant applications.

We made a random selection of SRM members and phoned 97 of them to get their ideas on 3 questions:

1. **What have been the most important accomplishments in range research over the past 10 years?**
2. **What are the most important problems for range researchers to address in the next 3 years?**
3. **What do you predict will be the most important range research question 10 years from now?**

Multiple replies (up to 3) were encouraged for the first 2 questions, but only 1 response was taken for question 3.

The respondents were asked to categorize themselves as primarily an educator, a researcher, or a manager (a manager included ranchers and land management agency personnel). Of the 97 respondents, there were 38 researchers, 36 educators, and 23 managers. Individual answers to each question were classified as follows: (1) the primary topic of the research; (2) whether the research was basic, applied, or basic research with implications for application; and (3) category of science (i.e., natural sciences, human sciences, or a combination of human and natural sciences).

The majority of all answers to question 1 (important accomplishments) fell into 5 topic areas.

1) **Succession**—responses in this category dealt with models; state and transition, and thresholds. This topic area ranked highest with educators and researchers, but was not considered important by managers who voted livestock production and vegetation measurements as the research areas where greatest accomplishments had been made (Table 1).

Table 1. The highest value (1 = highest value) topic areas of research, by category of respondent: educator, researcher, or manager. The question asked, What have been the most important accomplishments in range research over the past 10 years?

Response topic	Classification of respondent		
	Educator	Researcher	Manager
	ranking		
Successional models	1	1	—
Systems approaches	2	—	—
Invasive plants	3	—	4
Ecological sustainability	4	2	3
Grazing management	—	3	—
Restoration ecology	—	4	—
Livestock production	—	—	1
Vegetation measurement	—	—	2

2) **Systems approaches to management—**progress in ecosystem management and in whole watershed and landscape level management were considered important by educators.

3) **Invasive plants**—accomplishments in integrative management and control were noted by both educators and managers.

4) **Ecological sustainability**—answers in this category mostly dealt with both human and natural disturbance factors. Surprising, this politically correct item was among the top 4 answers for all of the 3 categories of respondents, but none ranked it number 1.

5) **Grazing management and restoration ecology**—intensive management, time control grazing and restoration of rangelands were often mentioned by researchers as being important accomplishments, but were not considered as important by educators and managers.

When asked "what are the most important problems in range research over the next 3 years?", all 3 categories of respondents felt that new practical ways to measure range vegetation were needed (Table 2). Systems approaches to management and livestock production were also important to 2 (educators and researchers) of the 3 groups of respondents. Other important problem areas that should be addressed included invasive species, ecological and economic sustainability, grazing and livestock production, and water quality issues.

When asked what would be the most important problem in range research 10 years from now, ecological and economic sustainability was considered very important by most respondents (Table 3). Problems with increasing urbanization and the need for social awareness were also considered important by 2 of the 3 groups. Managers placed high em-

Table 2. The highest priority (1 = highest priority) topic areas of research, by category of respondent: educator, researcher, or manager. The question asked, What are the most important problems for range researchers to address in the next 3 years?

Response topic	Classification of respondent		
	Educator	Researcher	Manager
	ranking		
Invasive weeds	1	—	—
Ecological sustainability	2	—	—
Vegetation measurements	3	1	1
Systems approaches	4	3	—
Grazing management	—	2	—
Livestock production	—	4	3
Water quality	—	—	2

Table 3. The highest priority topic areas of research, by category of respondent: educator, researcher, or manager. The question asked, What will be the most important problem for rangeland research 10 years from now?

Response topic	Classification of respondent		
	Educator	Researcher	Manager
	ranking		
Invasive weeds	1	—	—
Ecological sustainability	2	3	4
Economic sustainability	3	2	—
Biological diversity	4	—	—
Systems approaches	—	1	—
Urbanization	—	4	2
Water quality	—	—	1
Livestock production	—	—	3

Table 4. Categorization of either rangeland research accomplishments or short- and long-term needs as basic, applied or combined basic/applied research by category of respondent.

Question number	Respondent category	Classification		
		Basic	Applied	Combination
		%		
1	Educator	41	34	25
	Researcher	32	41	26
	Manager	3	68	29
	Weighted mean	32	42	26
2	Educator	26	45	29
	Researcher	21	50	29
	Manager	2	72	26
	Weighted mean	20	52	28
3	Educator	42	22	35
	Researcher	34	18	50
	Manager	4	70	22
	Weighted mean	30	32	38

phasis on water quality issues in both short- and long-term priority needs.

Of the 22 topic areas identified as priorities, 7 or 8 fit into the general category of human (social) sciences, while 12 to 14 may be more accurately termed as natural sciences. Sustainability and systems management share elements of both human and natural sciences. Among the most important accomplishments over the past 10 years, the only topic among the top 8 that includes a social component is that of systems approaches. In the near-term, economic sustainability joins systems approaches as a priority human science need. In the 10-year horizon, urbanization is added to economics and systems, thus illustrating an important perception among the SRM membership interviewed for this survey; that human sciences should have an increased presence on our research agenda.

Each category of respondent (educator, researcher, and manager) weighed into nearly all of the 22 priority topics identified in the survey. However, there tended to be greater agreement between educators and researchers about which topics were highest priority than between other groups. For past accomplishments, educators and researchers characterized basic, applied, and combined basic/applied research efforts as contributing about equally to the more important research findings over the past decade (Table 4). Managers found that applied investigations were more important, as expected.

There were no great surprises in the results from this survey. However, there are a few interpretations that deserve mention. First, while water quality and animal waste issues seem to be the prevailing environmental problems in disciplines throughout the agricultural sector, SRM members identified a much broader array of environmental problems requiring study; including biological diversity, ecological sustainability, and restoration ecology. Second, non-livestock uses of rangelands were perceived by many respondents as growing in importance; including identifiable topics such as land-use conflicts, wildlife, recreation, and urbanization. Finally, it should be noted that we tend to view applied research as appropriate for addressing short-term problems, but long-term issues will require investigations that combine basic and applied approaches.

In addition to the new emphasis on sustainability issues, our members have indicated a continuing need for research in areas we all know as core subjects, i.e., succession, measurements, and grazing management. Interviewees also pointed to some emerging areas of concern that are a result of modern society's impacts on and demands for rangeland resources; i.e., urbanization, water quality, and invasive species. Finally, we apparently all have come to the conclusion that systems approaches to management will address many of the ills of some past poor management.

[1]M. J. Trlica, Past Chair; D. L. Drawe, Chair; J. A. Young Chair Elect; and P. F. McCawley, Federal Research Agency Representative

Hawai‘i: The California Connection

Susan Edinger-Marshall

"2001: A Range Odyssey" is not merely a play on words from Stanley Kubrick's 1968 film classic "2001: A Space Odyssey," but the theme representing next year's journey to our 50th state for the Society for Range Management's 54th Annual Meetings. The theme of an odyssey, a long adventurous journey, speaks also to the historical connections between Hawai‘i and California. Before the Gold Rush of 1849 changed California and the rest of the world, there was arguably more commerce and communication between what would become the Golden State and the Aloha State than with the rest of the United States.

The Spanish explorer Cabrillo sailed to Alta California in 1542, but California's first Spanish mission at San Diego (1769), and first civil settlement at San Jose (1777), were established just prior to Captain Cook's first visit to the "Sandwich Islands" in 1778. The complex indigenous cultures of Hawai‘i and California each had a long history of natural resource management and use, and in each case, indigenous life and the environment was profoundly changed by European contact (see Maly and Wilcox, and Shlisky, this issue). European expansion also meant that global patterns of trade and development forged connections between Hawai‘i and California.

By 1800, the Hawaiian islands were rapidly becoming a favored stopping-over point for seafaring merchants transporting sea otter pelts from the Pacific Northwest to China in trade for spices and silk. King Kamehameha I, Ali'i (leader) of the Big Island of Hawai‘i, acquired a small schooner complete with arms and seamen in 1790 and began to consolidate his power throughout the islands. Asian goods were being traded for manufactured items from Europe and its colonies. Reportedly, the hunger for foreign manufactures among Hawaii's aristocracy led to the depletion of Hawaii's sandalwood forests, as the wood was used for trade (see Erdman et al. this issue). Demand for salt beef and other island products that could be sold to pay back foreign debt grew rapidly in the 1820's.

The salt beef industry stemmed from a California connection. British Captain George Vancouver brought five cows, two ewes, and one ram from Monterey (Alta California) as a gift to King Kamehameha on the sloop *HMS Discovery* in 1793. As some of the animals died *en route*, Vancouver brought more livestock from near Santa Barbara about a year later. Kamehameha I let the livestock run and placed a ten-year taboo on killing cattle on pain of death. The King was reportedly less impressed by the first horses to arrive, brought in by American Captain Richard J. Cleveland aboard the brig *Leila Byrd* from near San Quentin, Alta California, and San Borgia in Baja California in 1803.

As the herds grew in unchecked numbers, the interchange of people between Hawai‘i and other parts of the world also grew. Hawaiians gained a solid reputation as sailors in the fur trade and were eagerly sought by sea captains. In 1811, 23 Hawaiians left on the *Tonquin* for three years' work for the Pacific Fur Company out of Astoria. Captain John Sutter (on whose California property gold was discovered in 1848) left Honolulu in 1839 with eight Hawaiian men and two women to help build his agricultural empire in Alta California. Richard Henry Dana, Jr. wrote of several months spent curing cowhides with the Kanakas (native Hawaiians) at San Diego and San Pedro in 1835, in his classic narrative of pre-gold California "Two Years Before the Mast." So many native sailors left, usually in close-knit social groups, that in 1841 a law was passed forbidding captains of foreign vessels from taking Hawaiian sailors from Hawai‘i without permission from the island governor, and a $200 bond for their safe return within two years (Figure 1). Edward Vischer, a Bavarian merchant, wrote of Kanaka sailors in 1842 while aboard the schooner *California*: "They row uniformly, steadily, and untiringly, and are extremely dexterous in bringing a sloop safely and undamaged through breakers which no European would dare to cross." By 1844, 300 to 400 islanders worked for the Hudson's Bay Company along the Columbia River. In 1847, 40 Hawaiians made up about 10% of San Francisco's pre-Gold Rush population.

Fig.1. ***Two Hawaiian men in a canoe, ca 1890. Courtesy of The Bishop Museum.***

The 1820's marked the arrival of both Christian missionaries to

the islands and New England whalers, with continued visits for re-supply, ship repair, and recreation from other seafaring merchants. James Michener's popular novel "Hawai'i," and the 1966 movie starring Julie Andrews and Max Von Sydow, depict the conflict between the missionaries and visiting sailors who had varying interpretations of what kind of "paradise" was to be found in the islands. California's first printing press was originally shipped to Hawai'i to publish the secular views of merchants and traders to counter negative reports from missionaries stationed in Honolulu. The press arrived in Monterey, California, in 1833 aboard the *Lagoda* and was used in California to print government documents (Mexican), school books and later California's first newspaper, the *Californian*, as well as the Sacramento *Placer Times*, the Stockton *Times* and the Sonora *Herald.*

Meanwhile, "back at the ranch," wild livestock populations were getting so numerous on the slopes of Mauna Kea that in 1832 King Kamehameha III sent a royal emissary to California to bring back Mexican, Indian and Spanish vaqueros to teach Hawaiians how to control the wild beasts. These first cowboys, surnamed Kossuth, Louzeida, and Ramon, were the first recorded "paniolos" in Hawai'i (see Starrs, this issue). The origin of paniolo is generally considered to derive from Espanol (Spaniard), or Hispaniola (the Caribbean colony), but other suggested origins include panuelo (Spanish for handkerchief) or even Hawaiian terms meaning "hold firmly and sway gracefully." John Palmer Parker, Kamehameha's official bullock hunter from New England, started his cattle ranch on leased royal land near Mauna Kea in 1837, but didn't obtain title to a small parcel near Waimea until 1847, after the introduction of a land policy often referred to as the "Great Mahele."

This land disposal program (1845) apportioned land formerly held by the monarch to commoners, but resulted in foreign ownership of much of Hawai'i and the eventual demise of Hawaiian sovereignty. The stories of foreign-owned sugar and pineapple plantations (see Dinstell, this issue), importation of

Fig. 2. ***Loading cattle, Kawaihae, ca 1920's–1930's. Courtesy of Bishop Museum.***

Chinese and Japanese laborers, the overthrow of the last Hawaiian monarch Queen Liliuokalani in 1894, transpacific air races, the role of Pearl Harbor and World War II, statehood, and the development of the tourism industry are beyond the scope of this article, but are fascinating historical events in their own right.

What traces of the early odysseys between Hawai'i, California and the rest of the world remain? Global trade in manufactured goods and information no longer relies completely on a safe seaport in the middle of the Pacific Ocean. The sandalwood was depleted, silk was replaced by rayon or polyester, and the whaling industry was harpooned permanently by exploitation of petroleum resources (with much of the whaling fleet being destroyed shortly after the American Civil War). Missionaries still wander over the globe, increasingly via satellite transmission. But what of the paniolos?

One of the most notable and poignant odysseys of the Hawaiian paniolo was organized by Eben "Rawhide Ben" Low, a rodeo champ from the Parker Ranch. He arranged a trip to the 1908 Frontier Days in Cheyenne, Wyoming accompanied by his brother John, half-brother Archie Kaaua, and cousin Ikua Purdy. These paniolos had learned to rope half wild beasts while galloping across flesh-slicing lava fields and driving cattle through shark-infested waters out to boats for eventual shipment out of Honolulu (Figure 2). Ikua thrilled the crowds and took the World Championship in roping, and Archie took second place. Paniolos have been written of and visited by Mark Twain, Will Rogers, and other famous western figures. As with the icons of the buckaroo/vaquero, and the cowboy, the paniolo is increasingly revered as a keeper of culture, language and skills from times past. They wear traditional flowers as leis and hatbands and have a rich musical tradition. Speaking of musical traditions, have you ever thought about what the initials in the commercial jingle for "C&H Pure Cane Sugar from Hawai'i" stand for?

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The Hawaiian Island Environment

Ayn Shlisky

Paradise: the universal vision we have of Hawai'i. Hawai'i's habitats are diverse, unique, and lovely—a land of flowing red-hot lava, and at the same time, delicate pastel orchids. Yet the Hawai'i of today is much changed from that discovered by the Polynesians, or more than 1,000 years later, by Captain Cook. Over time, Hawai'i has been discovered and re-discovered by different groups of people of widely varied goals and aspirations. Partly because of this, the introduction of exotic species, an important concern to range managers worldwide, is one major challenge to rangeland and ecosystem management and conservation in Hawai'i.

The Hawaiian Ecosystem

Geologic evolution, tropical climate, and island isolation underlie the diversity and distribution of island vegetation (Hubbell 1968, Sohmer and Gustafson 1987). The eight islands considered within the State of Hawai'i are those between 19° N to 22° N latitude, although the entire Hawaiian Island chain follows a 1,600 mile arc from 9° N to 28° N latitude. Some islands rise to more than 32,000 ft, but the oldest island of the chain is low-lying Kure Atoll to the northwest, and the youngest, Loihi, is still below sea level, to the southeast.

Island ages range from over 75 million years to less than 500,000 years (Clague and Dalrymple 1989, Walker 1990). Erosion increases from east to west with island age, as evidenced by the contrast between deeply incised Waimea Canyon on Kaua'i, and the slightly eroded lava beds of Mauna Loa and Mauna Kea on Hawai'i. This progressive aging has been largely attributed to the hypothesis, first proposed by Wilson (1963), that the Hawaiian Islands are formed by the movement of the sea floor (Pacific plate) over sources of lava called "the Hawaiian hot spot". Each island is the result of accumulations of successive volcanic eruptions at the Hawaiian hot spot. The older volcanoes have been transported from the Hawaiian hot spot to the northwest by plate movement. Through time, they erode and subside to become a mere pinnacle of rock, then an atoll of accumulated coral, and finally a submerged guyot (flat, reef-capped volcano) (Normark et al. 1982). Only volcanoes of Hawai'i and Loihi are still active.

Nowhere else in the United States are rainfall gradients so steep. Annual rainfall averages 70 inches, but ranges from 5 to 470 (Blumenstock and Price 1972, McNab and Avers 1994). The highest annual rainfall is on the eastern, windward sides or crests of mountains, where almost year-round trade winds shed most of their moisture. The driest areas are the upper slopes of high mountains, where a trade wind inversion tends to suppress vertical lifting of air, or in leeward positions at the coast or inland. Winter cold fronts moving in from the northwest may infrequently travel far enough south to drop snow on the upper slopes of Haleakala (Maui), Mauna Loa and Mauna Kea (Hawai'i).

Geographic isolation is another important factor influencing Hawaiian plant and ecosystem diversity. The nearest continent, North America, is 2,300 miles away, while Japan, Australia and the Philippines are 2,500, 4,000 and 5,300 miles away, respectively. Never linked geographically with continental land (Carlquist 1982), the isolation of Hawai'i dictates that, before human ar-

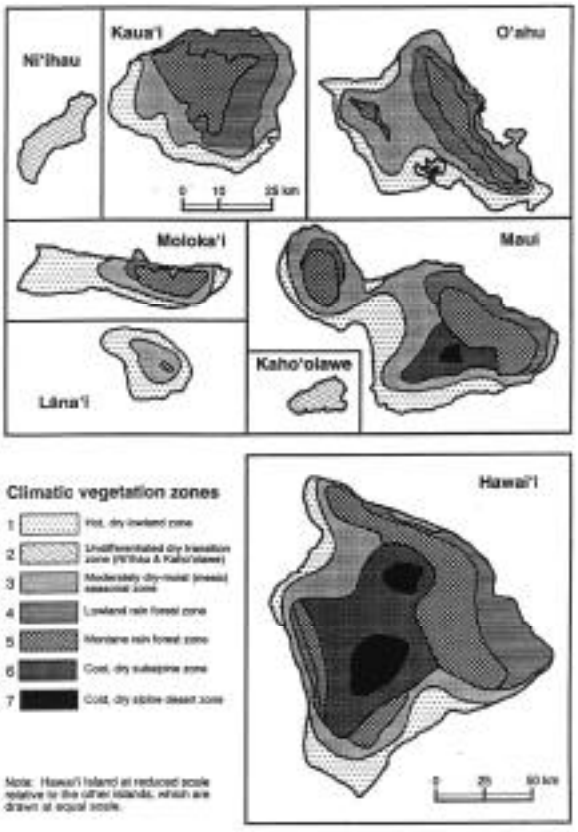

Fig. 1. ***Climatic vegetation zones of the eight main Hawaiian Islands (from Mueller Dombois and Fosbert 1998 with permis - sion from Springer-Verlag).***

rival, only species capable of long-distance dispersal, and pre-adapted to tropical climates, could become established. Major agents of dispersal for Hawaiian plant species are migratory birds (Carlquist 1982), led to the islands by chance or storm movements. Air and water currents also disperse plants, but are less important due to distance and the amount of non-coastal habitat in Hawai‘i. The largest proportion of native plants are related to plants in tropical Asia and Indonesia, and more than 20 percent to plants of North and South America (Carlquist 1982).

Once established, isolation and high habitat diversity favors speciation, as evidenced by the high degree of endemism in the Hawaiian Islands. The Islands contain 960 flowering plants and 168 ferns and fern allies (Wagner et al. 1990). Endemism within the Islands is estimated to be between 86 and 96 percent (Mueller-Dombois 1975, Mueller-Dombois and Fosberg 1998). Conversely, the small size of island land masses supports small populations, increasing extinction rates (MacArthur and Wilson 1967), and reducing resilience to disturbance (Loope and Mueller-Dombois 1989).

Plant Communities

Humans have altered the Hawaiian landscape. Nonetheless, island habitats remain highly diverse, and so are the plant communities that occupy them (Figure 1). The Hawai‘i Natural Heritage Program recognizes 150 distinct natural community types, including aquatic and subterranean types like caves. Most communities can be classified into nine broad types: tropical coastal vegetation, lowland grasslands and savanna, montane moist forests, lowland rain forest, montane wet forests and bogs, subalpine vegetation, alpine vegetation, and montane dry forests (McNab and Avers 1994).

Coasts are rimmed by coral sand beaches and associated strand vegetation (Figure 2). Leeward slopes, mostly below 1500 m, are dry, and were formerly covered by dry grassland, or open forest/woodland of predominantly broad schlerophyll trees, such as *Metrosideros polymorpha* (locally known as ‘ohi’a lehua) or *Diospyros sandwicensis* (Figure 1, zones 1 and 2). Hawai‘i’s northwestern side at Pu’u Wa’a Wa’a contains a notable remnant of this type (Mueller-Dombois and Fosberg 1998). Between the dry leeward and wet windward climates, montane moist forests once dominated, but today most of this type has been converted to other uses (Figure 1, zone 3). This type is either dominated by *lehua*, the Polynesian-introduced kukui nut tree (*Aleurites moluccana*), or a mix of *lehua* and the non-native *Myrica faya*, or *Acacia koa* (koa).

Fig. 2. ***Waipo Valley, Hawai’i, on the northeastern coast. Courtesy of Paul F. Starrs.***

Native lowland rain forests occupy windward low elevations, and are dominated by open forests of *lehua* (Figure 1, zone 4). Much has also been converted to other uses (e.g., development, agriculture), and like other vegetation types in Hawai‘i, has been invaded by introduced species, including *Casuarina equisetifolia* and *Paraserianthes falcataria.* These lowland rainforests include the conspicuous stoloniferous fern mats of the native false staghorn fern (*Dicranopteris linearis*), which usually indicate either advanced primary succes-

sion, or a breakdown stage of *lehua* forest (Mueller-Dombois and Fosberg 1998). Above these lowland rainforests lie tropical montane cloud forests, which as their name suggests, are enveloped with clouds at least part of the day. Similar to lowland rainforests, they are dominated by *lehua* in addition to *Cheirodendron trigynum*, although they differ in that they receive a large amount of additional precipitation as fog drip, contributing to their mossy character. Montane bogs mostly occur as rain forest openings, and are dominated by a mixture of sedges and grasses. Above 5,900 ft in the high elevations of Hawai'i and Maui, where conditions are relatively dry, and snow sometimes falls (Figure 1, zones 6 and 7), are found subalpine and alpine vegetation; either mountain parkland, schlerophyll scrub, *Chenopodium* scrub, or tussock grassland. Despite elevation and ruggedness, historic overgrazing by feral and domestic sheep and goats has contributed to exotic plant invasions and drastic composition changes (Mueller-Dombois and Fosberg 1998).

Island age, because it is linked to soil properties and topographical relief, in part determines the suite of species established on any particular island. There is a correlation between substrate age and soil moisture regime in mid-elevation rain forests, where soil water regimes tend to change from xeric to hydromorphic through time (Mueller-Dombois 1975). Tied to generally increasing soil moisture regimes from the younger island of Hawai'i toward the older island of Oahu is a decrease in range of the common forest tree *lehua*. Dieback of *lehua* on wet sites on the islands of Maui and Hawai'i have been attributed in part to this species' inability to adapt to aging soils (Mueller-Dombois and Fosberg 1998). Island age also determines its relative degree of erosion and its unique topography. For example, species such as *Cryptocarya mannii* and *Elaeocarpus bifidus* occur only in the mixed mesophytic forests on Kaua'i and Oahu (Sohmer and Gustafson 1987).

The past 200 years have witnessed drastic changes to native Hawaiian ecosystems. On the heels of European contact in the late 18th century, the introduction of large grazing and browsing mammals (some of which have become destructive feral populations), the exploitation of lowland forests for sandalwood (*Santalum* spp.), land clearing for agriculture (especially sugarcane) and development, koa logging, and the conversion of upland forests into cattle ranches (Cuddihy and Stone 1994, Mueller-Dombois and Fosberg 1998) have left few island ecosystems in their native state. The introduction of non-native plant species and the extinction of many native and endemic species have been two of the most significant results of these activities.

Of course a detailed account of all of the ecological issues facing Hawai'i today cannot be covered here, but introduced plant species and feral pigs are two of particular concern to range managers and scientists.

...overgrazing by large feral populations of grazing animals in the late 18th century caused invasion by non-native shrub species...

Exotic Species

Many ecological relationships on islands involve the interaction between native and exotic species. Greater than 8,000 plant species have been introduced (Yee and Gagne 1992), mostly within the last 200 years (Mueller-Dombois 1975). Of these, about 11 percent now have reproducing populations (Wagner et al. 1990), and at least 86 of these species pose threats to native ecosystems (Smith 1985). Smith (1985) lists 13 species, five of which are grasses, as some of the worst weeds, including *Myrica faya*, *Psidium cattleianum*, *Andropogon virginicus*, *Schizachyrium condensatum*, *Melinis minutiflora*, *Pennisetum clandestinum*, and *P. setaceum*. Some are so competitive that they can convert native forest to single-species stands, particularly after disturbances such as a hurricane or 'ohi'a *lehua* dieback. Others can alter natural processes such as nutrient cycling, sometimes facilitating the invasion of other non-native species (Vitousek 1986, Vitousek and Walker 1989).

In dry and mesic vegetation, alien grass establishment has increased fire frequency to a degree deleterious to native plants (Cuddihy and Stone 1994). The eastern North American grass *Andropogon virginicus* has spread across denuded lowland rain forest habitats on windward Oahu, now forming the dominant herbaceous cover. In addition to displacement of native species, this fire-adapted bunchgrass accumulates dead standing foliage, within a few years forming a straw-like mulch that prevents evapotranspiration from the soil surface during winter months when excess water is a problem (Mueller-Dombois 1975). Consequently, this habitat now shows more erosion and runoff than forested sites where evapotranspiration is considerably greater. In dry forest on the leeward slopes of Maui, African kikuyu grass (*Pennisetum clandestinum*) was introduced by ranchers for its forage value. The thick mat-forming habit of this grass inhibits native tree regeneration. On Oahu, overgrazing by large feral populations of grazing animals in the late 18th century caused invasion by non-native shrub species, such as *Prosopsis pallida*, *Acacia farnesiana, Lantana camara*, and *Opuntia ficus-indica*, which today make up their own community types within the dry lowlands (Mueller-Dombois and Fosberg 1998).

During the 1960's through 1980s, the montane moist forest once dominated by open *lehua* was invaded by *Myrica faya* from the Macronesian Islands. *Myrica faya* is a nitrogen-fixing tree, and its invasion not only increases forest density, but also causes nitrogen accumulation. The nitrogen is used by the Myrica trees themselves, allowing them to displace at least partially, *lehua* (Walker and Vitousek 1991). Effects of exotic species, in addition to community type and land use changes, contribute to ongoing species extinctions, with nearly a quarter of native plants proposed or listed as threatened or endangered (McNab and Avers 1994).

Feral Pigs

European feral pigs have had substantial effects on Hawaiian rain forests and

other ecosystems. In addition to eating common foods such as tree-fern trunks, strawberry guava fruits (*Psidium cattleianum*), and earthworms, pigs seek out certain now rare plant species for food (Loope 1998). Plants with fragile stems and leaves have drastically declined. Pigs also are dispersal agents for non-native plant species. They carry seed on their coats or in their digestive tracts, depositing it on the exposed mineral soil of the forest floor where germination is favored, often resulting in understory thickets of strawberry guava (Loope 1998, Mueller-Dombois and Fosberg 1998).

The isolation, tropical location, and beauty of the Hawaiian Islands have resulted in their uniqueness, but also contributed to their degradation. Few remnants of natural vegetation are left in the coastal and lowland areas, where resorts follow the ocean beaches, and agriculture or ranching claims arable and grazable lands. More than 75 percent of the recognized plant community types remaining in these areas are considered rare (Cuddihy and Stone 1994). Though less disturbed, montane and subalpine areas have not escaped the effects of development and non-native plant species invasions. Areas still covered with native vegetation can be found in forest reserves, the State Natural Area Reserve System, a State Wilderness Preserve, the National Park, and Nature Conservancy Preserves. While The Nature Conservancy continues to identify lands that contain unprotected ecosystem types, it will take a coordinated effort of increased preservation of unprotected sites, conservation of existing native ecosystems, restoration of degraded sites, and recovery of threatened and endangered species to ensure that Hawai'i's unique ecosystems and natural processes are not lost forever.

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A Short History of Cattle and Range Management in Hawai‘i

Kepa Maly and Bruce A. Wilcox

The introduction of cattle along with other grazing stock has significantly influenced the natural and cultural ecology of Hawai‘i. A tropical insular ecosystem with a particularly unique natural and cultural history, this influence has been perhaps more ecologically profound in Hawai‘i than is typical. Alteration of the landscape and cultural practices that followed the introduction and expansion of cattle in the 19th Century were nonetheless accommodated by the existing indigenous system of natural resource values and management practices. Ranching persisted as a viable industry, an accepted part of land and natural resources management, and an integral element of Hawaii's rich cultural landscape throughout most of the present century. Yet range management practice based on these indigenous values and practices has begun to be displaced by changes in ranch ownership or management practices during the last three decades. As a consequence of this, and the current drought, it appears the ecological sustainability and economic viability of cattle ranching may be going the way of the cultural legacy of the paniolo (or *paniola*) and the traditional knowledge and practices were the underpinning of the industry until recently.

Traditional Polynesian and Western Resource Management: Conflict and Assimilation

In pre-western contact Hawai‘i, all land and natural resources were held in trust by the high chiefs (*ali‘i ‘ai ahupua‘a* or *ali‘i ‘ai moku*). The rights of use of the lands and resources were given to the *hoa‘aina* (native tenants), at the prerogative of the *ali‘i* and their representatives. Boundaries of lands were defined, and individuals living within given *ahupua‘a* (native land divisions, usually extending from the sea to the mountains) were responsible for the wise use of the resources within their home land. The thought shared among many *kupuna* (elders) and Hawaiian people today—*E malama i ka ‘aina, a e malama ho‘i ka ‘aina ia ‘oe* (care for the land, and the land, in turn, shall care for you), is one that is centuries old and is rooted in the spirituality of the Hawaiian people.

Upon western contact, a largely new perspective on Hawaiian land was introduced—that of its value for extractable-exportable resources—first as a source of provision for ships; and second as source of trade items, such as *‘iliahi* (sandalwood). In 1778, European boars, goats, rams, and ewes were introduced by Captain Cook. Offered as "gifts," a motivating factor was to leave a breeding stock to supply other foreign ships (Beaglehole 1967:276, 578-579). Later, in 1793, cattle were brought to Hawai‘i by Captain Vancouver (Vancouver 1967). Given as gifts to Kamehameha I, the cattle were first let off at Kawaihae (then at Kealakekua), and were placed under a ten-year *kapu* to protect them and allow them to reproduce (Kamakau 1961:164). Between 1793 and 1811, new stock were added, and the numbers of cattle increased dramatically. Cattle and other introduced stock were rapidly becoming a problem to the native population and upland forests. Prior to this, a well-developed indigenous agriculture system (the most advanced in Polynesia), supporting an impressively large human population, had already altered the landscape through the cutting and burning of forest for crops, and the gathering of wood for fuel. Locally this affected micro-climates, erosion, and soil moisture at the lower elevations long before European contact (Cuddihy and Stone 1990). Yet the islands' upland forests remained largely intact.

By the 1830s, however, the upland forests had been stripped of sandalwood and the land began to show signs of significant impacts due to overgrazing and trampling, as well as the clearing made for collection and transportation of the *‘iliahi*. By the 1840s, free roaming cattle, sheep, and goats were having such a severe impact on the native dwellings (e.g., eating thatched houses) and consuming the produce of the agricultural fields, that most of the families who remained upon the land built stone walls around their residence and gardens (cf. Land Commission Award Testimonies, 1848–1850). The "*pa hale*" (house lots enclosed with walls or fences) are recorded in many of the Land Commission Awards. Reverend Lorenzo Lyons noted that by 1847, "two thirds of Waimea has been converted to government pasture" (Doyle 1953:48). He wrote:

> People are compelled to leave their cultivated spots and seek distant corners of the woods beyond the reach of the roaming cattle sheep and goats. But the cattle follow, and soon destroy the fruit of their labor. There is a despairing spirit among my people, and great suffering among them...

Lyons also noted that the forests and weather had changed over the years of his residence (since 1832 till his death in 1886). The once famous gale-force "*mumuku*" winds which blew down the plains towards the ocean did not blow as frequently:

> Waimea of an evening is a perfect cloud of dust. The soil is remarkably dry, and so extremely fine that water does not even seem to wet it…Cattle destroying the forest has changed the *mumuku*. It was formerly so strong that natives always lashed canoes to the rocks, stakes, or trees at Kawaihae (Doyle 1953:49).

That the free roaming cattle were having an impact not only on the cultivated lands of the native tenants, but also on

Fig. 1. ***Pu'u O'o Ranch House ca. 1898, Mauna Kea Slopes, Hawai'i . Note the native timber—primarily mamane—cut for fencing, contributing to demise of forest. Courtesy of Toshio Imoto.***

the remaining forests (Figure 1) was documented in 1856 by Kingdom land surveyor, Curtis Lyons, son of Reverend Lyons as well:

> It is in the memory of many foreigners now living here, when the whole of these plains were covered with thick wood... Where hardly a tree is to be seen for miles, we were informed by an old resident that twenty-five years ago he lost himself with his team in the woods (Lyons in Forbes 1991:54).

The younger Lyons also remarked that there was far more rain at Waimea than there is now.

By the second half of the 19th Century, Hawaii's the *ahupua'a* land management system had collapsed due to a combination of factors—the redistribution of land control as part of the Great Mahele and the decimation of the indigenous population by smallpox being the chief causes—though land stewardship remained an important cultural value. In an attempt to address the by now devastating impact of livestock, on September 19, 1876, King David Kalakaua signed into law, the "Act for the Protection and Preservation of Woods and Forests". This act authorized the Minister of the Interior to set apart and protect from "damage by trespass of animals or otherwise, such woods and forest lands, the property of government…best suited for the protection of water resources…" (Hawaii Laws Chapter XXX:39). The Minister of the Interior was authorized to appoint a superintendent of woods and forests.

The Act was further defined by the Legislature of the Hawaiian Kingdom, approved by Queen Lili'uokalani on January 4, 1893, establishing the Bureau of Agriculture and Forestry, which was absorbed by the Board of Commissioners of Agriculture and Forestry in 1900. (Hawaii State Archives—Com 2, Box 11). By this time, one far thinking commissioner (Boyd 1901), recognized and described the critical function of upland forest reserves as watershed, and the role of livestock in destruction of native forest via a cascade of ecological changes beginning with loss of understory vegetation and soil moisture, and ending with the invasion of aggressive non-native vines and grasses that "choke out" and prevent regeneration of the native ecosystem. Since then the impact of cattle and other non-native ungulates on native forest has been widely documented (Cuddihy and Stone 1990).

The Rise and Fall of Range Management and Ranching

The first attempts to control cattle herds began in 1815 when Kamehameha I hired foreigners to work the animals (Barrera and Kelly 1974:44). By 1830 Kamehameha III had *vaqueros* (Mexican-Spanish cow hands) brought to the islands to teach the Hawaiians the skills of herding and handling cattle (Strazar 1987:20; and Kuykendall and Day 1961:96). The *vaqueros* found the Hawaiians to be capable students, and by the 1870s, the Hawaiian cowboy came to be known as the "*paniola*" for the *Espanola* (Spanish) *vaqueros* who had been brought to the islands.

During the period leading up to the late 1850s, nearly all of the cattle belonged either to the King, the government, other chiefs close to the King, and a few foreigners who had been granted the right to handle the cattle (cf. Henke 1929:19–20). By 1851 there were around 20,000 cattle on the island of Hawai'i, and approximately 12,000 of them were wild (Henke 1929:22). With the development of ranching throughout the rest of the 19th Century and well into the 20th Century, the proportion of cattle in managed herds gradually grew while wild cattle declined, although some still persist today. However, many ranching operations continued clearing of upland native forest, particularly on Hawai'i and West Maui where ranches expand rangeland tens of thousands of acres upslope (Cuddihy and Stone 1990).

Though not without significant and

Fig 2. ***Ranch House on the northeastern slope of Mauna Kea, Hawai'i. Note the pasture land in the foreground, and remnant native forest in background, ca. 1920. Photo No. 1019, Courtesy of the Hawaiian Historical Society.***

continued impacts and assault on native forest and forest reserves, by mid-Century it might be said that Hawai'i had come to terms with cattle ranching, in the sense that range management practices were in place and had become part of the ranching and *paniolo* culture that incorporated stewardship values (Figure 2). As ranching evolved, so had a *paniolo* culture, which integrated many native Hawaiian elements, as is evident today from song and legend. This included a concern and respect for the land by *paniolo*, who managed the cattle in long grazing rotations.

By the 1960s to 70s, however, even these "neo-traditional" values and practices began breaking down with significant changes in ranch ownership and management practices. Some of Hawaii's ranches were bought-out by non-residents and large corporations whose owners had no connection to the land and sought to maximize short term profits. Until this time ranchers managed their herds according to a predictable seasonal rain and long term rotations. According to long time ranch managers and *paniolos* (personally communicated to Maly and whose commentaries are documented in detailed oral histories in various archives) these ranch management changes coincided with or brought about marked changes in climate, herd management, and culture. It became dryer and rainfall less predictable. Rotation periods were drastically shortened, and herd management less intensive. Most unfortunately, the *paniolo* culture declined, and with it, a knowledge of traditional management practices and an understanding range conservation presently all but lost from most operations throughout the Hawaiian Islands.

With the current "official" drought in its third or forth year, the effects of this gradual transition in ownership, management, weather, and culture have become more abundantly clear. Even the historically most successful cattle operations, such as the Parker Ranch, have significantly reduced herd size and are in a precarious economic position. Meanwhile, one of the other large historic operations, Molokai Ranch, whose once extensive dry forest covered slopes have given way to virtually bare ground and extensive gully erosion, has transitioned to the "eco-adventure tourism" business. Glossy brochures feature photos of happy tourist families astride mountain bikes with red dirt covered hills in the background. Somehow, in this burgeoning era of high tech outdoor equipment and adventure escapism, clever marketing has been able to transform an ecological calamity (at least from the authors' perspective) into a mountain biker's paradise.

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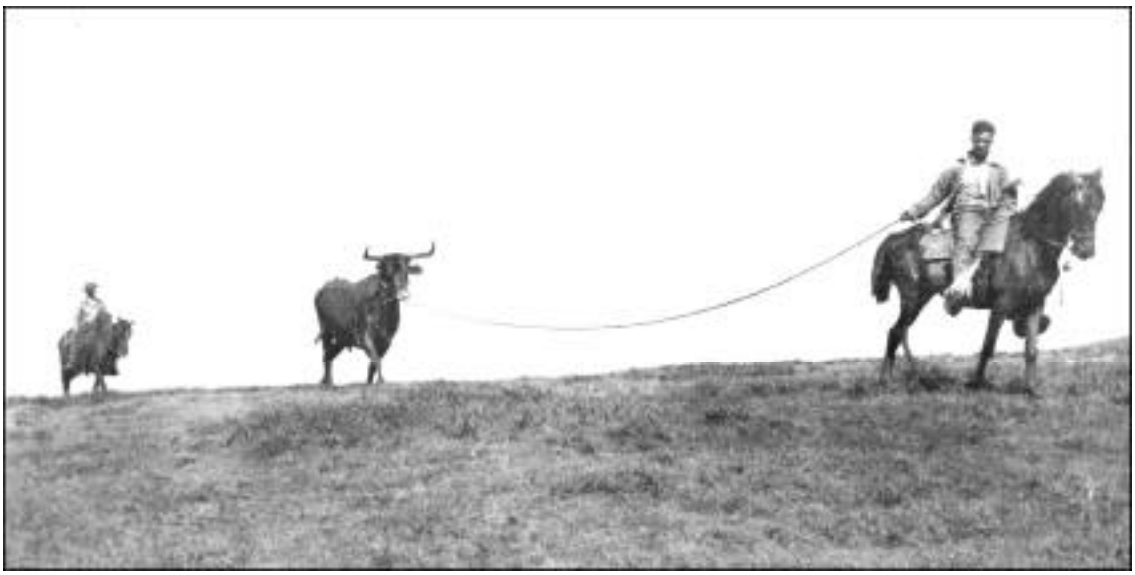

Fig. 1. ***Wild cattle were moved with some care and long leads. Courtesy of the Bishop Museum, Henriques Collection.***

The Millennial Hawaiian Paniolo

Paul F. Starrs

Across the American West, for 150 years, the number of real working ranch hands has in truth been anything but large. When a million miners thronged through 1850s California, fewer than ten thousand or so cowhands (many of them Native American, Hispanic, or black) were working from Missouri to the Pacific. But the western ranch hand has assumed a symbolic prominence far out of proportion to actual numbers. Ranching was a force for change, part of a striving economy, and something novel upon the land (Starrs 1998). Into this neatly fits the Hawaiian cowboy, or paniolo, the wild Hawaiian country, and, of course, pua'a pipi, the beef provender they provided. And yet, more folks are today familiar with the ukulele, the lei, or the lilting notes of Hawaiian song than are knowledgeable about the origins and significance of ranching done the Hawaiian way.

Everyone conveniently recollects that Pilgrims were the earliest Europeans to settle the North American continent. That "fact" is about as predictably wrong as it is ethnocentric; in Santa Fe, New Mexico, was a thriving Hispanic community and a finely formed full-on city a resolute thirty years before the English Pilgrims even thought to set sail for Plymouth. Inconvenient facts are swiftly forgotten. Among the most elusive details, even for aficionados of western Americana, is how early among ranch hands the Hawaiian paniolo really ranks. Paniolos were close descendents of the California vaqueros; the word for Spaniard, Español, became in its Hawaiian rendering "paniolo," just as "vaquero," in the parlance of Nevada and California, became "buckaroo" (Starrs and Huntsinger 1998).

Origins

The American West, even in the mid-1800s, was part of a great and reaching empire that could be said to stretch to the mid-Pacific Ocean (Meinig 1993). In 1803, the horse arrived shipboard to Hawai‘i, brought in an attempt to permit Hawaiians to travel their rugged backcountry swiftly and safely. Cattle came to the Islands still earlier, in 1793, as a gift to Kamehameha I, the king who had, despite some odds, mostly unified the Hawaiian Islands under a single sovereign. Cattle were immediately called pua'a pipi—literally, "beef pigs." The name made perfect sense; the pig was the domesticated animal that had traveled with Polynesians for weeks on great ocean-going canoes that originally populated the islands. The King took receipt with pleasure, if also with a measure of nervous anticipation, as contemporary traveler Thomas Manby would write in 1793 (Manby 1959):

> The cattle greatly delighted [the King], though it took some time to quiet his fears lest they should bite him. He called them large hogs, and after much persuasion we prevailed on him to go close up to them; at that instant one of the poor animals, turning its head around quickly, so alarmed his majesty that he made a speedy retreat and ran over half his retinue. His fright was not of long duration and ceased on seeing some of his attendants take them by the horns. ...The four cows were in tolerable condition and had got very tame by being on board. The concourse of people to see them landed was immense; we were a good deal diverted at seeing the terror the whole village was thrown into by

> one of the cows galloping along the beach and kicking up her heels. (24–25)

Cattle numbers increased at close to the biological maximum. Two of the first cows were pregnant; three bulls were brought the following year, in 1794 (Brennan 1974, 30). King Kamehameha I had immediately imposed a kapu, the Hawaiian word for taboo, on killing the livestock for a decade after arrival; the penalty for even injuring an animal was death (Manby 1959; Strazar 1987; Bryan and Brakha 2000). Captain George Vancouver did report in his journal having asked for such strict protection: "the king alone...could appropriate a certain number of the [bull cattle] to his table; but [we asked] that in doing so the women should not be precluded partaking of them, as the intention of [the cattle] being brought to the island was for the general use and benefit of every inhabitant of both sexes, as soon as their general numbers should be sufficiently increased to allow for a general distribution amongst the people" (Vancouver, quoted in Brennan 1974).

In terms of timing, 1793 was four decades before The Alamo, a generous eighty years before the great cattle drives along the Chisolm and other trails, and fully 140-plus years before the Taylor Grazing Act. By no small stretch of the clock, the Hawaiian cowboy, or paniolo, predates the Texas and Great Plains range rider; only the California buckaroo has a like age. Cattle eventually became a significant trade product of the 19th century Islands. It is no accident that, in the era before statehood when Hawai'i had its own currency, the fifty dollar bill was decorated with a ranching scene (Bryan and Brakha 2000).

Through these early years, the Hawaiian cattle were of undistinguished breed: long horned and fast-moving criollos of formidable temper and Alta California origin, they roamed the often-dense forests and dined on the native rangelands with impunity (Figure 1). "By 1813, twenty years after being introduced, the animals had so multiplied that they had become a nuisance, devouring and trampling the natives' crops of potatoes, ravishing their taro patches, and in short, raising havoc with whatever was planted" (Brennan 1974, 45). Five to ten years old when caught, some animals could top 1000 pounds—perhaps trifling by modern animal science standards, but how many of us have come face to face with a wild cow or bull five feet tall at the shoulder and with horns that spanned four feet?

Paniolo Arrivals

Nemesis of these rampaging animals would be the paniolo. Like much else in Hawai'i, the Hawaiian cowboy's origins were on the mainland, imported from Spanish and Mexican Alta California (Lyons 1892). Before long, though, more and more paniolos were home-grown on the Hawaiian islands. At first in the employ of the King, by the 1850s paniolos would begin moving to ranches being established throughout the islands as part of the great mahele, a disamortization of property removing it as an exclusive domain of Hawaiian royalty to become instead land a larger public might obtain and own (Chinen 1958, Juvik and Juvik 1998, Bryan and Brakha 2000). With land ready to be made into ranches, cattle to be had at low cost, skilled workers available, and a ravenous market for whatever beef and hides the islands could supply, the cattle business boomed (Wellmon 1973).

As a crowd, paniolos were rawhide tough, descendents in technique and heritage of the Spanish vaqueros (Figure 2). Francis Olmsted, a visitor in the 1840s, set the scene:

> Immediately back of these, a group of fine-looking men, in a peculiar costume, were leaning against the counter of the store. Some of them were Spaniards from California, and they were all attired in the poncho, an oblong blanket of various brilliant colors, having a hole in the middle through which the head is thrust. The pantaloons are open from the knee downwards on the outside, with a row of dashing gilt buttons along the outside seam. A pair of boots armed with prodigiously long spurs complete their costume. They were "bullock hunters," employed in capturing the wild bullocks that roam the mountains, and had just returned from an expedition of eight or ten days, in which they had been very successful. (1959, 78–79)

Not only was a distinctive look established, so too was an actual functioning technique. It was a straight distillation from California tradition, and none of it was for the faint of heart:

Fig. 2. ***Photograph of Kaholuamanu Riders and Francis Gay, in full paniolo regalia, Kaua'i, circa 1900. Courtesy of The Bishop Museum, Honolulu, Gartley Collection.***

> Great numbers of wild bullocks are caught in the mountains every year by the hunters. The lasso, the principal instrument in their capture, is made of braided thongs, upon one end of which is a ring forming a slip noose, which is thrown with astonishing precision around any part of the animal. Even while at full gallop in pursuit, the hunter grasps his lasso, and giving it two or three twirls around his head with the right hand throws it unerringly and entangles his victim by the horns or limbs. And now, be wary for thy life, bold hunter; for the savage animal is maddened with terror. See, he turns upon his pursuer, with eyeballs glaring with fire and his frame quivering with rage. But the well-trained horse springs to one side, and braces himself, while the unwieldy animal plunges forward, but is suddenly brought up by the lasso, and falls with a heavy momentum on the ground. (Olmsted 1959, 79)

Other paniolo techniques ranged across a gamut of usual vaquero practice. Cattle would be roped and tied by the horns to a tree, and at the end of a good day, one paniolo might be responsible for up to a dozen wild cattle bound to trees at the edge of a clearing. They would be left there overnight, until heads and horns grew sore. The caught wild cattle would be yoked to tame animals who were herded to the clearing. The two animals, one domesticated and sedate, the other savage but sore, would slowly work their way back to distant corrals.

Or large pits would be exhumed along cow trails, where animals would fall in and be recovered and roped out later by paniolos checking their trap lines. The cattle had their share of victories; travelers were warned to stay away from the mountains because of the ongoing risk to life and limb. Estimates of livestock numbers were impressive: perhaps 25,000 wild cattle on the Big Island of Hawai'i in 1846, and 10,000 tame cattle; at least 2,000 hides were exported annually in the 40 years from 1845 to 1884. Through all this, paniolos perished with some regularity; it was a dangerous business. A hand would be issued an entire string of horses, sometimes up to twenty, and be expected to produce from that bevy of broomtails a manageable string of saddle horses (Cowan-Smith and Stone 1988). Stock-breaking techniques, often including belaboring with a two-by-four or its equivalent, were nothing to impress the Horse Whisperer. As Parker Ranch historian Joseph Brennan would write, "It was a hard, raw life, but the men were working in a paradise of a land with unbelievably good weather most of the time. The biggest virtue was that they were doing the thing they most wanted to do." (Brennan 1974, 57)

Wild Cattle Reach the Ranch

The Parker Ranch was the first large ranch outfit formed on the Hawaiian islands, established in 1847. John Palmer Parker, who had jumped ship on the Big Island with a friend, Jack Purdy, spent several years learning to work the wild cattle, garnered a commission as a bullock hunter for Kamehameha, and ultimately married a granddaughter of Kamehameha I, Chiefess Kepikani. With land grants from the king, Parker eventually had upwards of 300,000 acres. Though somewhat reduced today, the remaining acreage makes the Parker Ranch the largest privately held ranch in the United States (in cattle numbers it is third largest after the King Ranch of Texas and the Deseret Ranch in Florida), and in acreage it ranks among the world's largest (Fullard-Leo 1993, Bryan and Brakha 2000) (Figure 3). Although the ownership has grown more complex, and some of the acreage is now in high-tone subdivisions, the Parker Ranch, elegantly wrapped around 13,796-foot Mauna Kea, remains one of several dozen surviving large ranches in the islands. Its 150 years of operation makes it a Hawai'i institution.

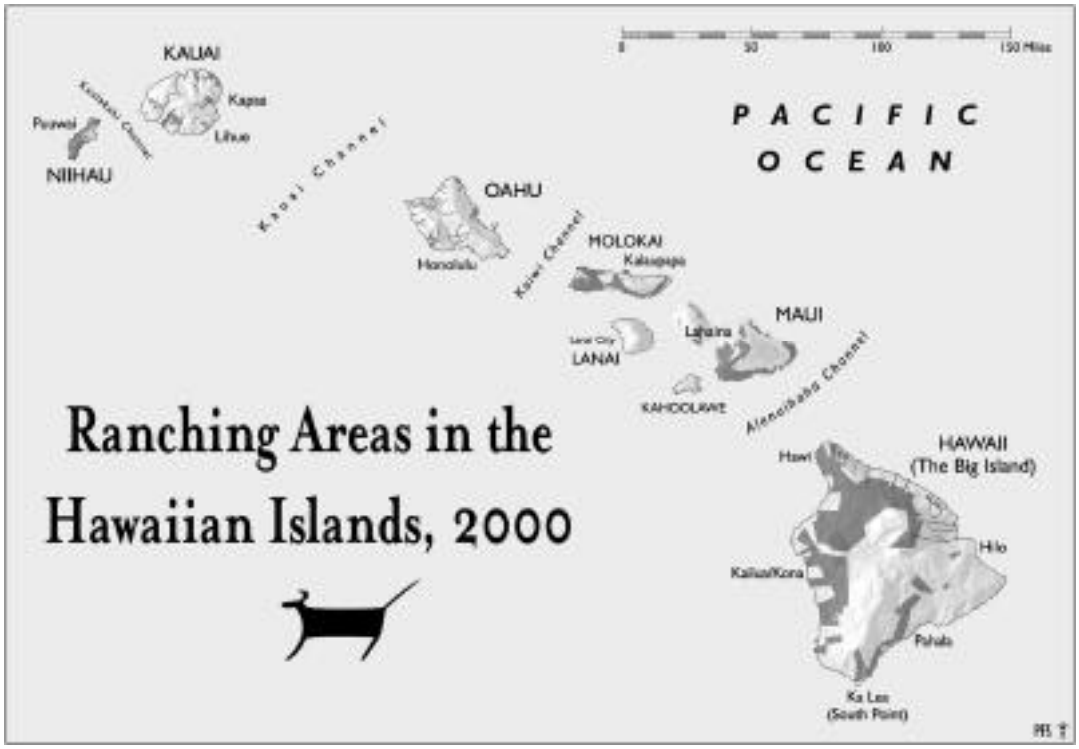

Fig. 3. ***Ranch Lands of the Hawaiian Islands, 2000; based upon data in Juvik and Juvik (1998) and Martin (1987); map by Paul F. Starrs.***

Fig. 4. ***Lava fields of Hawai'i may today seem like something of interest only to tourists and volcanologists, but in the heyday of Big Island ranching, not so long removed, crossing this kind of territory was necessary. (Photo by Paul F. Starrs).***

Hawaiian cattle ranches tend to be on the uplands, where breezes and the moderating effect of rising elevation make for a less stringent environment. That does, in many cases, leave the coastal zones for modern beach-going tourists, and visitors to ranches outside the Parker Ranch operations in Waimea are not common. Other big outfits include the Kahua Ranch, the Kealakekua Ranch, and the Pu'uwa'awa'a Ranch, all of the Big Island, and the Moloka'i Ranch on the "Friendly Island" of Molokai'i (Cooke 1949, Bryan and Brakha 2000). On Maui are a handful of large ranches including 33,000 private acres (and 6000 head) of the Haleakala Ranch, and the late Ikua Purdy's famous 'Ulupalakua Ranch. There remain sizable operations on Kaua'i and the native Hawaiian operation on Ni'ihau (Martin 1987, Fullard-Leo 1993, Bryan and Brakha 2000). In 1900, ranches made up 1.4 million acres of land, with over 100,000 head of cattle grazing the acreage. These days, more and more of the cattle born on the islands are actually shipped by boat to the mainland for fattening, since it makes no sense, given island-grown feed prices, to try and bulk up the animals locally.

Change

Since the mid-19th century, ranches in Hawai'i have, predictably, changed somewhat. The days when Parker Ranch hands rose at 2 am, so they could move their herds of cattle through lava fields before the sun rose and transformed the ropy pahoehoe lava into a literal inferno are mostly gone (Figure 4). There are still several hundred "authentic" paniolos on the islands, and no less than buckaroos in Nevada or cowboys in west Texas, they bemoan changes that have inevitably taken place.

Strikingly, however, many aspects of paniolo life, arrived at through decades of experience, remain. Hands will sport hats decorated with feather, shell, or dry-flower leis. Perhaps this is not so common on workdays, but traditions hold for more festive events. Women were not often working cowhands, except on a few of the smaller family or Hawaiian Homeland properties, though they developed a distinctive apparel that is still worn on occasion, the voluminous pa'us that were a feature of pre-statehood celebrations (Rose and Keawe 1987).

The Hawaiian range has also been altered. Some of the alterations are so monumental that they are barely perceptible; the entire landscape looks different. For example, on the Big Island of Hawai'i, many of the streams that used to drain to the west were diverted, at the upper reaches, and actually now flow eastward, through elaborate tunnels, under the divide and back to the eastern watersheds, where the captured water is used for irrigating sugar cane and other crops. The northwest of Hawai'i is, therefore, much drier now than it would have been 100 years ago, and an entirely new vegetation is in place. Improved livestock breeds came in as early as the 1860s, and cattle in the islands have a multifarious shading and lineage of little resemblance to the hearty criollos of 200 years ago. And the more progressive ranches have brought in improved pasture grasses, often of African subtropical origin, which are immediately evident to specialists, but have nothing to do with the precontact vegetation. High-intensity, short-duration grazing systems are in use at some ranches; veterinary care has improved, and the wild cattle of yore are no longer a factor.

And yet, for all that, the paniolo remains a force in the Hawaiian Islands. They are the subject of a number of books, recordings (Trimillos 1987), essays (Martin 1987, Rose and Keawe 1987), and exhibitions at major museums. The Hawaiian cowboy still works the range, but like cowhands in the American West, is not so often evident...unless you know where to look.

The Death of Nature, or, At Least, of the Naturalist...

In 2001, more than a thousand range managers from across North America will arrive on the island of Hawai'i. They will scuff their way through convention-hall astroturf, relish the kona (dry) west coast of the Big Island, or head out on field excursions to Hawaiian rangelands, and roam through the rangelands and subdivisions on aa or pahoehoe lava. There, Society for Range Management members will seek to ply their trade. They might choose, though, to watch their step. The old days of the paniolos are not so far gone; as William

Faulker is alleged to have said, "the past isn't dead, it isn't even past." Those botanizing and socializing might recall what happened to the late Professor Douglas in the 1830s (Olmsted 1959, 80):

> The bullocks of the mountains were till within a year or two very numerous and savage, so that traveling among the mountains was attended with great danger. For their capture, a mode frequently resorted to by the hunters was to dig deep pits and cover them with underbrush and dirt. A very melancholy casualty occurred three or four years since among the mountains. A gentleman named Douglas, of distinguished attainments as a naturalist, was engaged in a scientific exploration of the volcano. He had nearly accomplished the objects of his excursion when he met with an awful fate. As he was leaving an encampment where he had spent the night, he was particularly cautioned respecting three bullock pits that lay along the path he was expecting to take. He mistook the directions given him, it is presumed, for the first that was seen of him afterwards was when he was discovered by some natives, in one of the bullock pits under the feet of a savage bull, who was trampling him and goring him in the most terrific manner! The bull was very soon killed, and the mangled body of the unfortunate naturalist drawn out, but life had long since become extinct.

Watch your step!

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The Hawaiian Home Lands

Stacey Dinstell

The consequences of the Homestead Act of 1862 is one of range management's most familiar stories. Product of an era when the family farm was idealized, the vast majority of homesteads filed on western public domain lands did not last. Some "homesteads" did become the foundation of ranches that have persisted for generations, but they were seldom used or acquired in the way envisioned by the Congressional authors of the Act. Western settlers instead manipulated the Act to fit local needs and conditions, and the economy of ranching. What you may not realize is that Hawai'i has its own version of the Homestead Act, created for native Hawaiians. This Act has also not had the results some of its creators expected.

Testifying on behalf of the Hawaiian Homes Commission Act of 1921, Secretary of the Interior Franklin K. Lane asserted, "the native[s] of the Islands, who are our wards, … and for whom in a sense we are the trustees, are living in poverty and dying off rapidly" (Vause 1962). In the belief that providing lands to native Hawaiians for ranches, farms, and homes would help in "rehabilitating" a people severely weakened and impoverished by loss of land and resources, suppression of native culture, and western-introduced disease, approximately 203,000 acres of Hawaii's public lands were dedicated to a homesteading program for native Hawaiians via the Hawaiian Homes Commission Act. The source of these lands was the 1.8 million acres of crown and government lands ceded to the United States when Hawai'i was annexed as a territory in 1898.

But there were other motives for the Act's passage. Between 1917 and 1922, agricultural and grazing leases on more than 200,000 acres of public lands were due to expire. Under territorial laws, these lands would then be opened up to homesteading by the general public. Most was rangeland leased to cattle ranchers in large tracts, though about 26,000 acres of the expiring leases were valuable sugar cane fields. Both rancher and plantation owner lessees did not want to surrender these lands to homesteaders (Vause 1962).

It was by supporting native Hawaiian rehabilitation that planters found they could protect their most valuable leases.

"the native[s] of the Islands, who are our wards, … and for whom in a sense we are the trustees, are living in poverty and dying off rapidly"

By amending the territorial Organic Act, the Hawaiian Homes Commission Act (HHCA), passed in 1921, effectively terminated homesteading by the general public in Hawai'i. It established a trust to facilitate homesteading by native Hawaiians. Public lands were designated for homesteading by native Hawaiians for farms, ranches, and residences. However, the territory's best farm land, the leased cane lands, were not opened to homesteading, under the rationale that a portion of the monies raised from leasing cane lands would fund the homesteading program. A Hawaiian Homes Commission was established to oversee the homesteading, provide training to homesteaders, develop infrastructure, and make loans to support settlement.

Implementation

In the 80 years since the passage of the HHCA, approximately 6,500 long-term leases have been granted, of which only 301 are for ranches and 1,057 are for farms. The structure of the program itself, and the compromises made during its creation, has made agricultural use by homesteaders close to impossible.

A major problem was that the HHCA program lacked sufficient funding. Congress established the Hawaiian Home Loan Fund to receive receipts derived from the continued leasing of available lands not in homestead use, but placed limits on the amount of money that could be deposited into the fund. The Act also allocated the Fund only thirty percent of the money from leases of sugar cane lands and water licenses. This money was for program support and providing loans to homesteaders. These monies proved insufficient to develop land and to place homesteaders on the land to any great extent. Another obvious problem was that the available lands were consistently misallocated. Territorial governors' executive orders and proclamations withdrew and transferred land for federal agency use and non-federal public purposes.

Three other problems stand out. First, although the fund established by Congress is an important element of the trust, its existence created a conflict of interest within the Hawaiian Home Lands program that continues to this day: Although most of the land is supposed to be available for native Hawaiian homesteading, leasing it to paying customers is essentially the only way to fund the program.

Second, the structure of the funds removed any incentive to seek fair market value for the leases. As aforementioned, the amount that could be deposited in the fund was capped, initially at $1 million. Any revenues beyond that were to be turned over to the territorial government. Although the cap was occasionally raised, there were periods during the Territorial era when the trust received no revenue (GAO 1994).

Third, Hawaiian homesteaders had access to what were specifically under-

...native Hawaiians paid $1 per year for a 99 year lease.

stood at the time to be remote and essentially uninhabitable lands. Moreover, the Act barred homesteaders from patenting their land. Title to the Home Lands was to remain with the United States government, and native Hawaiians paid $1 per year for a 99 year lease. This limited the homesteaders' ability to obtain commercial loans and left them dependent on the Home Lands trust for financial support.

Current Management and Restitutions

The Hawaiian homesteading program has followed a tumultuous path. Statehood in 1959 created an opportunity to make improvements in the program, but little was accomplished in the way of facilitating land allocations to native Hawaiians.

Beginning in the late 1970s, longstanding complaints about the Home Lands trust led to a series of governmental and judicial investigations, out of which came a stinging indictment of Hawaiian Home Lands trust management and a consensus regarding the problems plaguing the Home Lands program. Two key issues are clear:

First, suitable land is often not allocated or made available. In 1979, only 25,000 acres or approximately one eighth of the available land was being homesteaded by beneficiaries. About 3,000 leases had been awarded but more than double that amount of beneficiaries remained on waiting lists for homesteads. Fifteen years later there were nearly 13,000 applicants on waiting lists. Over 3,000 of those applicants had been on the list for at least 10 years, with nearly 600 of them joining the list prior to 1970. While many of those applicants may have deferred homestead offerings, the large number on the waiting list indicates that applicants were not being offered homesteads that fit their needs or financial abilities. The Hawaiian Home Lands trust simply was not fulfilling its purpose.

Second, trust resources have been diverted to other uses. Home lands were being used illegitimately. Thirty-one executive orders or proclamations allowed 16,863 acres or almost nine percent of the home lands to be diverted to uses such as airports, schools, parks, game reserves, and other public facilities (DHHL 1977). Federal agencies including the Navy, Army and Federal Aviation Administration controlled vast acreages, paying only a fraction of market value in rent. Furthermore, over 20,000 acres of home lands, approximately ten percent of the total, were unaccounted for (Hawai'i Advisory Committee 1980).

In 1992 the state legislature paid the trust $12 million for the uncompensated state use of some trust lands.

Prodded by pressure from organized, astute, and active beneficiaries, the state and federal governments have made recent attempts to provide compensation for this history.

Repair of state breaches began in 1984 with the cancellation of 27 gubernatorial orders and proclamations that had transferred land out of the Hawaiian Home Lands trust for state and county uses. This action returned approximately 28,000 acres to the trust. In 1988 the state legislature enacted the Native Hawaiian Trusts Judicial Relief Act that initiated a protracted process for further restitution.

In 1992 the state legislature paid the trust $12 million for the uncompensated state use of some trust lands. By 1993 a process for replacing misallocated lands and resolving disputed set asides of Hawaiian home lands had been identified, and the state had begun paying fair market rent for the lands which it would continue to hold. All of the outstanding controversies were resolved by the passage of Hawai'i State Act 14 in 1995: $600 million was to be paid to the Department of Hawaiian Home Lands in $30 million annual installments for 20 years. With all state breaches supposedly resolved, any further claims against the state for the 1959 to 1988 period were prohibited.

In 1991 the legislature established an Individual Claims Review Panel to evaluate claims from individual beneficiaries, and to recommend corrective action to the legislature. Concerned that the Claims Review Panel was aiming too broadly, in June 1999 the Governor vetoed a bill extending its life. As of January 1999, of the 4,327 claims originally filed, 47 percent had completed review and 53 percent remained in limbo before a panel that was to go out of business before it could act on them. No claimants had received monetary compensation through this process.

The federal government has also attempted to make amends. The 1995 Hawaiian Home Lands Recovery Act resolves all claims involving federal misuse of Home Lands trust resources via a negotiated settlement with the Department of Hawaiian Home Lands for $80 million—not in cash, but in land, surplus federal land. The agreement is essentially a land exchange, with the federal government continuing to retain the land and conveying land of equal value, 950 acres, to the department in its place. The Department of Hawaiian Home Lands was also authorized to make claims for other illegitimate uses of lands, such as lands leased to the territorial government and private individuals without revenue returning to the program. The Secretary of Interior rejected all such claims.

The Home Lands trust began with 75 years of very un-trust-like treatment of trust lands, funds, and beneficiaries.

The Future of Homesteading

What then is the future of Hawaiian homesteading? While some past wrongs have been reconciled, home lands continue to be used primarily for non-homesteading purposes. Thirty eight percent of trust lands are managed to produce revenues for the trust, and 42 percent are unencumbered lands that are presently lying fallow or are included in forest reserves. Only 20% are used for home-

Fig. 1. ***Fewer than five percent of DHHL leases are granted for what appears to be "traditional" homesteading. This 300 acre pastoral homestead was let in 1952 to Ekela and Alfred Andrade. They continue to occupy their lease as the century closes.***

steading, though these homesteads are an important part of Hawaiian history and culture (Figure 1), just as those created on the mainland by the 1862 Homestead Act are an important part of ranching history and culture.

The Home Lands trust began with 75 years of very un-trust-like treatment of trust lands, funds, and beneficiaries. Despite this sorry history, the Department of Hawaiian Home Lands has moved unquestionably in recent years towards recognizing its primary obligations to native Hawaiians. But the future of the trust is not assured. The Department continues to be under enormous pressure to behave as a state agency bureaucracy and only marginally as a trust.

Homesteading remains the core of the Department of Hawaiian Home Lands' mission. The trust makes land available to native Hawaiians primarily for residential use. As needs have evolved increasingly toward suburban housing, the Department of Hawaiian Home Lands has worked with developers to plan and construct "master communities" (Figure 2). The department is responsible for developing infrastructure—water, roads, and utilities—to make home sites habitable. It has also become a guarantor of housing loans or, in many cases, the lender of last resort, for beneficiaries who have been awarded a home site and need additional resources for construction and financing. And, for beneficiaries who lack resources to purchase the department's contractor built homes, the department has begun to work, on a small number of its sites, with Habitat for Humanity.

The Department of Hawaiian Home Land's priority is to place beneficiaries on homesteads, and their potential for doing that has been markedly increased by the lands received in the state and federal settlements. No longer confined to the often undevelopable lands granted 80 years ago, the Department of Hawaiian Home Lands' plans for housing developments and construction have been ambitious. Yet, despite the settlements, they are still constrained by a

Fig. 2. ***The Princess Kahanu Estates is typical of the new master planned communities being built by the Department of Hawaiian Home Lands.***

Table 1. Homestead Applications and Awards, 1988-1998 (Annual Report, DHHL, 1988–98).

	1998	1996	1994	1992	1990	1988
Homestead applications pending, cumulative total	29,702	28,641	26,023	23,536	20,001	17,643
Homestead leases awarded, cumulative total	6,547	6,350	6,059	5,889	5,778	5,803
Leases Awarded in Previous Two Years, Total	197	291	170	111	–25	

lack of funding. One past estimate determined that $1.2 billion would be needed to provide infrastructure on available lands, and an additional $1.2 billion would be needed to construct 16,000 homes to serve those on the waiting list at the time.

The trust has now and always has had far more qualified homestead applicants than it could serve, given the funds available to support the program (Table 1). In the course of a decade, 744 leases were granted to homesteaders, but more than 12,000 applications for leases were filed.

Whether or not housing goals can be achieved with the new lands and incoming monies remains to be seen. Nevertheless, the future of the program, as has been its past, seems to be housing provision, an important contemporary need of native Hawaiians given the state's speculative real estate market, and not so much in rehabilitating native Hawaiians through ranching and farming, as envisioned by some of the original supporters of the Hawaiian Home Lands Act.

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Ranchers and Biologists in Hawai'i—Keeping a Business Strong and Protecting Native Forests at Ulupalakua Ranch, Maui

Sumner Erdman, Arthur Medeiros, Anthony Durso, and Lloyd Loope

The loss of ranchland to critical habitat has been a major concern to ranchers and other large landowners in recent years. On the island of Maui, a novel approach is in the works which seems to have merit both for conservation of endangered species and for helping a landowner ethically manage an ecologically sensitive area.

Ulupalakua Ranch's Critical Environment

Perched on the high, dry southwestern slopes of Haleakala volcano on Maui, Ulupalakua Ranch contains the type of heart-stopping views, ecological amplitude, and biological diversity more commonly found in national parks than on ranches. Stretching from sea level to an elevation of 6,000 feet, the ranch contains examples of no less than eight major vegetation communities, impressive considering its relatively small size of 23,000 acres. The Ranch currently supports populations of two animal and nine plant species listed as endangered species by the U.S. Fish and Wildlife Service (FWS) as well as many very rare native plants and animals which may be listed in the future.

Maui and the rest of the Hawaiian Islands represent an evolutionary showcase. The plants and animals which reached these islands through long-distance dispersal evolved in isolation on this remote archipelago for millions of years. The Hawaiian honeycreepers among birds and the silversword alliance among plants are species-rich groups which provide classic, textbook examples of evolutionary adaptive radiation from a single common ancestral population. Sadly, the Hawaiian islands also provide an all too excellent example of the devastating impacts of habitat destruction and alteration through introduction of invasive plant and animal species by humans. The occurrence of over 300 plant and animal species in Hawai'i (about one-third of the total nationwide, in two-tenths of 1% of the total land area) listed as endangered species by FWS represent a poignant symptom of the destruction and alteration through invasion.

A major societal challenge in the U.S. for the 21st century involves developing strategies to maintain biological diversity, especially in such vulnerable areas as Hawai'i, in an age of increasing population, globalization, and homogenization. Making this challenge all the more daunting, is the fact that these vulnerable habitats are often located on the property of economically strapped landowners. One of the most promising projects in the state of Hawai'i, perhaps comprising a prototype for progress toward meeting these challenges, is a growing partnership between Ulupalakua Ranch, funding sources, and conservation agencies. Here we explore the long-range potential of an incipient partnership effort on Ulupalakua Ranch.

The Rancher's Perspective:

Located in an economically struggling and ecologically sensitive area, Ulupalakua Ranch strives to balance its efforts to maintain a productive cattle operation and support Maui's agricultural industry with its interests in protecting Maui's environment. Traditionally, the Ranch has focused on beef production and currently runs 3,600 head of cattle, mostly Angus, Brangus, and Hereford. The drought and market woes known to all ranchers forced Ulupalakua to look for alternative sources of revenue and to open more pastures. The Ranch now maintains a herd of approximately 150 Rocky Mountain elk for velvet and exotic meat production and leases land to local farmers. Other on-going ventures include recreational and educational tours and paid game bird and axis deer hunts. Furthermore, it has fenced and installed water troughs in previously unused or little used areas.

In diversifying its income and increasing its pastures, the Ranch stumbled into a new set of problems. Those lands on which the tours take place and cattle graze are near the homes of some of Hawaii's endangered and rare species. Historically, the relationship between private landowners and conservationists has been adversarial. Consequently, these groups have battled with each other, to both their detriment at considerable cost. Unable to afford to lose such a battle, troubled by the waste inherent in this dynamic, and genuinely supportive of preserving native species, the Ranch prefers to solicit federal, state, and county cost-share funding for conservation programs and work closely with their agents to support economically sound and environmentally safe use of the land. The resulting construction of a greenhouse for native plants, the protection of forest areas for preservation and propagation of those plants, and an increase in and improvement of pastureland testify to the merits of this more cooperative strategy.

One of the featured projects is the dryland forest of Auwahi (Figure 1). Located in a remote area of the Ranch, Auwahi is just one of five current large-scale projects related to conservation of biodiversity, endangered species, and watershed protection. Supported by the Ranch, a multiplicity of federal, state and county government agencies, and local and national charitable organizations, these projects utilize seed collection and propagation, progressive fencing and grazing techniques, aggressive manual and chemical weed management, and community education to achieve goals. Thanks to the lasting commit-

Fig. 1. ***Remnant dryland forest at Auwahi, Ulupalakua Ranch, Maui, elevation 4,000 ft.***

ment and continuous effort of everyone involved, the success of these projects has exceeded initial expectations.

In the future, it is the Ranch's hope that its conservation efforts can be fully combined with its livestock operation and visitor activities. By showing that tightly controlled grazing can help control invasive plants around critical habitats, the Ranch hopes to maintain access to its pastures as well as protect endangered species. Furthermore, tours of native plant gardens and forests could provide Maui visitors with a completely unique opportunity to see and learn about some of Hawaii's most rare plants as well as one of Hawaii's most interesting forest types. The beauty of this plan is that the environment will be preserved and the Ranch will become more stable economically...a true symbiosis.

The Biologist's Perspective

Dryland forests are among the most threatened of Hawaiian ecosystems. On Maui, only an estimated 4% of the original dryland forest still remains. Auwahi, with a very high diversity of native tree species, is generally considered one of the most intact dryland forest areas in the state (Wagner et al. 1990). The area was first explored botanically in the early 20th century by Joseph Rock of University of Hawai'i and Charles Forbes of Bishop Museum. In his famous book *Indigenous Trees of the Hawaiian Islands* (1913), Rock praised the area for its botanical diversity calling it one of the richest districts in the State. Upon his return to the area some 20 years later in 1939, Rock is said to have wept over the dramatic deterioration during his absence.

The first attempts at conservation at Auwahi were made in the late 1960s, when retired Territorial Forester Colin Lennox and The Nature Conservancy constructed a large exclosure in an abortive restoration effort which unfortunately coincided with the invasion of the area by kikuyu grass (*Pennisetum clandestinum*). USGS scientists (with National Park Service until 1993) began exploratory work, with the permission (and blessing) of the landowner, Ulupalakua Ranch, 19 years ago. A status report based on extensive field exploration in the early 1980s (Medeiros et al. 1986) called attention to continued deterioration of native vegetation on leeward Haleakala and identified the Auwahi area as a prime area worthy of concerted conservation efforts.

Reasons for lack of reproduction may be complex and overlapping but probably include browsing by domestic cattle and digging by feral pigs; displacement by the aggressive introduced tropical African pasture grass, kikuyugrass, and microclimate change. Our observations suggest that with protection from ungulate browsing and digging, removal of the kikuyugrass mat, and restoration of favorable microhabitat, dryland forest restoration can be achieved at Auwahi.

The diverse forest continues to decline due to the absence of seedlings and saplings. For many species, reproduction by seed may not have occurred for a period of 50 to several hundred years. We have seen seedlings and saplings in the field for only 12 of 50 tree species at Auwahi over a 19-year period of field observations. Despite this, at least 36 species can be germinated and grown in greenhouse conditions. Of native trees found at Auwahi, six are listed by FWS as endangered species, five have been considered "species of concern," and many of the others are rare and declining range-wide.

Ethnobotanically, these forests were invaluable to early Hawaiians (Medeiros et al. 1999). Of the 50 tree species found here, 41 had specific uses. Nineteen species were used in medicines, 13 in making specific tools, 13 in canoe construction, eight in making bark cloth, eight to make dyes ranging from pink to blue to a rich yellow-orange. At least seven species have spiritual significance and were used in religious and cultural ceremonies. Other miscellaneous uses ranged from fireworks, to bird lime, to a fish narcotizing agent. There is tremendous interest within both the Hawaiian conservation community and the native Hawaiian community in restoring tracts of dryland forest. However, to date there are no major success stories for dryland forest restoration in Hawai'i.

Assisted by past funding from FWS, USGS has located one of the richest tracts of Auwahi for restoration, fenced a prime 10.4 acre site for experimental restoration (elevation 4,000 ft), and has initiated a greenhouse propagation and outplanting program with assistance of funds provided directly to the

landowner by FWS. We presented a conceptual plan for 120 acres of Auwahi restoration at the Hawai‘i Conservation Conference in July 1997 with landowner approval. The plan involves replacing the kikuyugrass cover among the museum-piece trees with a "nurse forest" of quick-growing native trees to create relatively moist, semi-shaded microhabitat in which dryland forest seedlings can become established and flourish (Figure 2). A relatively brief window of opportunity exists during which this declining dryland forest is relatively restorable. Though forest decline is at a relatively advanced stage, excellent seed sources for most species still exist.

Currently, we are in the midst of implementing an experimental USGS-funded research project to develop methodology for establishing a nurse forest of native shrubs/trees to secure the site from weed invasion and eventually (within several years) provide habitat for restoration of 50 tree species. Based on the results of this project, the most effective methodology would be used as soon as funding for management could be obtained (from FWS and other sources) to restore dryland forest on additional Auwahi land, up to the 120 acres to which the landowner has willingly agreed. Based on methods developed through our ongoing pilot project, we can soon feel confident in our ability to cooperatively restore and manage dryland forest at Auwahi.

Fig. 2. ***Halapepe (*Pleomele auwahiensis *St. John) in the Agave family is one of the dominant species in remnant dryland forests at Auwahi, but almost no natural regeneration has been seen recently. Several hundred experimental halapepe seedlings were planted at Auwahi in January 2000.***

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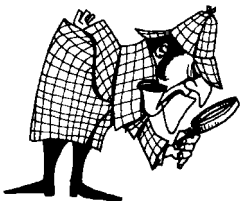
Wagner W.L., D.R. Herbst, and S.H. Sohmer. 1990 Manual of the flowering plants of Hawai`i. University of Hawai‘i Press and Bishop Museum Press, Honolulu, Hawaii

Sumner Erdman is an owner, and both Sumner and Tony Durso help manage Ulupalakua Ranch. Arthur Medeiros and Lloyd Loope are biologists with the United States Geological Survey (USGS), Biological Resources Division, based at the Haleakala National Park Field Station on Maui.



Sneek A Peek at the upcoming issue of Journal of Range Management

Predictive Equations for Biomass and Fuel Characteristics of Argentine Shrubs

José L. Hierro, Lyn C. Branch, Diego Villarreal, and Kenneth L. Clark

Estimating shrub biomass in semi-arid scrub ecosystems is necessary for evaluating shrub encroachment, net primary productivity, nutrient cycling, and effects of fire regimes. Predictive equations to estimate total aboveground biomass, foliage, and stems from field measurements of 8 shrubs in the semi-arid scrub of Argentina were developed. For all species, at least 1 shrub characteristic was a good predictor of total aboveground biomass and components. The equations will be useful in monitoring the effects of grazing on shrub dynamics, for examining the impacts of different fire regimes on aboveground shrub biomass, and for studies of ecosystem productivity in semi-arid areas.

Response of Incomplete Tifton 9 Bahiagrass Stand to Renovation

R. N. Gates

Bahiagrass and other warm-season grasses are difficult to establish from seed, often leading to incomplete stands. Stands of Tifton 9 bahiagrass with initial stands of less than 60% basal cover at two locations were treated in spring of two years with: rototilling plus seeding (5 lb/acre), disking plus seeding, interseeding alone or a control. One year following treatment, none of the tillage/seeding treatments resulted in stands superior to control. Therefore, bahiagrass stands with at least a few plants per square-yard should be managed to minimize weed encroachment and encourage spread of existing plants without additional seeding.

Fire History of the Rochelle Hills, Thunder Basin National Grasslands

Barry L. Perryman and WA. Laycock

Few sites exist within grassland communities where physical evidence of fire frequency can be obtained. The Rochelle Hills Area of the Thunder Basin National Grasslands in northeast Wyoming contain small areas, within the grassland matrix, dominated by conifer species exhibiting fire scars. A total of 65 fire scars representing 42 different fire years between 1565 and 1988 AD. were collected with a mean fire-free interval for the area was 7.4 years. The interval was 6.7 years during the fire suppression period (post 1940), and 7.9 for the non-suppression period.

Lichen Polysaccharides and Their Relation to Reindeer/Caribou Nutrition

B. Svihus and Ø. Holand

In winter, lichens are a high preference fodder source for reindeer, but their composition and nutritional value are unknown Carbohydrate composition and solubility of lichens from 3 sites in 2 mountain areas and ruminal breakdown was evaluated. Non-starch polysaccharides containing mannose, galactose and glucose were major constituents, but the composition and solubility varied greatly among species and genera. The content, composition and solubility of the fiber fraction are important criteria for determining the nutritive value of lichens for reindeer or caribou.

Red Deer and Cattle Diet Composition in La Pampa, Argentina

A.J. Pordomingo and T. Rucci

The presence of 2 large herbivores in the same rangeland makes assessment of proper stocking rates and management practices rather complex. The composition and overlap of red deer and cattle diets in a semiarid, temperate rangeland of La Pampa, Province, Argentina was estimated by microhistological analysis of feces. Red deer and cattle diets were different within the 4 seasons with deer consuming more forbs and 4 times the amount of shrubs than cattle. There was some overlap in diets of red deer and cattle depending upon the relative availability of palatable fractions of forbs, shrubs and grasses.

Stubble Height as a Tool for Management of Riparian Areas

Warren P. Clary and Wayne C. Leininger

Stubble height has been widely used in recent years to gage the impacts of grazing use in riparian areas. Based on limited research, a 10 cm residual stubble height is a recommended starting point, to be followed by monitoring to determine if adjustments are needed. Stubble height is a short term management guide that should only be applied to help attain long term ecological objectives. The recommended criterion would apply to streamside and nearby meadows with hydrophilic or potentially hydrophilic vegetation, but not directly to dry meadows or even all wet meadows.

Food Aversion Learning to Eliminate Cattle Consumption of Ponderosa Pine Needles

James A. Pfister

Conditioned food aversions are a potentially useful tool to eliminate consumption of some toxic plants by livestock. This study examined consumption of pine needles in South Dakota and Oregon by pregnant cattle. Although averted to green needles, cattle did not appear to generalize from green needles to dry needle litter and once cattle began eating dry needles, the aversion eventually stopped. Conditioning permanent aversions may require averting cattle to all forms of pine needles (green and dry) likely to be encountered in a pasture.

Impacts of western juniper on plant community composition and structure

Richard F. Miller, Tony J. Svejcar, and Jeffrey A. Rose

Western juniper dominates large areas of land across a broad array of environments but often is treated as a single component in management, resource inventories, and wildlife habitat. We evaluated successional phases of woodland development across several plant associations in eastern Oregon and northeastern California. Woodland structure and understory response varied across the different associations with stand structure ranging from 19% cover and 64 trees ha^{-1} in low sagebrush communities to 90% cover and 1730 trees ha^{-1} in aspen communities. The spatial and temporal differences of a site should be identified when conducting inventories or developing management plans.

Technical Note: Use of Digital Surface Model for Hardwood Rangeland Monitoring

Peng Gong, Greg. S. Biging, and Rick Standiford

We built digital surface models (DSM) that contain 3D surface morphological information of the entire landscape using digital photogrammetry and aerial photographs. Changes in landscape components such as crown closure and tree height in hardwood rangeland were estimated using DSM. In comparison with manual interpretation results, errors of crown closure and tree hieght estimation using DSM were less than 0.7% and 1.5 m, respectively. This technique can be used for rangeland management, monitoring and ecological studies.

Tracked Vehicle Effects on Vegetation and Soil Characteristics

Chad W. Prosser, Kevin K. Sedivec and William T. Barker

Care and maintenance of soils and vegetation on military training lands is necessary to sustain a realistic training environment. The ecological effects of tracked vehicle use on plant species cover, plant frequency and soil compaction was evaluated in east-central North Dakota. The tracked vehicle use did not change species composition or litter amounts but soil dry bulk density and bare ground increased. One year of tracked vehicle use was not detrimental to the vegetation but did change soil dry bulk density.

Grassland Fire Effects on Corroded Barbed Wire

David M. Engle and John R. Weir

In some areas, fire effects on barbed wire is considered a major limitation to implementing prescribed burning on rangelands. We determined the influence of grassland fire on wire that was 20 and 30-years old and had sufficient loss of the zinc coating to have undergone corrosion of the underlying steel. Regardless of age, wire subjected to grass fire did not differ in breaking strength, elongation, or ductility from wire not subjected to fire. Problems with repairing old barbed wire are not a result of fire but result from exposure to corrosive elements of the environment.

Suppression of grasshoppers in the Great Plains through grazing management

Jerome A. Onsager

Use of petroleum-based technology to protect rangeland forage from outbreaks of grasshoppers is discouraged by environmental constraints, costs, and the low level of expenditure justified from livestock production. An experiment was conducted in the northern Great Plains to test whether rotational grazing could suppress grasshoppers through deliberate manipulation of canopy during critical periods. The twice-over rotational grazing system not only produced lower infestations than conventional seasonal grazing but also prevented a local outbreak. It was concluded that grasshopper infestations in the northern Great Plains are affected by grazing strategies, and that ranchers can suppress grasshoppers through grazing rnanagement.

Close-range vertical photography for measuring cover changes in perennial grasslands

Lauren T. Bennett, Terry S. Judd, and Mark A. Adams

We describe a method of close-range vertical photography for measuring changes in total projective cover in perennial grasslands. Repeated photographs of permanent plots (1 m^2) were classified using supervised image analysis, providing a clear and objective record of the effects of single-burns on cover relative to controls. Simulated errors due to camera perspective were minimal (less than 4%), and the method was sufficiently accurate to elucidate relationships between independent growth parameters across a range of cover conditions. The technique was inexpensive, involved minimal field time, and provided outputs that were readily archived.

Long-term Effects of Fire on Sage Grouse Habitat

Pamela J. Nelle, Kerry P. Reese and John W. Connelly

Prescribed burning is a popular tool for conversion of sagebrush rangeland to grassland for livestock grazing or crop production that causes a loss of sage grouse habitat. The long-term impact of fire on sage grouse nesting and brood-rearing habitats was evaluated in southeastern Idaho. Prescribed burning did not improve sage grouse brood-rearing habitat and destroyed nesting sites for 20 or more years. Accumulation of land area burned by wildfire or prescription could seriously, negatively affect sage grouse populations in southeastern Idaho.

Protocol for Monitoring Standing Crop in Grasslands Using Visual Obstruction

Lakhdar Benkobi, Daniel W. Uresk, Greg Schenbeck and Rudy M. King

Assessment of standing crop on grassland is necessary for planning livestock grazing management and to indicate the status of wildlife habitat. A model for estimating grassland standing crop using a graduated pole was developed and evaluated on sandy lowland range sites in the Nebraska sandhills. Visual obstruction predicted average standing crop and in combination with previously estimated regression models, provide a simple reliable and cost-effective alternative to the clip and weigh technique. Monitoring protocols for the visual obstruction technique were developed for the use at the section level and for extensive grassland areas.

Sward Quality Affected by Different Grazing Pressures on Dairy Systems

Maria Rosa Mosquera-Losada, Antonio Gonzalez-Rodriquez and Antonio Rigueiro-Rodriquez

The chemical composition of forages are important for meeting animal nutritional requirements. Stocking densities on tiller density, botanical composition, and chemical (acid detergent fiber, Ca, P, K, and Mg) quality of pasture and the seasonal distribution were evaluated in Spain. Stocking density has an important effect on tiller density and chemical quality of the herbage, but did not affect the botanical composition of the pastures. It is important to understand the effects of the grazing intensity on the nutrient levels of the forage.

Letters to the Editor

Dear Editor:

I just received my June 2000 issue of *Rangelands* and read it with great interest.

I was most pleased to see that *Rangelands* has once again pro-vided a forum for dialog airing diverse opinions. I think this is very healthy, both for the magazine and for the SRM.

Years ago, I wrote a letter to the editor that provoked considerable discussion pro and con. In fact, I was offered the position of guest of honor at a necktie party. I survived, and the Society was stimulated to examine issues that are still vital today.

Jack Bohning

Dear Editor:

The August issue is the best ever. Full of thoughtful articles and most of them quite scientific (dispassionate). I enjoyed Thad's article, he's a jewel.

My congratulations!

Jim Brunner

Board of Directors Meeting Highlights
2000 Summer Meeting

The Society for Range Management Board of Directors 2000 Summer Meeting was called to order by President John McLain on Saturday, July 21, 2000, at 8:00 a.m. Those officers and directors in attendance were: First Vice President James T. O'Rourke, Second Vice President Rodney K. Heitschmidt, Directors Pat Shaver, Carolyn H. Sieg, Glen Secrist, James Linebaugh and Don Kirby. Others in attendance were Executive Vice President J. Craig Whittekiend, Washington Representative Deen E. Boe and Public Affairs Manager Jeff Burwell. Absent was Director Dick Hart. Guests attending the meetings were: Clayton Campbell, Mike Connor, Bruce Fox & Duane McCartney.

EVP Whittekiend reported that Membership Services Manager Helen Hall will be leaving her position in December. He recommended filling the position in the fall to provide adequate training to her successor prior to her departure. Whittekiend also reported that member numbers are up from this time last year.

The CRM Committee is working on a Memorandum of Understanding between SRM and the National Association of Conservation Districts (NACD) to cooperate for the advancement of CRMP.

The 2001 Annual Meeting budget and registration fees were approved by the Board.

Bruce Fox, Chair of the Public Affairs Committee reviewed proposed guidelines for new policy & position statements and resolutions and the draft guidelines for advocacy, which the Board accepted.

The Board approved a proposal to reimburse the meeting registration exchange rate difference for future Board members who are from outside the U.S. and are elected to serve on the Board.

EVP Whittekiend reviewed the business plan, and asked the Board to add two new items to the Strategic Plan: 1) value to members and 2) financial planning. He will revise and update the strategic plan and work with the Finance Committee to complete the Financial Plan.

Following is the Board's tentative meeting schedule for the Hawaii meeting in February:

Saturday, 2/17	8:00 am – 5:00 pm	Board Meeting
Wednesday, 2/21	1:00 pm – 3:00 pm	Strategic Planning w/Committee Chairs
	3:15 pm – 5:00 pm	Board Meeting
Friday, 2/23	8:00 am – 5:00 pm	Board Meeting

Browsing the Literature

Jeff Mosley

This section reviews new publications available about the art and science of rangeland management. Personal copies of these publications can be obtained by contacting the respective publisher or senior author (addresses shown in parentheses). Suggestions are welcomed and encouraged for items to include in the future issues of *Rangelands.*

Animal Ecology

Best management practices for shortgrass prairie birds: A landowner's guide. S.W. Gillihan and S.W. Hutchings. 1999. (Colorado Bird Observatory, 13401 Piccadilly Rd., Brighton, CO 80601). Provides drawings, descriptions and management recommendations for 13 different species of prairie birds.

Bird habitat relationships along a Great Basin elevational gradient—Introduction. D.E. Medin, B.L. Welch, and W.P. Clary. 2000. USDA Forest Service Rocky Mountain Research Station Research Paper RP-23. (Publications Room, Rocky Mountain Research Station, 324 25th St., Ogden, UT 84401). Total numbers of individual birds and bird species were highest where mountain big sagebrush was plentiful.

Digesta kinetics, energy intake, grazing behavior, and body temperature of grazing beef cattle differing in adaptation to heat. J.E. Sprinkle et al. 2000. Journal of Animal Science 78:1608-1624. (Gila County Cooperative Extension, P.O. Box 2297, Payson, AZ 85547). Tuli x Angus cattle and Brahman x Angus cattle were comparable in their adaptation to heat.

Elk distribution and modeling in relation to roads. M.M. Rowland, M.J. Wisdom, B.K. Johnson, and J.G. Kie. 2000. Journal of Wildlife Management 64:672-684. (USDA Forest Service Forestry & Range Sci. Lab, 1401 Gekeler Lane, La Grande, OR 97850). Limiting vehicular use of roads and related human activities during spring and summer should remain an important consideration when managing elk.

Resource selection and spatial separation of mule deer and elk during spring. B.K. Johnson, J.W. Kern, M.J. Wisdom, S.L. Findholt, and J.G. Kie. 2000. Journal of Wildlife Management 64:685-697. (Oregon Dept. of Fish & Wildlife, 1401 Gekeler Lane, La Grande, OR 97850). Mule deer avoided areas used by elk in the Blue Mountains of northeastern Oregon.

Shrubsteppe bird response to habitat and landscape variables in eastern Washington, USA. W.M. VanderHaegen, F.C. Dobler, and D.J. Pierce. 2000. Conservation Biology 14:1145-1160. (Washington Dept. of Fish & Wildlife, 600 Capitol Way North, Olympia, WA 98501). Brewer's sparrows and sage sparrows were most abundant on sites with deep, loamy soils whereas loggerhead shrikes were most abundant on sandy sites.

Social hierarchy in the domestic goat: Effect on food habits and production. F.G. Barroso, C.L. Alados, and J. Boza. 2000. Applied Animal Behaviour Science 69:35-53. (Dept. of Biologia Aplicada, Univ. of Almeria, Almeria 04120, Spain). Goats in the middle range of the herd's social hierarchy were the most productive.

Education

The importance of comprehensive agricultural education in land-grant institutions: A historical perspective. P.M. Grant, T.G. Field, R.D. Green, and B.E. Rollin. 2000. Journal of Animal Science 78:1684-1689. (Dept. of Animal Science, Colorado State Univ., Fort Collins, CO 80523). Tomorrow's agriculture will be best served by technically competent students who can think critically and communicate effectively.

The shortgrass prairie: Activities for learning about North America's grassland birds. J. Duberstein, S. York, and S. Bonfield. 1999. (Colorado Bird Observatory, 13401 Piccadilly Rd., Brighton, CO 80601). This 17-page booklet for youth highlights grasslands and grassland plants, prairie dogs, bison, and grassland birds.

Grazing Management

Do windbreaks minimize stress on cattle grazing foothill winter range? B.E. Olson, R.T. Wallander, and J.A. Paterson. 2000. Canadian Journal of Animal Science 80:265–272. (Dept. of Animal & Range Sciences, Montana State Univ., Bozeman, MT 59717). In Winter 1996-1997 and Winter 1997–1998, cattle grazing foothill winter range in southwestern Montana were not notably stressed by wind.

Effect of supplements on growth and forage intake by stocker steers grazing wheat pasture. H. Lippke, T.D.A. Forbes, and W.C. Ellis. 2000. Journal of Animal Science 78:1625-1635. (Texas Agr. Exp. Station, Uvalde, TX 78801). Cottonseed or cottonseed/corn supplements did not affect weight gains of steers grazing irrigated wheat pasture.

Palatability of wethers fed an 80% barley diet processed at different ages and of yearling wethers grazed on native range. P.G. Hatfield, R.A. Field, J.A. Hopkins, and R.W. Kott. 2000. Journal of Animal Science 78:1779-1785. (Dept. of Animal & Range Sciences, Montana State Univ., Bozeman, MT 59717). Slaughtering range-finished wethers at older ages produced acceptable carcasses with desirable meat palatability traits.

Hydrology/Riparian

River ice and its role in limiting woodland development on a sandy braid-plain, Milk River, Montana. D.G. Smith and C.M. Pearce. 2000. Wetlands 20:232-250. (Dept. of Geography, Univ. of Calgary, Calgary, AB T2N 1N4, Canada). Ice causes extensive damage to plains cottonwood trees along stream reaches that are wide and relatively straight.

Improvements

Effect of fire and grazing on forbs in the western South Texas Plains. D.C. Ruthven, J.F. Gallagher, and D.R. Synatzske. 2000. Southwestern Naturalist 45:89-94. (Texas Parks & Wildlife, P.O. Box 115, Artesia Wells, TX 78001). Prescribed burning increased desirable forbs.

Management Planning

Building consensus: Legitimate hope or seductive paradox? S.F. McCool, K. Guthrie, and J.K. Smith. 2000. USDA Forest Service Rocky Mountain Research Station Research paper RP-25. (Publications Room, Rocky Mountain Research Station, 324 25th St., Ogden, UT 84401). Interviewed participants about their satisfaction with two public planning processes in western Montana.

Plant/Animal Interactions

Feeding ecology and emergence production of annual cicadas in tallgrass prairie. M.A. Callaham, M.R. Whiles, C.K. Meyer, B.L. Brock, and R.E. Charlton. 2000. Oecologia 123:535-542. (Div. of Biology, 232 Ackert Hall, Kansas State Univ., Manhattan, KS 66506). Some species of cicadas fed mostly on shallow-rooted warm-season grasses whereas other species of cicadas preferred to feed on more deeply rooted cool season plants.

Great Plains at the Millennium. J.E. Mitchell, L. Hidinger, and L. Eskew (eds.). 1999. Great Plains Research, Volume 9, No. 2. ($15; Great Plains Research, University of Nebraska-Lincoln, 1215 Oldfather Hall, P.O. Box 880317, Lincoln, NE 68588). This journal issue contains 10 papers presented at the January 1999 symposium, "Great Plains at the Millennium", cosponsored by SRM at Omaha, Nebraska.

Historic aspen recruitment, elk, and wolves in northern Yellowstone National Park, USA. W.J. Ripple and E.J. Larsen. 2000. Biological Conservation 95:361-370. (Dept. of Forest Resources, Oregon State Univ., Corvallis, OR 97331). "We found that aspen overstory recruitment ceased during the same years that wolves, a significant source of elk predation, were removed from Yellowstone National Park."

Impact of grazing and desertification in the Chihuahuan Desert: Plant communities, granivores and granivory. G.I.H. Kerley and W.G. Whitford. 2000. American Midland Naturalist 144:78-91. (Dept. of Zoology, Univ. of Port Elizabeth, P.O. Box 1600, ZA-6000 Port Elizabeth, South Africa). The increased relative abundance of rodents vs. seed harvesting ants indicates a conversion from desert grassland to shrubland.

Plant Ecology

Altering rainfall timing and quantity in a mesic grassland ecosystem: Design and performance of rainfall manipulation shelters. P.A Fay, J.D. Carlisle, A.K. Knapp, J.M. Blair, and S.L. Collins. 2000. Ecosystems 3:308-319. (Div. of Biology, Ackert Hall, Kansas State Univ., Manhattan, KS 66506). Lengthening the time interval between rainfall events had a greater impact on plant yield than did reductions in the amount of rainfall received.

Implications of precipitation redistribution for shifts in temperate savanna ecotones. J.F. Weltzin and G.R. McPherson. 2000. Ecology 81:1902–1913. (Dept. of Ecology & Evolutionary Biology, Univ. of Tennessee, Knoxville, TN 37996). Increased summer precipitation would likely facilitate oak encroachment into grasslands of southeastern Arizona.

Reclamation

Effects of pasture applied biosolids on performance and mineral status of grazing beef heifers. M.E. Tiffany et al. 2000. Journal of Animal Science 78:1331–1337. (L.R. McDowell, P.O. Box 110910, Gainesville, FL 32611). Except for low levels of copper, mineral status of cattle was adequate when grazing bahiagrass pastures treated with high levels of municipal biosolids.

Socioeconomics

Age of calf at weaning of spring-calving beef cows and the effect on cow and calf performance and production economics. C.E. Story, R.J. Rasby, R.T. Clark, and C.T. Milton. 2000. Journal of Animal Science 78:1403-1413. (Dept. of Animal Sci., Univ. of Nebraska, Box 830908, Lincoln, NE 68583). Weaning spring-born calves at 150 days of age was more profitable than weaning at 210 days.

Grazing methods and stocking rates for direct-seeded alfalfa pastures: III. Economics of alternative stocking rates for alfalfa pastures. C.J. Wachenheim, J.R. Black, M.L. Schlegel, and S.R. Rust. 2000. Journal of Animal Science 78:2209-2214. (Dept. of Animal Sci., Michigan State Univ., East Lansing, MI 48824). The stocking rate that maximized profit was between the stocking rate that maximized individual animal gain and the stocking rate that maximized animal gain per acre.

World population growth, distribution and demographics and their implications on food production. R.E. McQueen. 2000. Canadian Journal of Animal Science 80:229-234. (126 Woodbine Lane, Upper Kingsclear, NB E3E 1S3, Canada). Predicts that by 2025 population growth and decreased global oil production will challenge world food production and force major food producing nations to make difficult social, economic and land use choices.

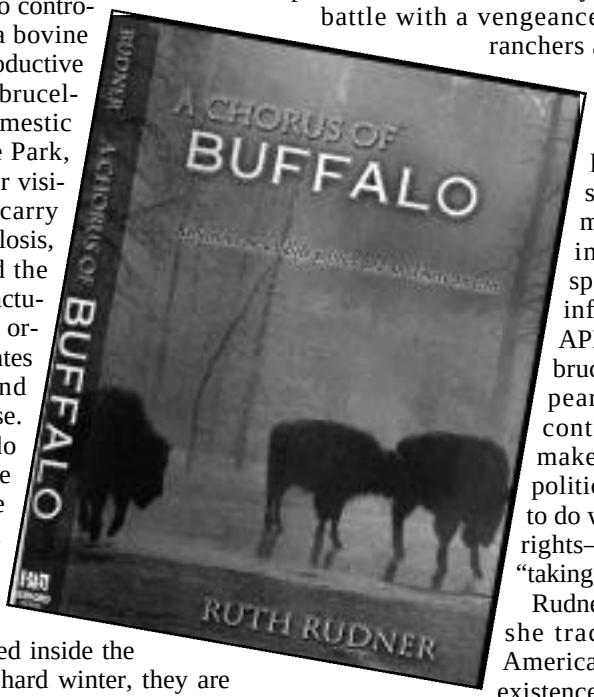
Author is professor and extension range management specialist, Dept. of Animal and Range Sciences, Montana State Univ., Mont. 59717.

Book Reviews

A Chorus of Buffalo. By Ruth Rudner. 2000. Burford Books, Inc., Springfield, New Jersey. 192p. US$22.95 hardcover. ISBN 1-58080-049-1.

In her preface Ruth Rudner writes that she wanted the stories in this book to paint a portrait of the buffalo. She wanted the reader to know the animal, to ride through the Yellowstone backcountry, watching buffalo on vast, primeval meadows, seeing this gorgeous animal at home in an amazing landscape. She did not want to write about the complicated politics surrounding the buffalo. Yet she found it impossible to just write stories about the buffalo without explaining some of the political controversy behind them. In her attempt to simplify the political aspects of the buffalo controversy and just tell stories, she gives us a book that lacks substance.

She begins by telling us that the buffalo controversy is, nominally, about brucellosis, a bovine bacterial disease transmitted during reproductive events. Buffalo became carriers of the brucellosis organism through contact with domestic cattle in the early days of Yellowstone Park, when cows were kept to provide milk for visitors and workers there. Many buffalo carry antibodies indicating exposure to brucellosis, although they have not themselves had the disease. A small fraction of buffalo are actually capable of transmitting the brucella organism. She goes on to say that cattle states have spent huge amounts of money and time ridding domestic herds of the disease. States classified as "brucellosis-free" do not want the status endangered. For the individual rancher, brucellosis can be catastrophe, because if even one cow in a herd tests positive for the disease, the rancher's entire herd must be destroyed.



The livestock interests would not be concerned if Yellowstone's buffalo stayed inside the park. But buffalo roam. Especially in a hard winter, they are apt to cross park boundaries to lower valleys in search of grass. Because the park is largely surrounded by public land (national forest), this should not be a problem, but there are grazing leases on some of that land. Areas attractive to buffalo are some of the same areas grazed by domestic cows. Numerous environmental organizations and private individuals would like to see the public lands surrounding the park made available to bison. These public lands do not have cows on them in winter and most of the spring. The U.S. Forest Service has stated it will not allow cattle on those lands until 30 to 60 days after the buffalo have gone.

Since buffalo and cattle have a genetic relationship extending back many years, they are capable of mating. A Montana state veterinarian talked with the author several years ago about the theoretical possibility of a bull buffalo passing the disease to a domestic cow in the mating process. He said it is possible for cows, grazing among the afterbirth materials of an infected buffalo, to ingest the bacteria, although it is highly unlikely given the fact that the brucella organism has limited viability outside its host and is quickly killed by direct sunlight. That same vet suggested the organism could remain frozen for months in a patch of old snow lying in the shade, then come to life in a sudden moment of summer sun. However, Rudner says there is no known instance of transmission from wild buffalo to domestic cattle. No one has produced a credible scientific study that shows transmission of brucellosis from buffalo to domestic livestock under natural pasture conditions where the animals mingle.

The Federal Animal and Plant Health Inspection Service, the agency charged with setting national standards for domestic animal health, maintains the risk of brucellosis transmission is so slight that there is no harm in buffalo and cattle using the same areas so long as it is not at the same time. The Montana Stockgrowers Association and the Montana Department of Livestock insist the risk is real. Frightened of sanctions being imposed on Montana cattle by other states, they have gone to battle with a vengeance, declaring that all Montana ranchers are at risk if the state loses its brucellosis-free status. The Animal and Plant Health Inspection Service does not have the authority to remove a state's brucellosis-free status merely because brucellosis exists in wildlife. A new regulation specifically stated that even if an infection occurs in one herd, the APHIS will not take away a state's brucellosis-free status unless it appears in a second herd. It is this controversy over brucellosis that makes it into the press. The broad political agenda here is one that has to do with big government and states' rights—what westerners consider the "taking" of their land, public or not.

Rudner gives us twelve essays where she traces her encounters with the American buffalo exploring its fragile existence. She witnesses the Montana's Department of Livestock pursuit to destroy buffalo that are either infected with brucellosis or that wander out of their grazing territory. She speaks with ranchers who are enraged that these animals have strayed out of the park onto their land. She visits individuals that have a passion for this cause and listens in on meetings attended by activists and private citizens fighting for, and against, the buffalo's freedom. Her stories bring wildlife politics to light, pitting rancher against environmentalist, bureaucrat against Native American, and even government agencies against each other.

Filled with emotion and passion from individuals and organizations on both sides of the preservation issue, she includes the oldest link to the buffalo, the Native Americans. To Native Americans the buffalo is a symbol, not only of the past but of the future. The buffalo is an American icon and its continual struggle for a place in our world is the subject of the book.

In Rudner's twelve essays she tells of her visits with the rancher, the government official, and the Native American. I didn't find any of her essays very interesting or informative.

She begins by saying she wants to write about the animal. She wanted the reader to ride through the Yellowstone backcountry, watching buffalo on vast, primeval meadows, seeing this gorgeous animal at home in an amazing landscape. I kept waiting for her to write more about the buffalo and less about the people and places she visited.

Sixty-five million buffalo once roamed the United States. Now about 2,500 of these majestic animals wander freely in Yellowstone National Park, which was once considered a safe haven. *A Chorus of Buffalo* gives the real picture of the struggle for survival these animals must endure from their chief predator, man. As the reader I wanted to hear more about the buffalo and less about the author's encounters with man.—*Jan Wiedemann,* Texas Section, Society for Range Management, Vernon, Texas.

Wildlife Stewardship and Recreation on Private Lands. By Delwin E. Benson, Ross "Skip" Shelton, and Don W. Steinbach. Edited by Judy F. Winn. 184 pp., 23 b&w photos, 8 tables, appendices, bibliography and index. Texas A&M University Press, College Station, US$29.95 hardcover. ISBN 0-89096-872-1.

Appropriately, the authors open the first chapter with Aldo Leopold's memorable words from *A Sand County Almanac*: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." This statement gives you the tone of the book and of things to come in this remarkable volume.

From the start the title seems controversial, because of the nature of the subject. In the Western states there is a constant clash between private lands and wildlife management issues. The problem is also compounded with the increasing demands of recreationists. Some recreation enthusiasts seem to show no respect when trespassing private land and in turn the owners are forced to impose more restrictions on private land access. Yet in this book the authors manage to tackle these various issues and offer pragmatic ideas for all concerned parties: private land owners, recreationists, and wildlife management agencies. According to the authors, implementation of the ideas presented in this volume will help us all to work together for the cause of wildlife conservation and stewardship of the land.

In order to understand the magnitude of this issue one has to realize that 85% of U.S. wildlife is found on private lands, and 2/3 of all land in the United States is privately owned. To illustrate the pragmatic nature of their ideas the authors give a European example:

> *Hunting may be a controversial activity opposed by some, but when controlled properly it is a natural tool of wildlife management. The production and harvest of wildlife for recreation, meat, and other products is much higher in European countries than in the United States (Bubenik 189). The human population is also considerably larger in Europe than in the United States, yet wildlife populations are thriving. In Germany the public has open access to many lands for recreational purposes. People may enter privately owned farmlands or forestlands pro - vided they do not interfere with agricultural or forestry enterprise (p. 16).*

Because of the conflicting interests presented the authors offer viable solutions that could help all. For example, the government could help private land owners in the following areas: estate and inheritance taxes, conservation easements, property taxes, federal income taxes, investment tax credit, liability; and landowner-friendly regulations. These measures are very likely to enhance opportunities for recreation, wildlife management and good stewardship.

In conclusion, the authors have done a remarkable job tackling one of the most pressing issues that concerns different parties: wildlife management, private land, and recreation demands. These issues are by no means easy to solve, but the authors managed to suggest very pragmatic ways to alleviate the tensions between the concerned parties and hopefully help wildlife thrive, especially endangered species.—*Mo Khamouna,* Nebraska College of Tech. Agriculture, Curtis, Nebraska.

Greener Pastures: Politics, Markets, and Community Among a Migrant Pastoral People. By Arun Agrawal. 1999. Duke University Press, Durham and London. 219 p. US$17.95 Paperback. ISBN 0-8223-2122-X.

This book uses the story of the raikas, a little known group of migrant shepherds in the semiarid parts of western Indian to revisit and supplement contemporary research on the nexuses between markets, politics, resource management, and community hierarchies. Specifically, the book asks three questions. First, why do the raikas migrate? Second, why do they migrate jointly? Finally, what institutions have they developed to deal with the problems that inevitably arise in the conduct of joint tasks? The author uses the eight chapters of this book to shed light on these questions. In the rest of this review, I shall comment on five of the book's eight chapters. This should provide the reader with a good idea of the intellectual contributions of this book.

The extant literature on pastoralists like the raikas has generally viewed them in one of two distinct ways. Some have seen such people as irrational creatures who are unable to function effectively in today's world. Others have seen them as highly innovative but threatened beings. This dichotomy notwithstanding, the author notes that the present literature on pastoralists does suggest that the actions of these people are likely to lead to the disappearance of the pastoralist lifestyle. Chapter 1 begins the process of debunking this suggestion by pointing to the utility of migration. As the author helpfully explains, "mobility is a strategy raika shepherds deploy to accommodate the spatial and temporal structure, intensity, and unpredictability of environmental variations" (p. 23).

Chapter 2 examines conflicts regarding the use of the grazing commons in Patawal village. It is noted that the benefits from the grazing commons are unequally distributed among the different castes in the village. This is largely because the "upper caste, landowning groups [have] used their control over the Village Council to enclose the village common and force some shepherds to migrate longer and more frequently" (p. 59). From a research perspective, this state of affairs leads to a rather counterintuitive finding. This finding is that social actors with the power to create new institutions will, on occasion, act rationally to reduce the absolute amount of their discounted benefits.

Chapter 4 studies the nexuses between mobility and sheep herding. It is noted that in comparison with migration as an individual household, joint or collective migration not only allows the raikas to combat political and environmental variability, but it also ensures higher economic benefits. As the author explains, "if the raika economy seems to be alive and well, it is only because of their...skill at collective mobility. Movement alone...would not help the shepherds enough" (p. 92). This is a nice chapter. It would have been even nicer had the author been more careful with his terminology. In particular, the notion of scale economies is bandied around somewhat cavalierly. Here is an example. On p. 95, the author says that by migrating jointly, the raikas ensure themselves at least 3 sets of economies of scale; one of these is the "lower payments of bribes and fines to government officials and settled populations." Generally speaking, this is not the way in which one thinks of scale economies. Moreover, even if this claim were true, surely it would be offset—either partially or wholly—by the diseconomies of scale arising from the much larger numbers of sheep that now require the attention of the shepherds. This last point is not discussed by the author.

The role of markets and exchanges in the lives of the raikas comprises the subject matter of Chapter 5. A central point made in this chapter is that even when parties in transactions are equal, even when the transactions are voluntary and free, and even when the bargaining powers of the parties matter, "the outcomes are unavoidably and systematically inflected by politics and the everyday social relations and production processes that lead to the transactions" (p. 121). This is a useful point and it deserves to have been made. Unfortunately, the same cannot be said about some of the other points that are made in this chapter. Here are two examples. On p. 105, the author says that face-to-face negotiations are the hallmark of competitive price setting. This is certainly at odds with the standard model of competitive price setting in economics which requires, *inter alia*, that transactions be "arms-length." On page 119, the author says that in standard undergraduate economics textbooks, buyers and sellers are unable to influence prices except by colluding. He then goes on to note that shifts and movements of demand and supply curves "remain underexamined." Nothing could be further from the truth. As discussed in most standard undergraduate economics textbooks, parties don't have to collude to influence prices. In fact, undergraduates—at the intermediate level and beyond—are taught oligopoly models in which sellers, for instance, can influence prices. Moreover, in undergraduate economics examinations, it is quite common to ask students to distinguish between events that result in movements along demand and supply curves and those that result in shifts of these curves.

Chapter 7 uses a principal/agent framework to explain the observed arrangements that describe the relations between the raika shepherds and their leaders. A specific point of interest here concerns the role and the nature of monitoring of the leader (the agent) by the shepherds (the principals). The author's analysis leads to two implications. First, when the actions of leaders "directly reduce the benefits of their followers, extending greater authority to followers to hold leaders accountable is even more likely to reduce cheating behavior [by the leaders]" (p. 161). Second, given that a large number of shepherds in a group weakens incentives to monitor, "institutional design must aim at lowering the costs of monitoring and collecting information" (p. 161). These are useful points and the use of a multiple-principal/single-agent framework is apposite. This notwithstanding, the author does not go far enough in his analysis. Surprisingly, with the exception of a one line reference on p. 161 to the common agency literature, the author pays no attention to what this literature might tell us about the interactions between the shepherds and their leaders. Further, on p. 152, the author unnecessarily restricts his discussion to an equilibrium in pure strategies. Are there mixed strategy equilibria? Can one construct reasonable payoffs such that one or the other player has a dominant strategy? What happens when the game being played is repeated over time? These sorts of interesting questions are left unanswered by the author.

In conclusion, let me say that is is an informative book. It makes a number of useful points that should be of interest to students of range management and to those readers who are interested in the more general political economy questions that affect resource allocation and management in semiarid areas.—*Amitrajeet A. Batabyal*, Rochester Institute of Technology, Rochester, New York.

WISDOM BORN OF AGES

Behind the curtains of my mind
Lies a landscape yet unscathed,
With rolling hills and cliffs
Above a whispering satin stream.
The sun is gently setting,
Casting shadows long and tall.
The eastern sky reflect its rays,
And a tow'ring peak o'erlooks it all.

As darkness gently cloaks the land
And earth and sky draw closer,
Cool airs drain from mountaintops
And stars begin to shine.
The winds of day have gentled now to a gently shifting breeze,
And as the moon above the hilltops rises
The land begins to speak.

The gentle swaying cottonwoods
Along the river whisper
Words of wisdom born of ages,
Of lifetimes come and gone.
They tell of endless patience
For the challenges of life;
Of bending but not moving,
No matter what the strife.

Upon the rolling hillsides,
The waving grasses join.
They tell the history of this land,
Of fire and of drought,
Of summers full of sunlight,
And winters cold and dark.
They tell of herds of bison,
And pronghorn, deer and elk.

In the rise and fall of the land's quiet song
The theme of life unfolds.
The ebb and rush of night and day,
The changing of the seasons,
The gift of rain,
The curse of drought,
The fires rejuvenating.
All part and parcel of the circle
Uniting earth and sky.

Behind the curtains of my mind
Lies a truth we oft forget:
That earth and sky were here before us -
Not to serve us as we wish.
And when man's time of reign has passed,
The land will be here still,
To tell of lifetimes come and gone,
And wisdom born of ages.

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