ELK/CATTLE INTERACTIONS:
AN ANNOTATED BIBLIOGRAPHY FOR THE INTERNET

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ABSTRACT

Science is a vital component of natural resource management. Land managers should rely on sound science to make and evaluate appropriate land management decisions. Hence, most natural resource managers need easy access to pertinent scientific material. The objective of this project was to create an easily accessed collection of important, summarized research on elk/cattle interactions. This database compiled 34 research and non-research articles. Research articles included significance, methods, results, and implications sections. Non-research articles included purpose and summary sections. Each article was designated as: professional resource knowledge, scientific synthesis, experimental research, or documented case histories. The summaries are organized into five topic sections of elk/cattle interactions including: Grazing Effects on Forage Quality, Diet/Habitat Interactions, Elk Response to Grazing Systems, Management Programs to Reduce Elk/Cattle Conflict on Private Land, and Disease Interactions Between Elk and Cattle. The summaries were published as annotated bibliographies on the Internet (www.uidaho.edu/range/elk_cattle/). The product was intended to help wildlife and range managers maintain adequate habitat, support decisions, and assist concerned citizens.

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CHAPTER I

PROMOTING SUCCESSFUL ELK/CATTLE MANAGEMENT BY INTERNET

Introduction

Some of the greatest challenges for land managers include finding ways to mitigate the effects of human disturbance on native plants and animals. The challenge for wildlife and livestock land managers is to identify and apply livestock grazing practices that promote good livestock-wildlife relationships (Vavra et al. 1999). To accomplish this task, natural resource managers need reliable scientific information on which to base management decisions (Kelly 2000). Additionally, this information needs to be readily available to managers and concerned citizens. The Internet shows promise for channeling valuable information. This thesis creates a database providing synthesized elk/cattle research to facilitate comprehension of their interactions published via the Internet.

Elk-Cattle Interactions

Elk and cattle habitat management can be challenging. The dilemma is characterized primarily by private land disputes, elk /cattle forage allocation and utilization, and disease transmission (Loomis et al. 1989, Cool 1992, Thorne and Herriges 1992). Mixed ownership of valuable wildlife and domestic stock habitat among public and private entities is a leading source of wildlife/livestock disputes (Cool 1992). Clearly, habitat availability may be limited leading to substantial dispute regarding elk and cattle abundance, forage requirements and, seasonal elk habitat. Annual elk migrations initiate conflict because significant portions of traditional elk home range have been converted to agricultural uses (Morris 1956, Cooney 1952). Private landowner studies reveal common perceptions that elk numbers are increasing above allowable levels, with some exceptions because of the aesthetics and hunting opportunities that elk provide (Nielsen et al. 1986, Jordan and Workman 1989, Rimbey et al. 1991, Gerrans 1992, Lacey et al. 1993). Consequently, elk population levels are significantly related to private landowner perception and, therefore, tolerance (Edge and Marcum 1990, Lacey et al. 1993, Van Tassell et al. 2000). Lack of tolerance by private landowners to big game effects can cause contention among landowners, land managing agencies, and wildlife enthusiasts.

Some authors consider livestock grazing a pervasive land use that has greatly degraded wildlife habitat (Vavra et al. 1999). However, appropriate livestock grazing is considered by some managers the most important and usually the least expensive way to improve forage production on rangeland (Anderson 1969). Benefits to elk from appropriate livestock grazing include improvement of winter forage quality (Anderson and Scherzinger 1975, Clark et al. 1998, Clark et al. 2000).

The extent of efficiently promoting private landowner/agency cooperation depends on the degree of knowledge concerning wildlife/livestock interactions that land managers and society possess. Cooperation depends largely on facilitating proper elk/cattle grazing on western public ranges to maintain adequate habitat and appropriate population levels. Implementing appropriate management strategies requires knowledge of competition theory, ungulate diet selection, forage requirements, ungulate habitat requirements, grazing forage impacts, disease transmission and, economic assistance to reduce big game damage on private lands (Anderson and Scherzinger 1975, Hansen and Reid 1975, Hanley 1982, Hanley and Hanley 1982, Thomas 1984, McCorquodale and DiGiacomo 1985, Grover and Thompson 1986, Wallace and Krausman 1987, Loomis et al. 1989, Rimbey et al. 1991, Westenskow-Wall et al. 1994, Van Tassell et al. 1995, Sheehy and Vavra 1996, Thorne et al. 1996, Clark et al. 1998a, Clark et al. 1998b, Clark et al. 2000). Ready access to such knowledge should help natural resource managers establish appropriate elk-cattle management on public and private land.

Facilitating Information Transfer

Scientific information allows resource managers to appropriately evaluate and adjust management decisions (Biddle et al. 1995). Additionally, compiled scientific information is needed to characterize habitat needs of wildlife species (Western Regional Planning Committee 1977). The Bureau of Land Management, US Fish and Wildlife Service, and National Parks Service employees were surveyed to evaluate where they acquired natural resource information (Biddle et al. 1995). Agency on site files, Department of Interior and other agency or organization experts, and informal networks with colleagues were chosen as their top three sources of information (1.54, 1.77, 1.77 respectively on a scale of 1=often, 4-never). The Internet received the lowest ranking because of limited access to information at the time of the survey (Biddle et al. 1995).

Technology is rapidly improving, however, and electronic forms of information are becoming integral to normal daily functions (Nodine 1998). Internet, bibliographic databases, and CD-ROM, for example, have increased the capability to store and retrieve scientific information. The Institute for Scientific Information (ISI) is a database publishing company that maintains multidisciplinary, bibliographic databases of research (www.isinet.com/about/overview.html). ISI recently produced Journal Citation Reports (JCR), a CD-ROM database product that includes citations from about 4,500 scientific journals (Jasco 1996). Additionally, ISI and biological sciences information service of biological abstracts (BIOSIS) are now producing a web-based version of BIOSIS Previews for the ISI Web of Science (web7.infotrac.galegroup.com). The Web of Science, and other databases currently provide 3,200,000 record links to full text documents of journal articles (web7.infotrac.galegroup.com).

The magnitude of available literature certainly indicates the arrival of the information age (Nodine 1998). The utility of this era, however, is largely associated with how well information is found, transferred, and retrieved (Finch and Mallory 1992). Published results are not always available in usable formats by resource managers. Additionally, retrieval of information in remote locations may be complicated by distance or funding (Finch and Mallory 1992). Consequently, valuable research that would benefit land management remains idle among countless numbers of stored journal publications (Thomas and Salwasser 1989). There is a greater need than ever to synthesize information using practical formats (Thomas and Salwasser 1989, Finch and Mallory 1992). The synthesized information and method of transfer should allow for the common use of information by various organizations and disciplines (Finch and Mallory 1992).

The need for efficient information transfer coincides with increasing demand by state and federal natural resource professionals for scientific based research (Wilson 1995). This need also corresponds with the increasing popularity of the Internet. However, while some may have difficulty adjusting to rapidly advancing technology, undoubtedly, technology has become more effortless to grasp (Nodine 1998). Via Internet transfer, natural resource professionals can obtain this synthesized scientific database that is imperative for developing prudent elk/cattle management decisions (Kelley 2000).

The need has emerged to synthesize information using practical formats (Thomas and Salwasser 1989, Finch and Mallory 1992). The design of electronic information sources should allow for the common use of information by various organizations and disciplines (Finch and Mallory 1992). Consequently, the objectives of this project were to summarize information in journal articles written about elk/cattle interactions and make this information available to land managers in a web-based database of article summaries.

Methods

This annotated bibliography of research articles about elk/cattle interactions was created using papers found at the University of Idaho Library. Studies were found by searching on-line reference databases such as Agricola and Absearch using keywords related to elk/cattle interactions. Articles were first briefly skimmed to determine their relevance. Literature citations from many articles, even marginally related to the topic, were then also skimmed to detect additional elk/cattle studies not identified by the on-line databases. Selected studies were organized using a card-catalog system to prevent re-examination of a previously reviewed or selected article. Documents were also classified according to the subject content. Consequently, five categories were created. The categories include: Grazing Effects on Forage Quality, and Diet/Habitat Interactions, Elk Response to Grazing Systems, Management Programs to Reduce Elk/Cattle Conflict on Private Land, and Disease Interactions Between Elk and Cattle.

Grazing Effects on Forage Quality studies examine elk and/or cattle grazing effects on vegetation vigor and quality. These articles also include the implications of vegetation grazing effects on elk and/or cattle population maintenance. Diet/Habitat Interaction studies are related strictly to the species and habitats commonly utilized by elk and cattle and, how to minimize overlap to reduce perceived competition. Studies in the Elk Response to Grazing System category describe systems that have been implemented based on plant and animal nutrient and growth requirements or, how grazing systems influenced elk distribution and plant community composition. The Management Programs to Reduce Elk/Cattle Conflict on Private Land category includes studies revealing approaches implemented to reduce adverse economic and social impacts caused by big game depredation on private winter range. Disease Interactions Between Elk and Cattle studies describe the historical status and transmission of disease such as brucelosis between elk and cattle. Programs to reduce the potential for transmission are also described.

All studies were further classified as: professional resource knowledge, experimental research, documented case histories, or scientific synthesis (Krueger and Kelley 2000). Professional resource knowledge represents material based on experience and qualitative knowledge of the authors in a particular field.

Experimental research is characterized primarily by replicated research whereas documented case histories also represent research, but not replicated. Additionally, experimental research and documented case histories describe cause and effect relationships, however, the conclusions drawn form replicated research can be applied to a wider geographic extent than those of documented case histories. Scientific syntheses are specialized literature reviews of original research. Scientific syntheses are reports that draw upon results from various fields to provide a large-scale description of a topic. Experimental research papers are organized into four sections: significance, methods, results, and implications. Because the other types of papers do not follow scientific protocols, they are organized into two sections: purpose and summary.

Project Summary

Literature reviews provide systematic knowledge and identify pertinent research. This is critical for managers because only appropriate science must be utilized (Thomas and Burchfield 2000). Studies were evaluated from a wide selection of journals because most journals are inaccessible to managers operating in remote locations. Additionally, data variety was necessary because scientific results are not universal in geographic application (Kelley 2000). Consequently, a large set of reference articles were sought to provide diverse approaches that have been used to reduce elk and cattle conflict.

Data quality and identity varies (Marlow 2000). Hence, categorizing scientific reports is necessary to distinguish between accepted scientific procedures and scientific opinion. The goal of this project was to gather the most useful, valuable, and reliable research pertaining to elk and cattle interaction studies. Categorizing articles according to Krueger and Kelley (2000) provided a way to group pertinent material on the basis of scientific merit. Such material should provide management with the basis of scientific data and allow managers to document scientifically supported decisions (Kelley 2000). Summaries of these articles are presented in Chapter 3 of this thesis.

Publishing this database on the Internet will allow wide distribution and provide efficient use (see Chapter 4). The database will be announced in Rangelands or a Journal of Range Management publication as a summary of elk/cattle interactions to increase awareness (see Chapter 2). Knowledge of this database may also occur by announcement on the USDA Forest Service Region 1 home page.

Future goals of this project are to complete the summarization of current articles in my possession and to continue gathering important elk and cattle research to enhance the database and benefit resource managers throughout the western United States.

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CHAPTER II

COMPLEXITIES OF ELK AND CATTLE INTERACTIONS: ISSUES AND POTENTIAL SOLUTIONS

Origins of Elk/Cattle Interactions

Land managers and researchers have long been concerned with the concept of competition between livestock and native ungulates and with approaches for promoting appropriate grazing relationships (Vavra et al. 1999). Concern about elk and cattle competition for space and forage and worries over transmission of disease emerge where cohabitation occurs. Coexistence of wildlife and livestock on North American rangeland, however, is not sufficient evidence to document competition.

Debates over livestock-wildlife interactions have been waged for nearly 100 years (Leek 1911, Graves and Nelson 1919). Much research and concern surrounds elk and cattle interactions on western rangelands. Elk and cattle interactions have traditionally been considered competitive because these species have similar diet and habitat preferences (Wisdom and Thomas 1996). Increased urbanization has intensified concerns by limiting habitat and forage resources, thereby, increasing the likelihood for conflict (Vavra and Sheehy 1996). Competition between elk and cattle may also involve disturbance or displacement of one species by the other resulting in population declines (Wisdom and Thomas 1996). Consequently, competition between elk and cattle continues to be examined. However, although definitive results have yet to be presented, indications of possible competition have been documented. Therefore, examining specific elk/cattle interactions is necessary to understand and facilitate successful management of these species.

Evidence for Competition

The potential for competition between two species depends primarily on the degree of diet and habitat overlap, especially when the food supply is limited (de Boer and Prinns 1990). Food availability and partitioning are important competition theory factors used to describe foraging relationships among coevolved species (Jenkins and Wright 1988). Elk and cattle, however, evolved separately (Vavra et al. 1999). The difficulty of defining their relationship is complicated because natural and anthropogenic factors influence their foraging and habitat use patterns. Consequently, competition may be less difficult to identify. Co-existence has been emphasized, as an alternative to coevolution, to define competitive herbivore interactions (Hastings 1987). Accordingly, herbivores adapt to forage and habitat conditions produced by other herbivores (Wiens 1977). However, this strategy for predicting herbivore adaptation to other herbivores is too simplistic to accurately define competition (Wiens 1977).

For competition to occur, interacting species must share a resource (i.e., habitat or forage) that is in short supply so that the populations of the competing species are damaged (Vavra et al. 1999). Elk starvation and mortality can certainly result from reduced forage supply (Morris 1956). However, research has not produced results suggesting reduced survival or reproductive potential in elk as a result of livestock grazing (Edge and Marcum 1990). Few studies have examined collective elk/cattle grazing impacts on forage availability and subsequent effects on their population status to confirm competition.

Social intolerance is an additional type of perceived competition between elk and cattle (Lyon 1985). This concept suggests that one species will avoid an area because of the presence of another species (Edge and Marcum 1990). However, research has shown that elk will avoid and select areas occupied by cattle, thus, the conditions that yield social intolerance are not well understood or documented (Lyon 1985).

While difficult to document competition conclusively, elk/cattle interactions may be defined by identifying diet and habitat selection and then inferring the effects of selection on forage availability, habitat quality, and population dynamics. Diet similarity has been commonly suggested as the basis of elk and cattle competition on western rangelands (Anderson et al. 1974, Lyon 1985, Dragt and Havstad 1987). Measured forage abundance, relative to grazing pressure, indicates habitat quality and the degree of competition between coexisting species (Westoby 1974, Wiens 1977). Additionally, knowledge of diet selection patterns increases understanding of ungulate ecology and impacts of herbivory on ecosystem function (Hanley 1982, Hobbs et al. 1983).

Diet/Habitat Interactions

Elk and cattle possess similar body and digestive morphologies. The dietary choices of these herbivores are governed by physiological and morphological adaptations to digestion with rumination (Baker and Hobbs 1987, Hofman 1989, Spalinger et al. 1993). Rumination increases food retention that facilitates digestibility of fibrous forage (Baker and Hansen 1985). This digestive strategy allows for increased efficiency of grass intake to fulfill energy requirements (Baker and Hansen 1985). Cattle have been classified as roughage feeders, while elk are considered intermediate type feeders (Hofmann 1989). Intermediate feeders exhibit a more flexible feeding style facilitating grazing and browsing depending on relative forage quality (Van Soest 1982, Hofmann 1989). Roughage feeders depend primarily on grass and fibrous plant material (Hofmann 1989).

Elk and cattle commonly select grass and grass-like plants (i.e., sedges and rushes), browse, and forbs throughout the year depending on their availability and quality (Table 1; Kufeld 1973, Holechek et al. 1982). Grasses, including Idaho fescue and bluebunch wheatgrass, are highly selected by elk during the spring (Kufeld 1973). Elk also select browse and forb species during the winter and spring, respectively, in addition to grasses and sedges (Nelson and Leege 1982). Wambolt (1996) also recorded greater than 90% consumption of mountain big sagebrush by elk during a 10-year study of natural winter foraging conditions. This may be because browse is more digestible than grass during the winter (Baker and Hobbs 1982). Hobbs et al. (1983) found reduced consumption of grasses by elk between November and January. Forbs are highly digestible and available in spring and are commonly selected by elk early in the growing season (Stephens 1966).

The cattle digestive system allows for relatively less diet variability throughout the year (Olsen and Hansen 1977). They select primarily grasses and sedges (Table 1; Hansen and Clark 1977, MacCracken and Hansen 1981, Sheehy and Vavra 1996). However, cattle may consume browse species in excess of 40%

in the absence of green grass (Holechek et al. 1982). Cattle also utilized forbs during the early part of the grazing season (Holechek et al. 1982). Hansen and Reid (1975) recorded up to 58% consumption of sedges by cattle in Colorado.

Dietary overlap between elk and cattle has been documented (Table 2: Patton and Judd 1970, Hansen and Reid 1975, Olsen and Hansen 1977, MacCracken and Hansen 1981, Kingery et al. 1996). Dietary overlap, in various locations, has ranged from as high as 89% in spring and 88% in summer to as low as 30 and 16% in summer (Hansen and Reid 1975, Olsen and Hansen 1977, Kingery et al. 1996). Overlap was attributed primarily to use of grasses and sedges (Hansen and Reid 1975, Olsen and Hansen 1977, MacCracken and Hansen 1981).

Habitat Considerations

Identifying the variables that influence ungulate use of habitat is difficult (Peek et al. 1982). However, elk generally migrate from high elevation summer rangeland to lower elevation winter rangeland in search of more tolerable climate and forage availability (Adams 1982). Elk usually occupy winter range, characterized as valley lowlands and adjacent mountain foothills after higher elevations have experienced significant snow depths and cover (Adams 1982, Skovlin et al. 1983). Cattle are also moved to lower elevations during winter as snow accumulates and temperatures become colder (Sheehy and Vavra 1996). Receding spring snowlines toward higher elevation, coupled with vegetative development initiates elk and cattle movement to higher elevation spring and summer pasture (Mueggler 1967, Frank and McNaughton 1992). Elk depend on summer range forage to provide annual nutritional requirements (Baker and Hobbs

1982). As the nutritional quality of summer forage declines with advancing season, elk maintain stable annual diet quality by exploring alternate food resources (Baker and Hobbs 1982, Collins and Urness 1983). Cattle usually graze forage grazed by elk during late fall and early spring. The effects of elk spring forage areas on summer cattle grazing could be more adverse than the effects of summer cattle grazing on winter food production for elk (Hansen and Clark 1977).

Environmental variables including forage plant density, distance to roads and cover, slope, elevation, and forage quality influence elk and cattle habitat selection in the spring, summer, and early fall (Grover and Thompson 1986, Edge and Marcum 1990). Cattle are also constrained by fences throughout the grazing season and by water requirements especially in late spring and summer (Sheehy and Vavra 1996).

Elk and cattle may exhibit dissimilar response to influential habitat selection variables, thus, reducing the likelihood for habitat overlap (Sheehy and Vavra 1996). For example, elk show greater preference than cattle for areas closer to grassland/forest vegetation edge types for security (Collin and Urness 1983, Sheehy and Vavra 1996). Human activities associated with livestock production may also influence elk habitat selection (Yeo et al. 1993). However, elk can become desensitized and tolerant of this human presence (Yeo et al. 1993).

Disease Transmission Between Elk and Cattle

Another potential concern regarding elk and cattle interaction is the transmission of disease. Brucellosis, caused by the bacteria *Brucella abortus,* can severely reduce elk and cattle reproduction (Thorne and Herriges 1992). Symptoms of brucellosis in domestic cows include abortion, infertility, reduced milk production, and delayed placental ejection from the uterus (Thorne et al. 1996).

Brucellosis eradication programs, initiated in the 1940's, treated infected cattle herds but not their wild counterparts (McCorquodale and DiGiacomo 1985). Therefore, the greater concern is the transmission of brucellosis from elk to cattle. The inclusion of wildlife into these programs was suggested to prevent wild populations from becoming hosts for the disease (McCorquodale and DiGiacomo 1985). Various serologic tests were conducted to detect the prevalence of *Brucella* in wild populations (McCorquodale and DiGiacomo 1985).

Brucellosis could be transmitted between elk and cattle during periods of close association (late winter and early spring). Domestic cattle can only get the disease if they come into contact with the placenta or birth fluids of an infected elk cow (McCorquodale and DiGiacomo 1985, Thorne and Herriges 1992). Transmission of brucellosis is extremely rare at any other time of year (Thorne and Herriges 1992). Additionally, contact with placental material is only likely in areas where cattle encounter dense populations of elk such as winter feedgrounds.

Elk were suspected to be highly susceptible to brucellosis because they did not evolve with the disease. However, little evidence was available to indicate active transmission of brucellosis between wild and domestic ungulates before 1990. A third of 32 elk ranging near infected bison in Yellowstone National Park tested positive for brucellosis in 1931. However, only 5% of elk outside the range of infected bison tested positive. Additionally, serologic surveys from several states and Canada indicated a low likelihood of infection in most elk populations (McCorquodale and DiGiacomo 1985).

Yellowstone National Park feedground elk were tested again in 1992 for brucellosis (Thorne and Herriges 1992). Only 1-2% of elk found outside the feedground complex, but inside Yellowstone, were infected by brucellosis (Thorne and Herriges 1992). Inside feedgrounds, about 5-12% of elk calves are lost to brucellosis infection (Thorne et al. 1996). Brucellosis is not thought to spread significantly among elk outside of feedground complexes (Thorne and Herriges 1992). Additionally, wildlife do not significantly impact the occurrence of brucellosis in cattle based on serologic tests and geographic distributions (McCorquodale and DiGiacomo 1985). Consequently, elk do not seriously threaten livestock with brucellosis contamination. Other diseases such as leptosporosis and bovine tuberculosis could cause significant impact on elk/cattle management but are currently not well researched (Adrian and Keiss 1977, Rhyan and Saari 1995).

Implications of Elk and Cattle Grazing on Forage Quality

Because elk and cattle share similar diet and habitat preferences, clearly these animals will use resources that were used by the other. However, elk and cattle use can be compatible on rangelands while maintaining the ecological integrity of the forage resource (Anderson and Scherzinger 1974). Improved grazing management practices can lead to improved forage conditions for both species (Anderson and Scherzinger 1974).

Vegetation improvement produced by spring cattle grazing can improve fall and winter forage quality for elk and cattle by delaying phenological development of perennial bunchgrasses as they enter dormancy (Anderson and Scherzinger 1974). Improved winter forage quality has been suggested as a critical component of winter habitat to maintain winter elk populations (Anderson and Scherzinger 1974, Pitt 1986, Westenskow-Wall et al. 1994, Clark et al. 1998a, Clark et al. 1998b).

Forage defoliation treatments have been conducted to simulate grazing effects on forage quality. Early season forage defoliation has improved winter forage quality for wildlife species (Pitt 1986, Westenskow-Wall et al. 1994, Clark et al. 1998a, Clark et al. 1998b). Plants defoliated during the reproductive stage exhibit greater crude protein content and digestibility relative to ungrazed plants (Clark et al. 1998a). Bluebunch wheatgrass, Idaho fescue, and elk sedge crude protein and, bluebunch wheatgrass digestibility, may be improved by defoliation during early development in spring relative to ungrazed plants (Pitt 1986, Westenskow-Wall et al. 1994, Clark et al. 2000)

Improved forage quality, characterized by increased levels of required nutrients, following forage defoliation can contribute to higher over-winter survival of elk (Clark et al. 1998a). Cattle should realize the same benefits, as their nutritional requirements are similar to those of elk (Nelson and Leege 1982). An added benefit of improved quality is the removal of seed stalks and stems, thus, improving the forage's palatability (Clark et al. 2000). Unpalatable plants hinder optimum foraging by reducing access to palatable plants (Collins and Urness 1983). Therefore, improved palatability may be attributed to increased accessibility of vegetative plant parts (Clark et al. 1998a.). Time spent harvesting important nutrients per unit of nutrient ingested is reduced which facilitates elk and cattle feeding styles (Clark et al. 1998a.)

Spring and fall defoliation treatments improve forage quality (i.e., crude protein and digestibility), however, production may be sacrificed. Ungrazed bluebunch wheatgrass produces greater dry matter yield relative to plants grazed during any stage of development (Clark et al. 1998a, Clark et al. 1998b). Plant production may decline with the removal of plant material during flowering and seed production. While potentially detrimental to plant productivity, however, forage defoliation can be implemented without adversely affecting habitat quality by the use of carefully planned cattle grazing and/or appropriate elk-cattle population maintenance (Anderson and Scherzinger 1974, Clark et al. 1998b). Carefully planned cattle grazing (i.e., rest and deferment) allows time for some plants to build carbohydrate levels, thus, maintaining adequate production, whereas other plants are grazed according to appropriate levels of intensity and duration to maintain forage quality.

Elk and Cattle Conflicts on Private Land

Competition is difficult to document. However, the difficulty associated with allocating forage to elk and cattle economically, after elk occupy private winter range, significantly increases the complexity of successfully managing these species (Vavra et al. 1999). Perhaps, competition can be addressed in terms of the economic and social implications of big game use on private lands in winter. Snow cover at high elevations and forage and habitat availability at lower elevations often cause wildlife to migrate to lower altitudes in winter (Rimbey et al. 1991).

Diverse land ownership at these elevations can cause significant wildlife issues (Rimbey et al. 1991, Van Tassell et al. 1995). Conflict arises over elk use of private agricultural lands once considered traditional wildlife winter range. For example, elk may increase alfalfa utilization, as more preferred forages become less available (Austin and Urness 1987). Forage and hunting issues related to elk use on private land can cause significant social and economic impacts to landowners and wildlife enthusiasts (Nielsen et al. 1986, Lacey et al. 1988, Van Tassell et al. 1995).

Claim systems were created to help state wildlife management agencies compensate landowners for damages caused by state-owned wildlife (Nielsen and McBride 1989, Rimbey et al. 1991). States are responsible for damages caused by wildlife because they are responsible for their management (Vavra et al. 1999). Claims provide landowners with the opportunity to report forage losses caused by elk grazing on their land (Rimbey et al. 1991). Increased number of claims submitted to state game agencies by private landowners indicates the level of depredation throughout the West (Austin and Urness 1987, Van Tassell et al. 1999). Hay and crop damage is significant because they are intended for livestock use and cultivation (Lacey et al. 1993). A 1993 survey of private landowners showed growing intolerance toward elk use of forage resources with more than half of respondents desiring measures to reduce elk numbers (Lacey et al. 1993). While many species of big game can cause damage, landowners in a 2000 survey were less tolerant of elk related damages than damages caused by antelope, deer, and moose (Van Tassell et al. 2000). This perception occurred even though compensation returns associated with elk claims were less valuable than those for deer and antelope (Van Tassell et al. 2000).

Damage claims totaled more than $11 million in 1995 in Wyoming (Van Tassell et al. 1999). Likewise, Lacey et al. (1993) reported an average loss of $6,467 per landowner to big game damages. Damage claim amounts increased from less than $50,000 in 1950 to more than $250,000 in 1994 in Wyoming (Van Tassell et al. 2000). Other costs and damage associated with big game include fencing, trampling, defecation, illegal hunter trespass, and hunter damage (Nielsen and McBride 1989, Rimbey et al. 1991, Swensson and Knight 1998).

Claim reimbursement programs have ineffectively provided full compensation to landowners for wildlife damage. Many landowners describe damage claim payments as unfair or insufficient (Nielsen and McBride 1989, Van Tassell et al. 1999). Methods used to assess relative wildlife damage have also been subject to inaccuracy in claim descriptions (Rimbey et al. 1991). For example, the forage consumption method, a method used to determine wildlife utilization, failed to account for trampling and defecation costs (Rimbey et al. 1991). Additionally, number of animals estimated, and the period of residence reported could be stated inaccurately by claimants (Rimbey et al. 1991, Lacey et al. 1993). Ineffective claim payments can produce sentiment among ranchers that wildlife management agencies are allowing wildlife resources to increase at the rancher's expense, as wildlife primarily survive on private lands during winter (Nielsen and Mc Bride 1989).

While hunting has provided some degree of relief from adverse economic impacts caused by elk damage, it has proven ineffective in providing sufficient compensation. This dilemma occurs because big-game animals sometimes utilize certain private lands for an extended time before moving to a different location at the onset of the hunting season (Nielsen et al. 1986). Thus, the economic burden of wildlife utilization can be disproportionately shared among private landowners (Nielsen et al. 1986). Hunting has been associated with unacceptable levels of road and fence damage (Lacey et al. 1988). Landowners have also experienced difficulty modifying management programs to adjust for increasing wildlife numbers and associated hunting impacts (Nielsen and McBride 1989, Lacey et al. 1993).

Reducing Elk-Cattle Conflicts

Research has provided management with practical approaches and the rationale for improving elk-cattle management. Grazing systems have been implemented that result in habitat improvement. Indirectly, improved elk-cattle management on public lands has improved cooperation among livestock and wildlife interests. Herbivore interaction research continues to be a vital component of successful elk-cattle management.

Frisina and Morin (1991) described an approach used by the US Forest Service, Montana Fish Wildlife and Parks, and a private landowner to improve habitat on public and private land and provide greater foraging opportunities for elk and cattle. The system incorporated is rest-rotation cattle grazing on combined public and private land. The incorporation of private land into the grazing system can increase winter range for elk and reduce spring and winter grazing impacts by elk on cattle. Consequently, census data for elk and cattle showed increased numbers over a period of 35 years. Improved rangeland and soil conditions were also realized.

Frisina (1992) and Alt et al. (1992) also describe grazing systems that improved elk and cattle habitat in Montana while reducing conflict between private landowners and land managing agencies. Both approaches used a planned livestock grazing system based on habitat requirements and improving forage quality for elk and cattle. Subsequent adverse impacts caused by winter utilization on private lands by elk were also reduced.

Planned cattle grazing systems based on range research techniques and results show promise for reducing elk and cattle conflict. However, providing big game winter range requirements will continue to significantly influence the success of elk/cattle habitat management and cooperative programs that reduce landowner/agency disputes. Accordingly, effective approaches have been developed to increase cooperation among livestock and wildlife interests.

A proposed solution for providing economic relief for depredation and maintaining suitable wildlife habitat has been providing private landowners that incorporate wildlife management into their livestock operations with economic assistance for their efforts. Some state agencies have also required that private landowners allow hunting access before they can file damage claims (Van Tassell et al. 1995). However, such efforts have proven ineffective because the profits gained from such efforts by landowners are much lower than those gained from normal livestock functions. Fee-hunting provides economic incentive for private landowners to maintain hunting access and increase cooperation among hunters and livestock producers (Thomas 1984). Ultimately, final resolution of private land disputes will require cooperation and respect among landowners, natural resource agencies, and wildlife supporters (Vavra et al. 1999).

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Table 1. Percent sedge, grass, forb, and browse in elk and cattle diets in Western North America. Diets in these studies were determined by fecal analysis

	Percent of Diet			
Forage Class	Cattle	Elk	Season Examined	Source
Sedge	8.0	21.0	Summer	Hansen and Reid (1975)
Grass	53.5	83.0		
Forb	31.6	---		
Browse	3.5	10.0		
Sedge	30.0	32.0	Summer	Hansen and Clark (1977)
Grass	58.0	24.0		
Forb	3.0	4.0		
Browse	2.5	27.0		
Sedge	4.0	1.0	Four-season average	Olsen and Hansen (1977)
Grass	74.0	62.0		
Forb	5.0	1.0		
Browse	10.5	29.0		
Sedge	40.0	17.0	Summer	MacCraken and Hansen (1981)
Grass	49.0	37.0		
Browse	1.0	23.0		

Sedge	17.2	12.0	Early mid summer – early fall average	Kingery et al. (1996) Study 1
Grass	67.8	51.7		
Forb	1.3	14.7		
Browse	1.4	12.7		
Sedge	5.3	8.5	Early/mid summer – early fall average	Kingery et al. (1996) Study 2
Grass	75.9	42.4		
Forb	3.4	20.6		
Browse	1.5	15.6		

Table 2. Percent of diet overlap ranges between elk and cattle foraging on rangeland in Western North America

Overlap (%)	Major Species Selected	Season of Overlap	Location	Source
30 – 50	sedge, fescue, bluegrass	Summer	Fort Garland, Colorado	Hansen and Reid (1975)
39 – 53	sedge, needlegrass, wheatgrass	Summer	Northwestern Colorado	Hansen and Clark (1977)
16 – 89	wheatgrass, needlegrass	Four season average	Red Desert, Wyoming	Olsen and Hansen (1977)
39	wheatgrass, sedge	Summer	Southcentral Colorado	MacCracken and Hansen (1981)

37 – 74	bluegrass, sedge	Early/mid summer - early fall average	Northern Idaho	Kingery et al. (1996)

CHAPTER III

ELK/CATTLE INTERACTIONS: AN ANNOTATED BIBLIOGRAPHY

Introduction

The effectiveness of land use management is a function of the level of science on which it is based (Krueger and Kelley 2000). However, science and experience are both important in making and implementing land use decisions (Krueger and Kelley 2000). Experience combined with relevant scientific data provides a powerful approach to effective natural resource management (Krueger and Kelley 2000). Hence, resource professionals need to understand the relevance and class of available scientific data because scientific results are significantly abundant and dynamic (Marlow 2000).

Elk and cattle interactions represent just a fraction of the total realm of subjects needing scientifically based management in the western United States. Though just a small topic, elk/cattle interactions are, in fact, critical components of multiple-use land management. Additionally, elk/cattle interactions research is also abundant and can potentially be quite dynamic.

As with most information, published results on elk/cattle interactions are not always available in usable formats by resource managers. Additionally, retrieval of their information in remote locations may be complicated by distance or funding (Finch and Mallory 1992). Consequently, valuable elk/cattle research that would benefit land management remains idle among countless numbers of stored journal publications (Thomas and Salwasser 1989). The need has emerged to synthesize this information using practical formats (Thomas and Salwasser 1989, Finch and

Mallory 1992). The synthesis and method of transfer should allow for the common use of this information by various organizations and disciplines (Finch and Mallory 1992).

To accomplish the goal of providing usable information for natural resource management, I read many published research reports on elk/cattle interactions and created individual research summaries (34) of the articles most central to the topic. The summaries were categorized under the categories: Grazing Effects on Forage Quality, Disease Transmission Between Elk and Cattle, Diet/Habitat Interactions, Management Programs to Reduce Elk and Cattle Conflict on Private Land, and Elk Response to Livestock Grazing Systems. These summaries were also classified as: professional resource knowledge, experimental research, documented case histories or, scientific synthesis (Krueger and Kelley 2000). Professional resource knowledge represents material based on experience and qualitative knowledge of the authors in a particular field. Experimental research is characterized primarily by replicated research whereas documented case histories also represent research, but not replicated. Additionally, experimental research and documented case histories describe cause and effect relationships, however, the conclusions drawn form replicated research can be applied to a wider geographic extent than those of documented case histories. Scientific syntheses are specialized literature reviews of original research. Scientific syntheses are reports that draw upon results from various fields to provide a large-scale description of a topic.

Grazing Effects on Forage Quality

Anderson, E.W. and R.J. Scherzinger. 1974. Improving quality of winter forage for elk by cattle grazing. J. Range Manage. 28:120-125.

Scientific Synthesis

Purpose:

Late spring cattle grazing is widely studied as a tool to improve winter big game forage quality. This article provides the rationale for improving elk winter forage based on plant physiological and morphological response to cattle grazing. The authors also describe how grazed plant responses may coincide with environmental conditions to prevent excessive cattle grazing and rangeland deterioration.

Summary:

This article provides a case study of the Bridge Creek Wildlife Management Area wildlife/livestock grazing relationship in northeastern Oregon. The cattle grazing system implemented in 1964 was designed around season and degree of cattle use to reduce the potential of dietary overlap with wildlife and to improve wildlife forage quality. Before the wildlife management area was established in 1961, cattle were reported grazing in undulating plateaus and broad ridgetops at 1,200m elevation during spring and summer. Cattle seldom grazed steep slopes. Elk grazed undulating sites in winter. Elk grazed steep slopes after higher elevation plateaus became snow-covered. Elk and cattle distribution was recorded using ground observations, mapped utilization zones, and Oregon Wildlife Commission census data.

Elk numbers increased from 120 during 1948-1960 to 1,190 in 1974 on the study site. The increase was attributed primarily to range improvements and the grazing system established in 1964 that incorporated range readiness and specified use levels. The area was also closed in 1970 to winter vehicle traffic. The elk population of 1974 reflected a 78% increase in time spent on the area by elk during winter. Cattle grazing also increased from 340 AUMs in 1965 to 900 AUMs in 1969. Ocular estimates of ecological condition from 1964 were compared to those of 1973. The vegetation had improved.

Deferment and rest allowed plants time to reproduce and store carbohydrates. Plant carbohydrate balance was promoted by proper degree of seasonal utilization and adequate remaining foliage following cattle grazing.

The grazing system was designed to improve plant palatability and nutritive value by manipulating the morphology and physiology of the forage resource with cattle grazing. The authors suggest that, at the time this report was published, grazing animals preferred shallow soil, burnt, poor-site, drought affected, and mature re-growth forage. Using documented plant research, the authors concluded that increased heat promoted sugar content, conversion of starch to sugars, and reduced metabolic activity. Younger tissues were more drought-hardy than older tissues. Younger tissues also grew longer with subsequent wilting as water moved from old to young tissue. Wilting also reflected a reduction in starch and increased total sugars. Heat or drought reduced or eliminated translocation of nutrients through the plant’s cells thus, establishing a mature green foliage nutritional level of quality, and increasing palatability through conversion of starch to sugar.

Wildlife distribution and their forage preference were also used to design the grazing system. This knowledge was supplemented with known cattle distributions, forage preference, and then compared to seasonal growth curves of important forage species on important range sites to decide when to move livestock on or off a pasture. Consequently, the Bridge Creek system allowed for recovery from early spring elk grazing, re-growth on key grasses, appropriate timing of cattle grazing during the critical boot-to-seed stage, adequate winter elk forage, and plant physiology manipulation. The cattle grazing treatment was rotated to prevent delaying the process of plant food storage.

The authors also attribute the success of the program to effective water development, salting, fencing, safe degree of cattle use, plowing and seeding of 120 acres of farmland to grasses and forbs, and the establishment of a wildlife sanctuary. In the event that elk numbers became excessive, the authors suggested doubling the amount of pastures so that the amount of rested pastures are doubled or, implementing effective elk control measures.

Clark, P.E., W.C. Krueger, L.D. Bryant, and D.R. Thomas. 1998. Spring defoliation effects on bluebunch wheatgrass: I Winter forage quality. J. Range Manage. 51:519-525.

Experimental Research

<u>Significance</u>:

Conversion of traditional big game winter range to agricultural use has increased the need to improve the quality of big-game winter range on public land. Bluebunch wheatgrass is a valuable elk winter forage used to maintain minimum winter body fat requirements for big-game. Improved forage conditions characterized by green succulent plant tissue could increase elk foraging efficiency. Elk generally select plants containing more live tissue over plants containing large proportions of dead material. This study presented bluebunch wheatgrass response to several clipping treatments designed to stimulate grazing effects. The clipping treatments were hypothesized to increase bluebunch wheatgrass nutritional quality by producing regrowth that would cure at a younger stage of development than ungrazed plants.

Methods:

The study was conducted in 1993 and 1994 at two study sites (Winter Ridge and McCarty Spring) in the Blue Mountains of northeast Oregon. Treatments for bluebunch wheatgrass included clipping the whole plant at mid-boot stage, clipping half the plant's basal area at mid-boot, clipping the whole plant at flowering, and an unclipped control. Forage was harvested in early November of 1993 and 1994 from plots treated the previous spring. Crude protein, in vitro dry matter digestibility, and dry matter production from each of the treatments and from an unclipped control were compared to early winter nutritional requirements of elk.

Results:

Across study sites and years, all clipped plants contained greater crude protein content than unclipped plants. Dry matter digestibility was higher in clipped plants than unclipped plants with the highest digestibility exhibited by plants clipped at the flowering stage. Mid-boot/whole plant and flowering stage clippings exhibited greater levels of crude protein in 1993 and 1994 than mid-boot/half plant clippings.

However, control plants produced more biomass than clipped plants in the study leading to greater total crude protein content of control plants compared to total crude protein content of treated samples.

Implications:

Livestock grazing on rangelands may improve the forage quality of some plants important for winter grazing by elk such as bluebunch wheatgrass. Grazing applied before the flowering stage can improve winter forage quality of bluebunch wheatgrass. Though forage quality of grazed plants may be higher, forage quantity may be less compared to ungrazed areas. Additionally, to ensure optimum bluebunch wheatgrass competitive status, plants must not be stressed before defoliation, defoliation should occur only once during the growing season, and rest should be allowed for grazed plants. Grazing may reduce the proportion of dead plant material while increasing the availability and accessibility of live tissue in plants. Increased accessibility of live forage would likely decrease energy expenditure associated with grazing, thus increasing ungulate foraging efficiency.

Clark, P.E., W.C. Krueger, L.D. Bryant, and D.R. Thomas. 1998. Spring defoliation effects on bluebunch wheatgrass: II Basal area. J. Range Manage. 51:526-530.

Experimental Research

Significance:

Bluebunch wheatgrass is valuable winter forage for elk in the northwestern United States. Research suggests that spring clipping or grazing improves the quality of bluebunch wheatgrass for elk winter maintenance. However, improper late spring grazing could reduce regrowth potential and plant vigor. This study examined the effects of three clipping treatments on bluebunch wheatgrass basal area and resulting winter forage quality for elk. This study was a continuation of research to define spring defoliation effects on bluebunch wheatgrass.

Methods:

This study was conducted during 1993 and 1994 on the McCarty Spring and Winter Ridge study sites. They are two USDA Forest Service big game winter range management areas located near Starkey Experimental Forest and Range in the Blue Mountains of northeastern Oregon. Each study site contained a 0.5 ha livestock exclosure. Plant mortality and change in basal area of bluebunch wheatgrass one year after late spring clipping treatments were evaluated within each exclosure. Each exclosure contained 32 whole plots. Sixteen of the 32 whole plots in each exclosure were treated in 1993. The other 16 were treated in 1994. Subplots consisted of sixteen randomly selected bluebunch wheatgrass plants within each whole plot. Clipping treatments included: mid-boot with entire basal area clipped, mid-boot with half of basal area clipped, flowering stage with entire basal area clipped and, an unclipped control. Plants were clipped to a height of 7.6 cm in late spring. Mortality was assessed visually. Basal area measurements were taken for each subplot 2 months after treatment and compared to measurements one year after treatment to determine change in live basal area.

Results:

Production of live bluebunch wheatgrass basal area (plants with no dead tillers) declined after the entire basal area was clipped during the mid-boot and flowering stages. However, these clipping treatments improved forage quality. Greater crude protein content was recorded in 1993-94 relative to unclipped controls. Greater digestibility was recorded in 1994 relative to unclipped controls. Control and mid-boot/half plant basal area increased. Clipping caused 0.2% plant mortality of clipped plants in this study.

Implications:

Plant sustainability should be considered in any grazing system designed to improve forage quality on elk winter range. Grazing of only half the plant's basal area at the mid-boot stage will provide for maintenance of plant vigor. Additionally, on ranges dominated by bluebunch wheatgrass, grazing systems should allow for rest during periods of environmental stress to maintain wheatgrass vigor. Vigor may be maintained with late spring grazing followed by a year of early spring grazing or deferring grazing until late summer after a year of late spring grazing. Late summer deferment should start before initiation of fall regrowth. The objective of rest is to provide an entire growing season to recover losses of vigor. One full year of rest is also suggested to recover losses of plant vigor. Longer periods of rest between late spring grazing may be needed during periods of drought. The authors suggest that adherence to these guidelines should improve forage conditions for elk and cattle.

Clark, P.E., W.C. Krueger, L.D. Bryant, and D.R. Thomas. 2000. Livestock grazing effects on forage quality of elk winter range. J. Range Manage. 53:97-105.

Experimental Research

Significance:

Clipping plant biomass has been the primary technique used for testing if livestock grazing affects big-game winter range forage quality. The effects caused by livestock grazing are distinct, however, from those caused by clipping. This study was initiated to examine if changes in forage quality observed in clipping studies were also observed in response to grazing. Bluebunch wheatgrass and Idaho fescue dominate elk winter range in northern inter-mountain region of North America. These two grasses are important constituents of elk winter diets. Implemented late-spring livestock grazing could improve the quality of these forages by increasing their palatability and by delaying their reproductive development, relative to ungrazed forage, as they enter winter dormancy.

Methods:

The study was conducted in 1993 and 1994 within the McCarty Spring Big Game Winter Range Management Area on the USDA-Forest Service McCarty Spring Sheep Allotment in the Blue Mountains of northeast Oregon. Two grazing sequences were applied at three locations throughout the study area. Domestic sheep were allowed to graze one plot in each location during the boot stage of bluebunch wheatgrass while another plot at each location remained ungrazed the first year. The grazing sequence was reversed the following year to imitate a rest-rotation grazing system. Forage utilization and standing reproductive culms per plant were quantified after grazing at both plots in each location. Crude protein, in vitro dry matter digestibility, and dry matter standing crop were also measured in early November and early March in both years of the study.

Results:

Greater crude protein levels were recorded for bluebunch wheatgrass, Idaho fescue, and elk sedge in grazed plots than ungrazed plots. In vitro dry matter digestibility increased in bluebunch wheatgrass but not in Idaho fescue or elk sedge in grazed plots relative to ungrazed plots. Standing biomass of elk sedge, bluebunch wheatgrass, and Idaho fescue were not affected by light, late-spring, livestock grazing. Bluebunch wheatgrass produced greater standing crop and more reproductive culms when growing in the openings than under the tree canopy. Conversely, suspected less intense solar radiation and competition from bunchgrasses under the tree canopy provided better growing conditions for elk sedge.

Implications:

Sheep, not cattle, were used to measure the response of these forages to late spring grazing. The effects of late spring grazing by sheep may not be identical to those of cattle. The information presented here still provides valuable insight, however, into the quality response of certain plants to late spring grazing; similar effects would be expected for cattle. This study also reveals that the numbers of standing reproductive culms may be reduced in bluebunch wheatgrass and Idaho fescue under moderate levels of late spring grazing, thus, increasing their palatability to grazing herbivores including elk. Moderate grazing increased the crude protein content of Idaho fescue and the digestibility of bluebunch wheatgrass. The authors point out that livestock grazing, as a tool to improve the forage resource, may be applied at very low cost and should be flexible to adjust for annual weather variations. This prescriptive grazing tool could reduce the amount of winter dry feed costs incurred by livestock producers and increase the quality of forage for wintering elk.

Westenskow-Wall, K.J., W.C. Krueger, L.D. Bryant, and D.R. Thomas. 1994. Nutrient quality of bluebunch wheatgrass regrowth on elk winter range in relation to defoliation. J. Range Manage. 47:240-244.

Experimental Research

Significance:

Bluebunch wheatgrass is an important forage plant for wintering elk in the Rocky Mountains and Pacific Northwest. Bluebunch wheatgrass is also widely selected by cattle. Grazing of bluebunch wheatgrass by cattle in the growing season can improve elk winter forage by causing the forage to enter dormancy at a less advanced stage of development. The information provided by this study may be used to estimate whether spring or fall grazing treatments affect the degree to which bluebunch wheatgrass meets elk winter maintenance requirements.

Methods:

The Winter Ridge and McCarty Springs sites, near the Starkey Experimental Forest and Range in the Blue Mountains of northeastern Oregon were examined in this study. Clipping treatments were used to condition forage regrowth. Clipping was initiated in June 1988. Treatments included spring defoliation in June, fall defoliation in September, and an unclipped control. Regrowth was clipped to 2.5 cm stubble height, oven-dried and analyzed to determine forage quality. Samples were collected in November of 1988 and 1989 and April of 1989 and 1990. Dry matter digestibility, calcium, and phosphorus levels were determined.

Results:

Bluebunch wheatgrass quality was not affected by spring defoliation. Calcium, phosphorus, and available forage were not different from the November control samples. Regrowth resulting from fall defoliation was higher in digestibility and phosphorus than the control and spring defoliated samples. Spring clipped and control samples, therefore, lacked the nutritional content that fall clipped forage provided wintering elk. Additionally, the April forage status exceeded elk requirements for calcium and phosphorus. Forage digestibility was high (76-87%) from all treatments for both years in April. Therefore, previous year's fall grazing did not affect the following spring forage quality. Compared to control samples, spring clipping reduced available forage in November by 33 and 47% in 1988 and 1989, respectively. Fall clipping reduced available forage in November by 95% in 1988 and 81% in 1989.

Implications:

The season in which livestock grazing occurs can influence the quantity and quality of forage used by elk. Grazing can remove decadent material thus, increasing the availability of current year's forage growth. Fall grazed forage may not allow sufficient time for regrowth before the end of the growing season thereby reducing the quantity of winter forage. However, regrowth that does occur after fall defoliation is of higher quality than ungrazed plants and exceeds elk requirements for calcium, phosphorus, and digestibility. Spring grazing may reduce quantity of winter forage or not enhance forage quality, though not as much as fall grazing.

With spring-grazed, fall-grazed, and control plants, the resulting winter assemblage of plants will vary in quality and quantity. Older, more mature forage will dominate undefoliated sites while less abundant, possibly more nutritious plants, will occupy spring and fall defoliated sites depending on environmental factors. Stocking should not exceed a level that will damage forage plant vigor thereby reducing the health of rangeland communities. A proper balance between ungulate grazing and forage availability should be maintained so that nutritional carrying capacity can be maintained.

Diet and Habitat Interactions

Grover, K.E., and M.J. Thompson. 1986. Factors influencing spring feeding site selection by elk in the Elkhorn Mountains, Montana. J. Wildl. Manage. 50:466-470.

Experimental Research

Significance**:**

Ungulates select among habitats depending on certain features such as available cover, forage quality, or presence of roads. However, the degree of influence these environmental features impose on habitat selection varies by species and region. This research provides information concerning factors including cattle grazing that may affect elk habitat selection. The influence of other factors such as roads, cover, and forage characteristics were also examined because their influence on habitat use may vary by population and region. Consequently, this research provides useful information for natural resource management of multiple uses including cattle grazing and wildlife habitat.

Methods:

The study took place on the Crow Creek drainage of the Elkhorn Mountains about 16km west of Townsend, Montana. Observations were conducted to estimate local elk densities. Cattle grazed the area from June 11 to October 15 in 1983 under a 3-pasture deferred grazing system that was established in 1970. Ungulate use, vegetation attributes, and topographic features were examined at 48 randomly located sample plots within bunchgrass communities. Thirteen variables were measured at each plot. Quantities of rough fescue, Idaho fescue, and bluebunch wheatgrass utilized by elk was estimated on each plot during the first week of June 1984. Grass utilization by cattle was estimated in fall of 1983. Distances from each plot to the nearest road, visible road, and cover were recorded as were elevation, slope, aspect, and percent upslope. Percent upslope indicated the location of each plot along the slope of a hill. Zero indicated that the plot was located at the bottom whereas 100 indicated it was on the ridge.

Results:

Elk experienced appropriate foraging conditions. Four variables including previous grazing by cattle, proximity to cover, nearest visible road, and densities of bunchgrasses were the most influential characteristics affecting selection of spring feeding sites by elk. Collectively, these four variables accounted for 65% of the variation in elk feeding distribution. Desirable conditions of any single variable affecting elk feeding-site selection did not occur in short supply. However, combinations of variables more favorable for elk feeding were not abundant.

<u>Implications</u>:

Wildlife habitat selection may be influenced by unknown factors. However, in this study elk consistently chose areas characterized by dense stands of bunchgrasses previously grazed by cattle. The forage in previously grazed areas typically contains less residual vegetation such as dead standing stems. However, elk also selected areas that were no more than 274 m to dense cover, and at least 463 m to the nearest road, and 979 m to the nearest visible road. Although the distribution and number of cattle may be the most easily modified, other land use practices must be considered when determining how wildlife will select various habitats. As Grover and Thompson mention, some combinations of environmental variables where cattle graze may have greater influence on elk feeding-site selection than others. For example, while cattle grazing may be used to improve forage quality, grazing will be most beneficial for elk if it maintains adequate forage density and is applied in areas near cover and within safe distance from roads. Therefore, cattle grazing should be implemented based on factors other than cattle grazing that influence elk habitat selection.

Hansen, R.M. and L.D. Reid. 1975. Diet overlap of deer, elk, and cattle in southern Colorado. J. Range Manage. 28:43-47.

Documented Case History

<u>Significance</u>:

Dietary overlap is a vital component of livestock/wildlife interactions. Dietary overlap studies are site-specific and are related to the quality of certain habitats. Dietary overlap between deer, elk, and cattle is the focus of this study. The research describes how overlap may occur on a seasonal basis using microscopic analysis of fecal samples.

Methods:

The study was conducted on a private ranch 8.3 km east of Fort Garland, Colorado. Aerial surveys from 1970 were used to determine local elk and deer densities. The ranch manager identified eight areas (13 to 16 Km^2) that were seasonally preferred grazing locations for each species. Fecal samples were collected on each site between December 1970 through November 1971 for deer and elk, and from June 1971 through September 1971 for cattle. Samples were collected about the middle of each month. Fecal samples were analyzed by microhistological analysis to estimate the relative proportion of plant species in the diet. A trophic diversity index was used to measure variety and evenness of diets. A similarity index was used to compare diet compositions between herbivores.

Results:

Elk and deer were found to share similar diets during the growing season but they concentrated in different areas. Elk and deer diet overlap ranged from 5 to 45%. Deer and cattle shared similar diets for four months of the cattle-grazing season but in different areas of the landscape. Elk and cattle diet overlap was the greatest of the species compared ranging from 30 to 50%. Elk and cattle were found using the same areas of the study. The primary grasses shared among the three ruminants were fescue and bluegrass, while true mountainmahogany comprised most of the overlap in terms of browse.

Implications:

Dietary overlap between deer, elk, and cattle undoubtedly exists. This study revealed dietary overlap between the three species during the months of June through September; months when cattle were present. The implications of dietary overlap may be less severe if animal species occupy different habitats. Where common use occurs, however, stocking should be maintained at levels that do not cause overuse by wildlife or livestock species. Stocking levels should be based on adequate experimentation. Results from other studies incorporating annual weather patterns and forage densities should also be considered to maintain an adequate forage base because the food base may become limited with drought. Consequently, dietary overlap may be more likely to occur.

Holcheck, J.L. 1980. Concepts concerning forage allocation to livestock and big game. Rangelands. 2:158-159.

Professional Resource Knowledge

Significance:

Efficient forage allocation between wild and domestic herbivores is one indication of successful livestock-wildlife habitat and population management. This paper addresses the issue of allocating forage between elk and cattle on a one-to-one basis and the problem of allocating forage using intuition. The author also provides a basis for allocating forage using experimental evidence to improve range forage management decisions.

Summary:

Where wild and domestic animals occupy a common area, certain aspects of the community, such as the identification of key forage plants, and degree of use by either animal must be determined before competition can be assessed. Holechek presents six principles specific to large ruminants that may occur in nature. These principles pertain to forage allocation and include abiotic and biotic factors that influence feeding patterns, animal distributions, and vegetation trends, all of which may initiate or exacerbate dietary overlap. Briefly, Holechek states that:

- animals with broad food habits are more able to endure low forage conditions,
- larger ruminants are more able modify diet selection than smaller ruminants,
- less preferred areas may be selected during or after periods of severe disturbance,
- animals may be more affected by forage availability prior to critical periods than during,
- habitat use may change depending on wild/domestic animal numbers,
- selected vegetation communities may decline in abundance if grazed by only one type of herbivore species

Through proper management, degrees of dietary overlap may be reduced. However, consideration should be given to maintenance and improvement of the forage resource. Strategies such as the reduction of wild or domestic animals, acquiring parcels of private land to expand winter range, and brush control, seeding, and burning are offered as ways to reduce dietary overlap and improve habitat.

Implications of annual weather fluctuations were also discussed. Weather fluctuations affect the seasonal amount and quality of available forage. Managers must consider these fluctuations when determining appropriate levels of big game and domestic populations. Environmental conditions sometimes call for reductions in either population. If the need arises to reduce a population, the decision will be more easily accepted by society if they are well informed and educated about local range conditions.

Kingery, J.L., J.C. Mosely, and K.C. Bordwell. 1996. Dietary overlap among cattle and cervids in northern Idaho forests. J. Range Manage. 49:8-15.

Experimental Research

Significance:

Dietary overlap between livestock and wildlife is indicated by common preference for specific plants and plant parts. Therefore, common preference may be detected at certain levels of plant community succession. This research adds knowledge to forest ecosystem management regarding grazing impacts at specific stages of plant succession.

Methods:

Two study sites (habitat types) were selected to compare the diets and dietary overlap among cattle, elk, and white-tailed deer using fecal microhistological analysis. The study was conducted on the Clearwater National Forest near Boville, Idaho. Five plant communities represented by varying seral stages were selected within each habitat type: herb-shrub, sapling, pole, mature, and potential natural community. Ungulate forage preferences were compared by seral stage of chosen forage. One study site was in a grand fir/queencup beadlilly habitat type. The other study site was in a western red cedar/queencup beadlilly habitat type.

Results:

Graminoids comprised 96% of cattle diets during the 3 seasons (early summer, mid-summer, and early fall) on the grand fir study site. Elk diets contained 93% graminoids in mid summer. Cattle and elk diets in mid-summer were 88% similar. The primary graminoid dietary constituents were Kentucky bluegrass and sedge. Additionally, cattle and elk selected early seral plant communities in early and mid-summer. However, elk selected a greater diversity of plant communities than cattle in early fall.

Less dietary overlap between elk and cattle occurred during mid- and early summer, 53% and 37% respectively, on the red cedar site. Most overlap (74%) occurred in early fall. Elk utilized more graminoids as the season progressed into fall. The community most chosen by cattle during all three seasons was graminoids. Cattle use of these species averaged 92% of the diet. Kentucky bluegrass was also the primary graminoid species for cattle. Early successional plant species were chosen by elk in early fall while cattle exhibited the same preference during all three seasons.

Implications:

Assessing whether competition occurred between the herbivores in this study is difficult. Competitive interactions are difficult to identify because of unknown conditions, other than plant and animal characteristics that benefit one herbivore species more than another. For example, human disturbance may reduce the quality of a foraging area for elk or cattle regardless if forage conditions are optimum. The authors determined that if competition did exist in this study, however, most likely it was for Kentucky bluegrass or sedge.

While the identification of herbivore diets can be important in the management of wild and domestic herbivores, this study suggests that knowledge of the successional community in which the plants are organized is also important. This study determined that monitoring of early successional plant communities would appropriately indicate grazing impacts by elk and cattle in both studied habitats because they preferred Kentucky bluegrass and sedge in the herb-shrub and sapling communities.

MacCraken, J.G. and R.M. Hansen. 1981. Diets of domestic sheep and other large herbivores in southcentral Colorado. J. Range Manage. 34:242-243.

Documented Case History

Significance**:**

Livestock grazing can affect foraging of big-game even if the species do not occur on a piece of land at the same time. Lands used in winter by deer and elk are often grazed by livestock during the growing season. Therefore, it is imperative to examine dietary characteristics even if the herbivores do not share the same range at the same time. Elk, mule deer, cattle, and sheep diets were compared on a range used by big-game in winter to provide critical information about successful elk and mule deer winter survival.

Methods:

The winter range study area was located on the Alamosa District, Rio Grande National Forest winter range in the San Juan Mountains of southcentral Colorado. Plant compositions were distinguishable in xeric and mesic habitat types. Domestic sheep grazed the area in late spring and were herded to higher elevations as the snowline receded. Domestic cattle grazed the area primarily in early summer. By late summer cattle had also moved to higher elevations. Mule deer and elk arrived on the area in fall through early winter and remained until late March or even April and May depending on snowfall accumulations.

Fecal samples from sheep, cattle, elk, and mule deer were taken from two areas on the winter range during the summer after domestic stock had used the area and were examined using microhistological technique for plant composition. The two areas were approximately 1km^2 and were located along common borders of sheep and cattle allotments. A similarity index was used to measure diet overlap.

Results:

Cattle use was greatest in early summer but decreased as the season advanced. Cattle were found primarily in higher elevations by late summer. Diet similarity was highest among sheep, cattle, and elk. Elk and cattle dietary overlap averaged 39%. Their most commonly preferred species were western wheatgrass, sedge, prairie junegrass, and fescue species. Forbs were scarcely present. Inclusion of mountainmohagany, and Douglas fir caused only slight variation in detected elk selection. Cattle and deer and sheep and deer diets overlapped very little in this study.

Implications:

Increased elk populations in the study area indicated that forage for elk and domestic livestock, despite the high dietary overlap, was sufficient. However, declining deer populations and high dietary overlap between deer and elk was also noted. Without indication of the nutritional content of selected forages, it is difficult to speculate why elk increased and deer decreased. The authors suspect, however, that high dietary overlap between deer and elk may have contributed to the decline of deer. Therefore, while estimating dietary overlap is valuable, research must also provide estimates of forage availability and the condition of its quality. This data should be compared with animal densities and their relative nutrient requirements. Variables that may initiate dietary overlap should also be considered.

Olsen, F.W. and R.M. Hansen. 1977. Food relations of wild free-roaming horses to livestock and big game, Red Desert, Wyoming. J. Range Manage. 30:17-20.

Documented Case History

Significance:

Information about diet preference is valuable when establishing appropriate wild and domestic animal stocking rates. In this study diet composition and overlap was determined for wild horse, cattle, elk, sheep, and pronghorn. Potential impacts to forage plant densities and trends were also evaluated using ungulate population estimates and diet preference.

Methods:

The dietary overlap among horses, cattle, elk, sheep, and pronghorn was determined on the eastern portion of the Red Desert, Wyoming during four seasons.

The area encompasses approximately 2,500 km^2. Animal densities were estimated using aerial surveys and ground observations. Microscopic fecal analysis was used to examine botanical composition of diets for each ungulate. Fecal samples were collected from random locations during the four seasons. Sample areas varied from 10 to 20 ha and 20 samples were collected each season. A similarity index was used to quantify diet overlap.

Results:

Although more than 27,000 sheep were permitted to graze the study area, no adverse effects on the diversity of plant species were detected. Horse, cattle, and elk diets consisting of bluebunch wheatgrass and thickspike wheatgrass and needle-and-thread were the most similar. Pronghorn fed primarily on sagebrush while saltbush comprised most of the sheep diets. Cattle and elk dietary overlap ranged from 16% in summer to 89% in spring. The diets of all species varied seasonally because of their dissimilar physiological demands and varying quantities/qualities of forage plants.

Implications:

This study was not specific to cattle and elk. However, it provides a comprehensive evaluation of their diet characteristics compared to other common herbivores in the region. Grazing by multiple species is a characteristic common to most western ranges. Additionally, biomass production may be enhanced through the multiple-use of herbivores that exhibit diverse food habits and dietary needs. Estimating plant utilization is critical, however, because intense grazing by one herbivore species could cause unfavorable ecological shifts and undesired plant types. Maintenance of suitable habitat requires knowledge of the plant species present, their abundance, distribution, and the number and species of large ungulates present.

Patton, D.R. and B.I. Judd. 1970. The role of wet meadows as wildlife habitat in the Southwest. J. Range Manage. 23:272-275.

Documented Case History

Significance:

Elk and cattle commonly use the same areas at similar and/or different times of the year. Thus, considerable research exists on the effects of livestock grazing on wildlife habitat use. This research has provided management approaches for improving cattle distribution and maintaining adequate wildlife habitat. This study examines specifically the dependence of wildlife on wet meadows and how this relationship may be affected by livestock grazing. Results from studies that examine specific wildlife habitats may assist in accomplishing multi-use objectives.

Methods:

Herbage production, plant composition, and protein content of forage plants were evaluated on two meadows in the Apache National Forest in Arizona. Wildlife use was determined on four meadow locations. Herbage production and plant species density and composition were determined in each of three different sites (meadow, transition, and dry forest) at each location. Crude protein content of major forage plants on these sites was also determined. Fecal pellet counts were used to estimate use by elk.

Results:

Herbage production and plant composition varied among the three sites. Meadows (average production = 3,015 kg/ha) consistently produced more than moist areas (average production = 1,490 kg/ha), which produced more than dry forest (average production = 190 kg/ha). Plant composition included 20 genera of grasses and forbs in the wet meadow site, 43 in the moist transition site, and 28 in the dry forest site. Plant density was highest in the moist site. Eleven plants used by livestock and wildlife in and around the meadows were analyzed for protein content. Dandelion, rush and sedge contained the greatest protein content of all plants in any area. Dandelion, rush, and sedge were found most often in the moist and wet meadow sites. Elk use was highest in the forest while cattle used the meadows more consistently. A forest edge effect was evidenced by the majority of deposited elk droppings within 50 yards from the forest edge.

Implications:

The authors determined that meadow use by elk was more important for grazing because this site contained higher quality and quantity of forage than dry forest sites. However, dry forest sites received greater use by elk. Because elk foraged in wet areas and used forest primarily for cover, maintenance of higher protein content forage in wet meadow sites was determined to be critical. Additionally, meadow and transition areas are limited throughout the western United States. Therefore, maintenance of these areas is critical and will require proper levels of use by wildlife and livestock to reduce adverse impacts.

The authors suggest maintaining livestock and game numbers at levels that will improve or maintain desirable plant composition and not induce trampling or erosion. However, a grazing schedule would also help managers alleviate over-use during periods when meadows are most susceptible to trampling. Herding may be used to move livestock away from meadow areas. Failure to implement such actions may increase the likelihood of erosion and/or dry site species encroachment into wet sites, thus, reducing total wet site acreage.

Sheehy, D. and M. Vavra. 1996. Ungulate foraging areas on seasonal rangeland in northeastern Oregon. J. Range Manage. 49:16-23.

Experimental Research

Significance:

Plant communities and topographic land features will undoubtedly influence the nature and level of interaction between cattle and elk on a shared range. This study provides information on how the selection of foraging areas by elk and cattle, and their degree of overlap, may be affected by factors such as vegetation and terrain. Ungulates prefer specific plants and plant parts. However, ungulates display variable degrees of preference in certain terrain and plant communities. Determining the influence of terrain and plant community on elk and cattle foraging should indicate options for livestock management.

Methods:

The study was conducted on 1,844 ha of privately owned seasonal rangeland in the Blue Mountains of northeastern Oregon. Observations of foraging area use by cattle and elk were conducted between March 1982 and August 1984. Estimates of plant cover were used to classify vegetation into plant communities. Seventy-three 0.05 ha macroplots were established by plant community. Plant frequency and basal cover were determined in each macroplot. Terrain features were derived from USGS topographic quadrangle maps. The potential for ungulate overlap in each of the foraging areas was determined.

Locations of ungulates, boundaries of plant communities, and boundaries of terrain classes were initially recorded on 1:24,000 scale aerial photography, and later on 19 cm scale USGS topographic quadrangles. Ungulate preference for plant communities and terrain features was described using ratios of used to available areas to develop selectivity indexes. Preferred areas were those selected by an ungulate in greater proportion than found in the study area. Areas selected in lower proportion than found in the study area were classified as undesirable. Areas selected in proportion to availability were classified as desirable. Plant communities, slope, aspect, elevation, and distance to edge were examined.

<u>Results</u>:

There was little direct temporal overlap between cattle and elk. Cattle use occurred in late spring-early summer and fall while elk exhibited greatest use during the winter and spring seasons. Cattle averaged 1,280 AUMs/year of use between 1982 and 1985. Elk displayed a spatial and temporal pattern of use based on availability of forest communities with an average use of 134 (2 adult cow elk per AU) AUMs per year.

Grass steppe comprised 74.3% of the vegetation communities of the study area while shrub, meadow, riparian, and talus garland communities covered 25.7%. Collectively, the influence on plant community location affected cattle and elk foraging site selection. Fall growth of perennial grasses was highly valued by elk as determined by observations of winter and early spring grazing. Compared to early winter availability, standing crop of study area plant communities increased between 191 and 487% after wild ungulates migrated in summer to higher and lower elevations. Community structure and location were influenced in combination by soils and climate, and features such as slope, aspect, and elevation. A maximum slope of 62.5% was recorded in the area.

The frequency at which plant communities or terrain features occurred differed from the frequency with which they were grazed by cattle or elk. Elevation, plant communities, aspect, and distance from edge influenced selection of foraging areas by cattle and elk. Cattle selected Idaho fescue-annual grass communities on higher elevations at moderate distances from the forest edge. Cattle did not avoid any specific aspect but avoided areas close to or furthest from forested communities and areas occurring at highest and lowest elevations. Cattle use patterns were affected by ambient air temperature during summer because of the need to regulate body temperature. Cooler temperatures during fall and early winter reduced the need by cattle for shade and water.

Elk preferred bluebunch wheatgrass-annual grass and Idaho fescue-bluebunch wheatgrass communities that occurred at higher elevations near the forest edge. Elk did not forage in areas at lower elevations or furthest from forest edge. Elk relied on the security provided by forest cover. They preferred level terrains and avoided slopes greater than 37.7%. They also depended on forage and thermal cover in canyon riparian communities during adverse weather conditions.

<u>Implications:</u>

Temporal separation was the most important factor that reduced the potential for direct interaction between cattle and elk. Elk and livestock interaction would probably ensue, however, with an increase in ungulate grazing intensity. Although ungulates using seasonal rangeland in the Intermountain Region select different plant communities, dietary overlap will occur. While dietary overlap can reduce forage supply, summer cattle use of Idaho fescue may have improved winter and spring vegetation quality for elk. Additionally, late fall use of lower elevation foraging areas by cattle may have improved the vegetation quality of these sites for subsequent late spring and early summer cattle use.

Wallace, M.C. and P.R. Krausman. 1987. Elk, mule deer, and cattle habitats in central Arizona. J. Range Manage. 40:80-84.

Replicated Research

Significance:

While environmental factors undoubtedly influence ungulate habitat use, elk habitat use is also affected by the presence and the stocking rate of cattle. The study provides observational data concerning the affect of environmental variables on elk, mule deer, and cattle habitat use and distribution. Slope, exposure, and elevation were not highly variable in the study area. Therefore, the study allows for concentrated examination of how cattle presence and stocking rate influence elk habitat selection.

Methods:

The study was conducted from July to August in 1981 and May to October 1982 on the U.S. Forest Service established Circle-Bar pasture in the Chevelon

Wildlife Management Area, Apache-Sitgreaves National Forest, Arizona. The 135 km^2 study area contained a grazed and control pasture. Cattle did not graze either pasture in 1981. Cattle grazed from May 15 to July 30 in 1982 in one of the two paddocks. A driven travel route was used to assess mule deer and elk habitat use. Number and location of mule deer, elk, and cattle was examined during the course of the route. Elevation, slope, exposure, distance to water, fencing, meadow, cover, and draws were identified at each site. Differences in number of animals recorded per kilometer and animal group sizes were tested.

Results:

Elk were observed in equal frequency on both sites in 1981 and less often in the grazed pasture in 1982. However, elk were observed within 15 m of cattle on the grazed site. Because of the flat topography of the Apache Sitgreaves National Forest, slope, elevation, and exposure were not considered important for differentiating among ungulate habitats. Elk shifted use from a Gambel oak, aspen, mesic grass habitat type in both pastures in 1981 to a ponderosa pine, buckbrush, and muhly habitat in 1982 on the grazed pasture. Use of the 1982 ungrazed pasture did not change.

Implications:

A moderate stocking rate of cattle in this study displaced elk from meadows, draws, and silviculturally disturbed areas. The implications of elk displacement on their nutritional status are not known. Without such information, the understanding of competitive interactions between wildlife and livestock would not be complete. Thus, multiple use management would suffer from an incomplete knowledge base that could produce adverse impacts to one or both species. Management could adversely affect elk and livestock survival. Additionally, overuse by elk or cattle could inflict adverse impacts on certain vegetation communities.

Grazing Systems

Alt, K.L., M.R. Frisina, and F.J. King. 1992. Coordinated management of elk and cattle, a perspective-Wall Creek Wildlife Management Area. Rangelands. 14:12-15.

Professional Resource Knowledge

Purpose:

Implemented grazing systems should be based on the growth requirements of ungulate and forage to maintain productive rangeland and appropriate population levels. Consequently, such systems also reduce conflicts between private landowners and management agencies by reducing the degree of winter wildlife forage depredation on private land. The southwest Montana, Wall Creek Wildlife Management Area, Beaverhead-Deerlodge National Forest grazing program is described. The program was developed to improve elk/cattle management, rangeland quality, and resolve private land disputes.

Summary:

The Montana Department of Fish, Wildlife and Parks (FWP), Beaverhead-Deerlodge National Forest, and the Wall Creek Stock Association developed a coordinated grazing management plan for the Wall Creek Wildlife Management Area in the 1980’s. Management goals included improved soil, and vegetation conditions, winter elk forage quality, relations with lands adjacent to the WMA, and reductions in elk-cattle competition on winter range.

The area encompassed 7,067 acres of mostly bluebunch wheatgrass and Idaho fescue grasslands. The grazing system implemented in 1988 incorporated rest-rotation grazing principles. Several modifications such as no grazing from 1960 to 1982 and, experimental cattle grazing in 1982 were evaluated before implementation of the grazing system in 1988. Elk numbers increased from <10 in 1935 to 1,200 to 1,400 in 1987.

Ten pastures were established by 1992 in low, mid, and high elevations. Six pastures provided winter habitat for elk. Seven hundred head of domestic cattle grazed the area from May 1 through September 30. The system allowed for a full season of rest on three pastures once every three years. The other two sets were grazed only once during the growing season or after seed ripe.

Consequently, the grazing plan provided a substantial amount of winter forage for elk on the lower- and mid-elevation pastures and summer forage in the high pastures. The system required a significant amount of fence construction to facilitate appropriate winter elk distribution between pastures. This was accomplished with let-down fencing. Although cattle movements were timed annually, cattle could be moved early during low forage years or drought. Changes in the vegetation were monitored using long-term monitoring techniques such as ECODATA plots and Parker three step procedures. Cattle grazing effects on elk distribution/population status and forage abundance were monitored using pellet group/vegetation transects, and permanently marked photo plots.

The removal of residual plant material by cattle resulted in increased palatability of major vegetation types. Consequently, elk significantly reduced utilization of adjacent private lands. Cooperation was improved between FWP, private landowners, and the Beaverhead National Forest.

Frisina, M.R. and F.G. Morin. 1991. Grazing private and public land to improve the Fleecer elk winter range. Rangelands. 13:291-294.

Professional Resource Knowledge

Purpose:

The type of grazing systems implemented on rangeland can influence the use of that land by wildlife. Grazing systems can also affect adjacent forage resources. Reduced wildlife depredation of winter forage on private land reflects how such systems have reduced conflicts between private landowners and public land managing agencies. A grazing system used in southwest Montana developed to reduce conflicts between elk and livestock is described. This system was also implemented to generate cooperation among state and federal agency managers and private landowners.

Summary:

The Montana Department of Fish, Wildlife, and Parks, US Forest Service, and Smith 6-Bar-S Livestock Company developed the Fleecer Coordinated Grazing Program in 1987. Rest-rotation grazing principles were implemented. The program incorporated range management principles with scientific research. The program goals were to manage the entire area as one unit, increase elk and livestock numbers according to their respective potentials, maintain and improve soils, vegetation, and riparian areas, and reduce private land conflicts.

The area encompassed 16,570 acres. Most of the area is incorporated within Forest Service and Montana Department of Fish Wildlife and Parks ownership while Smith 6-Bar-S owned the least. The area was predominantly bluebunch wheatgrass and Idaho fescue grasslands. Some rough fescue was present with Douglas Fir on the ridgetops and willow and aspen along the stream bottoms. Season-long grazing resulted in deteriorated range conditions according to 1953 Forest Service range surveys. Range condition improved, however, since 1953.

Cattle grazed the area in 1991 totaling 1,342 AUMs (740 head). Elk numbers increased from <200 in 1960 to 1075 in 1988 after Smith 6-Bar-S lands were included in the Forest Service and Montana Fish Wildlife and Parks rest-rotation grazing system. The grazing system was based on the hypothesis that livestock grazing could be used to improve the winter forage quality for elk. Consequently, this measure increased the availability of rest pastures and improved habitat for later winter elk use. Increases in elk were also attributed to restricted hunting seasons.

The authors state that the objectives for the Fleecer Coordinated Grazing Program were met. Conflict between the Smith 6-Bar-S ranch and Montana Department of Fish, Wildlife, and Parks was relieved by the cooperative effort that incorporated Smith 6-Bar-S private lands into the federal grazing program. The alternating periods of rest and use resulted in increased forage quality and quantity, thus, reducing conflict between elk and livestock and their respective interested parties.

Frisina, M.R. 1992. Elk habitat use within a rest-rotation grazing system. Rangelands. 14:93-96.

Experimental Research

Significance:

It is vital to base cattle grazing systems on research that supports successful elk-livestock management. A rest-rotation grazing system approach used by the Montana Fish Wildlife and Parks was implemented for reducing competition between cattle and elk on summer ranges. The goal of this grazing plan was to provide abundant, high quality habitat for wildlife.

Methods:

Three pastures were used to compare elk use in 1984 and 1985. Each year one pasture was grazed during the growing season (June 15 to seedripe); another pasture grazed after seedripe; and, the third pasture was rested from grazing for the entire grazing season. This grazing strategy was designed to maintain plant vigor and facilitate the incorporation of seeds into the soil when cattle were moved into the fall-grazed pasture. Elk calving grounds were provided in rested pastures where abundant security cover and forage could be found. Elk use was determined from ground observations made on an 11-mile travel route that occurred 3 times a week during July and August.

Results:

The 1984 and 1985 results of elk distribution were unexpected after elk use in each treated pasture was determined. Elk made 86% use of the rested pasture in 1984, but 96% of elk use was recorded in the fall-grazed pasture in 1985. Possible explanations for this occurrence were not given. More elk were observed in the summer-grazed pasture than the fall-grazed pasture in 1984. However, because elk preferred higher elevation dry meadows and forest types at this time, and abundant standing vegetation was available for cattle, it was concluded that elk were less affected by fall grazing. Additionally, although elk were found in the summer-grazed pasture, elk made less use of these pastures because they provided less forage. Therefore, forage availability was more suggestive of elk habitat use than predicted level of social intolerance for cattle.

During May and early June of 1985, elk made 28% use of the summer-grazed pasture, 68% use of fall-grazed, and only 4 % use of the rested pasture. Elk distributed themselves on the study area before cattle were allowed to enter. The rested pasture was composed primarily of standing cured vegetation. Although more elk were observed in the fall-grazed pasture, elk use in summer- and fall-grazed pastures was in similar vegetative sites. Both grazed pastures contained green, vegetative plant material providing more energy and nutrients than the standing cured vegetation in the rested pasture.

Implications:

In rest-rotation grazing systems, such as the one presented in this study, elk may be only slightly affected by cattle use on two-thirds of the area using this system. High quality forage may also be provided in pastures that had been grazed the previous year. Additionally, rest-rotation systems provide a large proportion of the area that is not grazed in summer, thus, providing adequate vegetation in meadows and riparian areas that elk could utilize to maintain a productive population.

Hart, R.H., K.W. Hepworth, M.A. Smith, and J.W. Waggoner Jr. 1991. Cattle grazing behavior on a foothill elk winter range in southeastern Wyoming. J. Range Manage. 44:262-266.

Experimental Research

<u>Significance</u>**:**

Elk and cattle often share common diets and habitats. The extent of overlap varies, however, throughout the year and affects foraging dynamics. The variability in foraging patterns is a function of several factors such as the cattle stocking rate. The intent of this research was to determine if increased cattle stocking rates affected selectivity and grazing distribution of cattle and elk. Two objectives of the study were to analyze how stocking rate influenced cattle distribution on different range sites and slopes, also at different distances from water, and to compare summer cattle distribution with winter elk distribution.

<u>Methods</u>**:**

Two pastures (612 and 563 ha) were grazed with a deferred system at different intensities on the Wyoming Game and Fish Department's Wick Brothers Management Unit, near the Elk Mountains in southeast Wyoming. Pastures were stocked at 0.29 (moderate) and 0.035 (very light) AMUs/ha in 1984 and 0.28 (moderate) and 0.033 (very light) AUM/ha in 1985. Cattle grazed 35 days in June and July of 1984 and 33 days in July and August of 1985. An observer on horseback traveled through each pasture twice a day to locate and map cattle distribution. USGS topographic maps were used to plot slope and distance from water for each observed cattle location. Results were compared to a study conducted in 1981-82 in which pastures were stocked at 0.18 (light) AUM/ha.

Results:

In 1984-85, 76% of cattle use was recorded on loamy range sites, an area comprising only 13% of the landscape. The shallow loamy site, an area comprising 44% of the landscape, received only 16% of the cattle use. The loamy range site was used more than expected. Wetland/subirrigated and coarse upland sites received more use at higher stocking rates and less at lower intensities. This may have been attributed to adequate forage on preferred loamy range sites at lower stocking levels reducing the need for cattle to forage in wet insect-infested areas.

Under very light stocking in 1984-85, selectivity decreased compared to light stocking in 1981-82. Loamy and shallow loamy sites constituted 100% of the site preference in 1984-85 while cattle made use of all six range types in 1981-82.The heavier stocking rate in 1984-85 was 2.65 times the recommended rate. Lower stocking rates of 1984-85 received slightly lower than recommended use on loamy sites while all other sites were stocked lower than recommended levels. Even distribution of cattle across varying range and soil types was not easily achieved. Cattle tended to congregate on more desirable sites. Cattle were found grazing farther from water with increased stocking and as associated decrease in forage availability close to water decreased from 0.29 km in week 1 to 0.58 km in week 5.

Advancement of the grazing season also resulted in cattle distributing farther from water. Cattle progressively increased use of greater slopes with increased stocking rate.

Dissimilar habitat use between elk and cattle was detected as elk preferred steep slopes, hilltops, and ridgelines, while cattle preferred low-lying loamy, shallow loamy, and wetland/sub-irrigated sites. Therefore, little spatial or temporal overlap was found for elk and cattle. However, elk and cattle were not present on the same range at the same time; elk resided in the area in winter and cattle only during summer in this study.

Implications:

Although cattle did not exhibit preference for areas used by elk during winter, amensalism, a form of disturbance in which one species is adversely effected by another species prior presence, may have occurred. Additionally, because heavier stocking rates resulted in greater spatial use of pastures, competition would be more likely at higher stocking rates. A closer examination of the food supply would have indicated potential competition. Thus, forage quantities produced by various stocking rates should be examined to reduce the potential of damaging elk or livestock survival and to maintain adequate range forage conditions.

Jourdonnais, C.S. and D.J. Bedunah. 1990. Prescribed fire and cattle grazing on an elk winter range in Montana. Wildl. Soc. Bull. 18:232-240.

Experimental Research

Significance:

Rough fescue is valuable, moderately utilized winter forage for elk. Selective grazing patterns by elk and absence of fire led to increased proportions of standing litter of rough fescue on western Montana ranges. Management strategies that reduce the proportion of decadent plant material in rough fescue increase plant palatability thus benefiting wintering elk populations. Standing crop and elk use of rough fescue as affected by burning and cattle grazing were examined and appropriate management strategies are presented.

Methods:

This research was conducted on the 8,100 ha Sun River Wildlife Management Area in north-central Montana from 1983 to 1985. Areas experiencing cattle grazing were compared to ungrazed plots in terms of elk use. The cattle herd consisted of 104 cow/calf pairs that were allowed to graze from October to December on a 104 ha pasture. Treatments were designed to remove standing litter and minimize plant damage by grazing while forage plants were dormant. A paired-plot weight-difference method was used to measure forage use on the cattle grazed and control plots. A paired-plot weight-estimate, modified grazed plant method, and current season pellet group count was used to determine elk use in days/ha. Elk use was measured after they had migrated out of the research area.

Results:

Rough fescue biomass, total standing crop, and standing litter were all reduced on cattle-grazed treatments compared to ungrazed treatments in the first growing season post-treatment. No differences between treatments were found in biomass of any other grass, forb, or shrub after the second and third post-treatment growing seasons. There was a 274% increase in rough fescue biomass between 1984 and 1985 on the cattle-grazed treatment compared to 174% for the control to above normal precipitation.

Elk use averaged 16 days/ha during the winter of 1983-84. Elk utilized greater amounts of rough fescue and Idaho fescue on cattle-grazed sites than on the control sites during the winter. Elk averaged 82% use of rough fescue across treatments in 1984-85. This was 14% greater use by elk than the previous winter. Rough fescue constituted 95% of elk selection across treatments during the winter-spring of 1986-87.

Cattle effectively removed standing litter without affecting the amount of ground litter. Elk will initially avoid plants consisting of accumulated standing litter. However, in this study elk utilized individual plants containing accumulated litter as the number of plants containing only live material became less abundant. Increased elk use during the winter of 1984-85 was attributed to the removal of accumulated plant litter.

<u>Implications</u>:

Cattle grazing and burning programs to reduce litter could be applied in small areas with large accumulations of standing litter. Reduction of standing litter can benefit elk winter foraging as was shown in this study through greater use of grazed plots by elk relative to control plots. Small areas with plants free of standing dead material could lure big game animals. Targeted grazing of rough fescue could also increase water and nutrient levels for bluebunch wheatgrass and shrub growth which are more valuable elk forage plants. This study demonstrated that heavy utilization of rough fescue in the cattle grazed treatment produced greater biomasses of bluebunch wheatgrass and shrub species. Rough fescue biomass also experienced declines from stem base removal and trampling on cattle-grazed sites. Consequently, early use of rough fescue could damage plant health and long-term site productivity.

Skovlin, J.M., P.J. Edgerton, and B.R. McConnell. 1983. Elk use of winter range as affected by cattle grazing, fertilizing, and burning, in southeastern Washington. J. Range Manage. 36:184-189.

Experimental Research

Significance:

Cattle grazing influences elk habitat use and diet composition. However, livestock grazing may be combined with additional approaches for improving wildlife habitat quality. This study examined the effect of spring cattle grazing on elk use of winter range. The effects of burning and fertilizing were also examined, as they too were methods commonly used in improving winter range forage conditions for elk.

Methods:

An area on the Wooten Habitat Management Area in southeast Washington was examined in this study. A split-plot-design totaling 6 plots was used. Three plots were grazed and 3 were not. Each whole plot was split into fertilized, burned, and control for three years of measurement. Grazing occurred at a rate of 2.4 ha of range per AUM. Let-down fences were installed so that cattle use was limited to summer grazing, and so that elk could access the sites during the winter.

Ortho-Unipel fertilizer (27% N, 12% P2O5, 0% K, 4% S) was applied by helicopter at a one-time rate of 56 kg of N/ha in 1971. Burning occurred in late fall 1971. Spring pellet group counts were conducted to estimate elk use in the winters of 1971-72, 1972-73, and 1973-74 to examine response to treatments. The ocular-estimate-by-plot method was used in surveying forage utilization after cattle grazed on fall burned and fertilized spring treatment plots.

Results:

The average of all treatments and years revealed that spring cattle grazing had no significant effect on subsequent winter elk use. Cattle grazing in spring 1972, however, reduced winter elk use in 1973 by 28%. Elk also exhibited decreased use on grazed ranges during the other two winters. The differences, however, were not significant. Fertilized range received more elk use than burned or untreated range in the first winter following treatment. Fall rains had begun before burning was conducted in this study and, consequently, did not result in increased winter use by elk. Actual cattle use totaled 1.1 ha/AUM.

Elk showed the same habitat preference before, during, and after the three years of treatment. Cattle had no apparent affect on elk winter range use and elk had no effect on spring cattle grazing because elk harvested forage had re-grown before cattle were introduced in mid-April.

Implications:

Fertilization and spring cattle grazing might be used to improve elk winter range while burning may prove inefficient. The impacts of elk and cattle grazing may not be adverse if utilization levels are maintained at sustainable levels. With optimum levels of forage during the winter and an acceptable range condition, light cattle grazing could be implemented without adverse affects to elk grazing in spring or early summer.

Where range conditions are unacceptable, fertilization may be a practical approach used in improving forage conditions for elk and cattle. However, cattle may benefit more than elk because elk may select fertilized forage that was previously ungrazed by cattle and was observed in this study.

Wisdom. M. 1992. The Starkey Project: new technologies chase old questions about deer and elk management. West. Wild. Spring:32-38.

Scientific Synthesis

Purpose:

Habitat management concerning elk and cattle requires scientific understanding. The knowledge gained by research may indicate proper levels of elk and cattle population numbers. This article describes development of the Starkey Project designed to examine deer, elk, and cattle response to various management activities. Land managers were anticipated to use the study results to create habitat management guidelines, and definitive models of habitat use for improved management of deer, elk, and cattle.

Summary:

The Starkey Project was initiated in 1987 in a 40-mi^2 area to provide sufficient summer range requirements for deer and elk herds. The area is also provides big-game winter range habitat. The Starkey Project area also provided excellent elk hunting opportunities. Revenues from hunting matched those from timber and livestock industries. Timber and livestock interests argued during national forest plan revisions in the early 1980's that mitigation for elk produced unnecessary and drastic reductions in forage supply. Hunters and environmentalists countered by claiming that elk mitigation measures were inadequate in maintaining ungulate populations. Resource managers decided that more research was needed leading to the development of the Starkey Project. The article emphasized, however, that only definitive results about the population response of animals to intensive management of timber, cattle, and recreation would warrant project funding.

Starkey scientists required three primary conditions: a closed system, tracking technology, and an experimental design that would limit animal response to summer habitat change without being confounded by winter range or weather. Closed systems, however, do not exist in nature. Difficulties associated with closed systems were mitigated with the acquisition of a sufficient land base and adjustment of winter-feeding levels to compensate for variable winter climate conditions. The study animals were fed and sheltered during the winter and allowed to forage under natural conditions during the spring and summer. Winter maintenance of animals ensured that they were in healthy condition during the growing season, thus, limiting impacts to productivity on summer range. These mitigation measures allowed researchers to maintain consistent deer and elk physical conditions. Additionally, the enclosure was equivalent or larger than the summer home range of most deer and elk. Animal tracking and location were accomplished with the Loran-C navigation system that included 150-foot relay towers and a base station. Nine elk and 9 cattle were fitted with Loran-C radio collars in 1989. By 1991, the program had expanded to a permanent base station and seven relay towers. Ultimately, the movements of more than 60 elk and 70 cattle were monitored by the summer of 1991.

The paper provides four major studies that were in progress during the time. The first examined deer, elk, and cattle use of an intensively timber managed area during a sale that occurred in 1991. The study continued for five years. The second study examined effects of frequency and type of motorized traffic on animal use of habitat adjacent to roads. The third project consisted of animal unit equivalency studies. The objective was to estimate accurate animal unit equivalencies by comparing the habitat choices of deer and elk to different grazing systems and stocking rates of cattle. Radio-collared elk were used to examine their movements in relation to presence, absence, and movement of cattle under different grazing systems. Results from the animal unit study were expected by 1993. Results from all studies were to be used in creating maps of potential areas of competition. Comparing deer and elk dietary selection to cattle selection in the same area would also be used to create the maps of potential competition.

Yeo, J.J., J.M. Peek, W.T. Wittinger, and C.T. Kvale. 1993. Influence of rest-rotation cattle grazing on mule deer and elk habitat use in east-central Idaho. J. Range Manage. 46:245-250.

Experimental Research

<u>Significance</u>:

Livestock grazing systems have been implemented to maintain or improve wildlife habitat. This paper studies shifting mule deer and elk habitat use and, differences in plant community use as affected by rest-rotation cattle grazing. The quality of elk and mule deer habitat could indicate the effectiveness of the livestock grazing system.

Methods:

The study took place in the Herd Creek tributary of the East Fork of the Salmon River in 1975-79. Steep terrain and north to south ridge systems characterized the 21,590 ha study allotment. The majority (82%) of the allotment was sagebrush-dominated communities. Habitat use by elk, mule deer, and cattle was determined weekly to biweekly from fixed wing aircraft. Three habitat use treatments were established: rested, cattle present, and cattle not present. Rested pastures had no cattle grazing since the initiation of that year's plant growth when observations were recorded. Grazed pastures (cattle present) experienced cattle grazing when observations were recorded. Cattle had already grazed the third treatment pasture (cattle not present) before observations were recorded. The 3 grazing periods were summer/fall, winter, and spring. A selectivity index was used to compare elk and mule deer selection of treatments and seasonal use of community types within treatments. The index showed preference, expected occupancy, and avoidance by elk and deer for selected treatments.

Results:

Cattle made use of higher elevations during each successive year after implementation of water developments and strategic salt placement. Water development, salting, and herding also resulted in increased use of steeper slopes and wider distribution of cattle. The majority of land used by cattle (79%) was of slopes less than 20 degrees. Cattle made significant use of mountain big sagebrush communities over the entire study period.

Elk used sagebrush communities primarily during summer and fall, and winter. Elk use of higher elevations, steeper slopes, and forested communities was higher in grazed than ungrazed areas. Minimal interaction between elk and cattle occurred on pastures previously grazed while use of rested pastures by elk increased. Pastures with observed cattle grazing offered adequate forage for elk calves because cattle did not go on to the allotments until July. Adjacent pastures grazed in the previous season also offered sufficient forage and habitat for elk.

Vegetation impacts caused by cattle grazing augmented those caused by mule deer and elk. Additionally, cattle grazing affected elk habitat use. However, increased elk populations were not a result of the cattle grazing but from a conservative hunting harvest. Livestock management goals were met in this study without adversely affecting elk or mule deer distributions.

Implications:

Elk showed greatest preference for rested pastures. During the course of the study, however, elk occurred more frequently with cattle. Human disturbance associated with moving cattle may have displaced elk more than the presence of cattle. Therefore, elk may have been more influenced by human disturbance associated with livestock production. Despite the growing tolerance for cattle, however, elk still preferred pastures without cattle for 5 years.

Rest-rotation cattle grazing systems may be implemented to improve cattle distribution on grazed land. Water developments and careful salt placement are additional methods used to improve cattle distribution and habitat use. Improved distribution of cattle decreases over-utilization in areas such as lower slopes and riparian areas. Changes in cattle distribution, however, may cause shifts in mule deer and elk habitat use. Benefits to elk and mule deer habitat use will depend on proper planning and appropriate vegetation, climate, and terrain conditions.

Management Programs to Reduce Elk/Cattle Conflict on Private Land

Bayoumi, M.A. and A.D. Smith. 1976. Response of big game winter range vegetation to fertilization. J. Range Manage. 29:44-48.

Experimental Research

<u>Significance</u>:

Wildlife often utilize crops and hay fields on private lands. Management strategies have been implemented on public rangelands to reduce the economic impact of wildlife foraging on private landowners. Range fertilization is one of several methods used to improve wildlife habitat and foraging conditions for cattle. Bayoumi and Smith (1976) studied the response of bitterbrush and sagebrush browse species and three herbaceous species (Pacific aster, beardless wheatgrass, and prairie Junegrass) to nitrogen and phosphorus fertilization. The effects of fertilizer on crude protein content of bitterbrush and sagebrush were examined. Use of fertilized and unfertilized bitterbrush and sagebrush plants by elk and deer was also examined.

Methods:

The study was conducted on big-game winter range at the Hardware ranch in Blacksmith Fork Canyon in northern Utah during the winters of 1972-73 and 1973-74. One-time applications of phosphorus or nitrogen, and in combination were conducted in 1972. Nitrogen alone was applied in 1973. The treatments were applied in a randomized block design with ten replications of eight fertilizer treatments in 1972 and five fertilizer treatments in 1973 with unfertilized control plots. Production of three herbaceous plants beardless wheatgrass, prairie junegrass, and pacific aster was determined using the weight-estimate method. Current year twig length response was used to measure browse production. Browse twig length measurements, however, did not provide quantitative data per unit area. Therefore, browse production was determined by multiplying increased twig length percentage by results from an unpublished report from the same area. Crude protein of the browse plants was determined. Twig length was measured before and after treatment to determine the effect of fertilization on utilization of bitterbrush and sagebrush by elk and deer.

Results:

Phosphorus application had no effect on browse or herbaceous plant production. Yields were equivalent when nitrogen alone, and nitrogen-phosphorus combinations were applied in equal proportions. The three herbaceous species responded to nitrogen fertilization at all application rates in 1972 and 1973. Because 1973 experienced greater early summer precipitation than 1972, higher production occurred than in 1972 at similar nitrogen levels. Increased yields corresponded with the amount of nitrogen applied. Herbaceous species exhibited greater production than sagebrush or bitterbrush in 1973. Production of bitterbrush and sagebrush was reduced in 1973 with nitrogen applications that exceeded 100.8 kg/ha. Nitrogen fertilization increased crude protein of twigs and leaves in both browse species in 1973, and in leaves only in 1972. Nitrogen fertilized sagebrush and bitterbrush plants received greater use by elk and deer in both winters.

Implications:

Fertilization could increase the production and quality of sagebrush and bitterbrush. Additionally, the authors predicted that the effects of fertilization at the studied rates would persist but, with incremental reductions in at least 3 years. The forage provided by increased production was assumed to increase foraging opportunities for ungulate species. For example, bitterbrush treated with 33.6 kg/ha of nitrogen would provide 5.3 more elk days/ha of use. Days of use, however, may vary with yearly precipitation levels. Additionally, animal intensities should not be allowed to exceed levels that will negatively impact plant vigor or survival.

Fertilization may provide a way to enhance elk winter range, however, it may not be economically feasible. Additionally, game animals may not utilize the forage produced by fertilization. Palatability differences between fertilized and unfertilized plants may also vary thus, increasing the potential that some, less palatable forage, will not be harvested. Therefore, actively improving big-game forage production with fertilization may only be justified where livestock also utilize fertilized areas.

The cost to benefit ratio of fertilization must be determined before it is implemented as a wildlife habitat improvement tool. The price of fertilization was twice as high in 1976 as it was in 1974 in this study. Additionally, wildlife depredation issues on private land will persist despite fertilization applications. However, increased forage production and subsequent cattle use, may assist private landowners by offsetting economic losses caused by wildlife on private land.

Edge, W.D. and C.L. Marcum. 1990. Elk and cattle on public lands: A new look at an old conflict. West. Wildlands. Summer:12-15.

Scientific Synthesis

Purpose:

Elk and cattle relationships have been extensively addressed. Additionally, most elk and cattle issues are commonly accepted as controversial as they relate to forage allocation and private land disputes. Consequently, research has also extensively reviewed possible strategies for effective elk-cattle management. An overview of the literature concerning elk and cattle interactions until 1990 is provided in this commentary article with possible solutions for resolving disputes.

Summary:

Recognition of amenity values such as recreation and wildlife by public land management agencies might result in reduced livestock grazing intensities. Compatibility of elk and livestock is questionable because of biological, economical, and societal factors. Research findings investigating this uncertainty, however, have been complicated by contradictory observations suggesting both compatibility and interference between elk and cattle.

The authors concluded that the potential for competition centered on dietary and spatial overlap, and social intolerance between elk and cattle. Disturbance competition, which causes an animal to leave an area because of another animal's presence, was considered most responsible for the uncertainty about the nature of elk-cattle interactions. However, competition of any type is difficult to document, thus, reducing the urgency to detect if disturbance competition exists. Conflicts occurred, however, and the authors expressed that management objectives should be implemented to minimize or eliminate these conflicts.

Research findings suggest that dietary overlap between elk and livestock was significant. Where forage availability was reduced, or in areas where cattle were highly concentrated, the potential for high dietary overlap was substantial. Properly developed management guidelines could reduce potential adverse impacts on the forage resource. However, several findings indicated that cattle and/or elk grazing could benefit grazing for each other by improving the quality or quantity of forage, but only when other factors such as forage plant density, and distance to roads and cover were considered. The utility of improved forage conditions depends on the extent to which these issues are considered. Improved foraging conditions may also depend on adequate levels of precipitation. For example, drought could reduce forage abundance. However, differential habitat selection by elk and cattle may reduce dietary overlap in these situations.

Where disturbance competition was suspected, it was primarily a function of stocking densities, habitat quality, and undetectable factors. A knowledge of appropriate cattle stocking levels was expressed as critical for effective range management. Additionally, stocking levels were stated to be site specific and vary regionally.

Damage to agricultural crops on private lands by elk was also discussed. Solutions ranged from grazing permit cutbacks to wildlife depredation payments. However, these approaches only seemed to intensify pressures between landowners and state and federal agencies. Land acquisition and habitat enhancement were proposed as appropriate alternatives for resolving landowner conflicts. Alleviating elk-cattle conflicts would also require determination of efficient forage allocations. Lastly, innovative approaches to natural resource management were suggested necessary to improve natural resources. Land managers were criticized for lacking the will to incorporate research results into forest management plans.

The author stated, “many wildlife mangers now believe that elk numbers are primarily a function of landowner tolerance, not habitat capacity”. Therefore, cooperation among landowners, agencies, and researchers is key in resolving public/private forage utilization issues. Additionally, existence of private land disputes implies failed resource management that could adversely affect elk survival. Ineffective management can only be warranted site-specifically, however, because it does not occur region-wide. Additionally, district level land managers have applied innovative approaches in the last 10 years, but are not widely recognized.

Jordan, L.A. and J.P. Workman. 1989. Economics and management of fee hunting for deer and elk in Utah. Wildl. Soc. Bull. 17:482-487.

Documented Case History

<u>Significance</u>:

Fee hunting opportunities may be associated with indirect improvements in elk and livestock interactions. This article focuses on proposed fee hunting enterprises in Utah to alleviate wildlife conflicts on private lands. Implementation of agricultural practices on private land to maintain or improve wildlife habitat, improved landowner/agency coordination, and/or greater hunting access were used to measure the success of the fee-hunting program. Fulfillment of any of these measures would improve relations between livestock producers and wildlife enthusiasts. Consequently, lower pressures to reduce elk or cattle populations were anticipated.

Methods:

Attempts were made to contact all Utah landowners that received payments for deer and elk hunting in 1986. The survey included 251 landowners. Landowners were contacted by mail and telephone to establish eligibility and to reduce the chance of interviewing more than one person about the same ranch or hunting opportunity. Landowners were asked to describe the size and location of their property, revenues and costs of hunting opportunities, and types of hunting opportunities offered.

Results:

Ninety-seven percent of the 121 eligible landowners completed telephone interviews. One hundred and fourteen landowners offered 155 different hunting opportunities. The basis for offering hunting opportunities was primarily to control trespassing (36%) or earn extra income and cover costs of having hunters on their land (26%). Charging a minimal access fee was preferred for controlling trespassers and damage. Although respondents reported problems with wildlife consumption of grain crops and hay, only 6% established fee-hunting enterprises to compensate for wildlife depredation.

The number of landowners that sold permits directly to individuals was almost equal to the number of landowners that leased to hunting groups or outfitters. Landowners gained an average net income of $6,649 or $0.27/ha from fee hunting. Landowners considered hunting ventures as secondary sources of income in comparison to livestock operations. Fee hunting caused 18% of landowners to lose money, 56% to gain less than $5,000 net income, and 26% to earn greater than $5,000 net income in 1986. It is believed that landowners who used the fees from the fee-hunting program strictly for hunter management received less than $1,000. However, this group was satisfied with the results despite the negative net income, or was unaware of their costs. Landowners who relied on hunting as a source of income ranged from 55%, who claimed it accounted for less than 10% of gross ranch income, to 3% who claimed that fee hunting accounted for greater than 50% of gross ranch income. Most landowners (75%) had been practicing fee hunting for at least 5 years and half had been charging for at least 10.

The authors expressed that maintenance of roads and facilities were substantial costs for Utah landowners experiencing damage or trespassers. The extent of damage during the hunting season exceeded that which was caused during normal livestock operations. Great expense was attributed to changes in livestock operations to accommodate wildlife and hunters. Costs incurred by landowners were primarily the result of human disturbance and not wildlife.

One quarter of the landowners had invested in fee hunting ventures. Habitat enhancements for deer and elk were implemented by 19% of the landowners while 10% invested in wildlife habitat improvements annually. Deer and elk population estimates were estimated by 19% of the landowners.

Implications:

Fee hunting opportunities were believed to provide incentive for landowners to improve wildlife habitat on their lands. However, incentive may be lacking because of low financial returns considered inadequate to sustain habitat improvement costs. Economic improvements realized from fee hunting practices were more evident in terms of trespass control and reduced damage than those from wildlife habitat improvements. Income gained through fee-hunting may not provide appropriate incentive for improving wildlife habitat. Policymakers advocating fee-hunting enterprises must realize that trespass and damage control are equal in landowner benefits to the development of wildlife habitat management goals. Whether adopted or advocated, costs, expected income, and management requirements should be considered before fee hunting initiation.

Lacey, J.R., S.B. Laursen, J.C. Gilchrist, R.M. Brownson, J. Anzick, and S. Doggett. 1988. Eonomic and social implications of managing wildlife on private land in Montana. Northwest Sci. 62:1-9.

Documented Case History

Significance:

Reduced wildlife depredation of private land forage will improve elk-cattle management by reducing pressure between livestock producers and wildlife enthusiasts. This study presents results of a survey of Montana private landowner views of fee hunting and/or other recreational activities provided on private land. The survey was designed to provide information that could be used in evaluating multiple-use management alternatives for private landowners.

Methods:

One thousand randomly selected members of the Montana Stockgrowers Association received a self-administered mail-back questionnaire in April 1986. A second questionnaire was delivered two weeks later to landowners that did not respond to the first letter. Members of this Association were selected because their lands accounted for a majority of the lands in Montana where hunting occurred. The questionnaires were intended to analyze wildlife value perception by private landowners, and to determine the extent of consideration for wildlife habitat maintenance in land management decisions on private land. Regional trends were accounted for by dividing the state into 5 regions.

Results:

The survey consisted of 526 respondents. Regional leasing activity to sportsman depended on the proportion of private land vs. public land, and the quantity of cropland. The northcentral region was comprised of 45% cropland resulting in less incentive to lease big game hunting. Only 3% of respondents increased leasing activity to sportsman between 1975 and 1985. However, during the same period 54% of respondents leased more than one-half of their land to hunters.

Elk were reported to occur on 30 ranches in the study and consumed a total of 576 AUMs of forage. Combined mule deer and elk utilization totaled 986 AUMs. Most respondents that provided elk hunting opportunity to sportsman reported $1,000 to $2,000 of total 1985 gross income. Elk and mule deer hunting opportunities were reported as the two activities that would realize the greatest economic return. However, hunting leases provided only 5% of the respondent's total annual income, and only 8% of the lessees reported a 15% or greater return from hunting fees. There was great variation in the time hunters were allowed to hunt on a region-wide basis because of the informal manner in which leases were provided.

More than half of the respondents (57 %) used management practices to improve habitat. Additionally, 14% had established food and/or cover plantings or manipulated wetlands. Only 8% of the landowners that did not lease to sportsman were aware of habitat improvement practices that could be implemented on their property. Thirty-nine percent of the respondents felt that development of a certain number of hectares was necessary for creating sportsman opportunities on their land. Thirty-four percent of lessees felt that overall habitat quality would improve with leasing.

Implications:

Wildlife populations were noted as increasingly threatened by expanding urban populations in the western United States. This problem was amplified as private landowners incurred the responsibility of managing increased numbers of wildlife inhabiting their lands. A proportion of landowners attempted to incorporate sustainable wildlife management into their private operations, however, a significant proportion did not. In this situation, wildlife were considered an economic burden as competitors with livestock for forage, and agents of destruction to crops and hayfields. Without proper incentive to provide for wildlife, quality of habitat will decline. Providing economic incentives to all landowners to promote cooperation between natural resource agencies, sportsman, and landowners is critical. In this survey, 90% of all respondents felt that landowners should be reimbursed for providing opportunities to sportsman. Lack of proper economic incentive for the landowner to improve wildlife habitat on private land would be detrimental to wildlife populations.

Lacey, J.R., K. Jamtgaard, L. Riggle, and T. Hayes. 1993. Impacts of big game on private land in southwestern Montana: Landowner perceptions. J. Range Manage. 46:31-37.

Documented Case History

Significance:

Reduced wildlife depredation of private land forage should improve elk-cattle management indirectly by reducing tension among livestock producers and wildlife enthusiasts. Study of big-game numbers and exact costs incurred by private landowners will also direct management toward specific needs for improving wildlife-livestock management. This study reveals big game economic impacts sustained by private landowners and possible measures to reduce the impact.

Methods:

Self-administered, mail-back questionnaires were sent to 858 rural landowners of 7 southwestern Montana counties in December 1989. The study area included. The intent of the survey was to estimate the impact of big game animals on private land. Possible error in response consisted of overestimated animal densities and duration of time spent on private lands. The impacts of big game grazing on hay and grain yield or long-term range productivity were not evaluated. A rate of $11.00/month supply of forage for a 455 kg animal was used to estimate the monetary value of forage harvested by big game. Respondent acceptance of non-monetary big-game benefits was summed using an index of intangible benefits. Four categories (enjoyment of big game occupancy, family hunting, hunting by friends, and other) comprised the index. Nonresponse bias was not evaluated, nor was nonrespondent analysis conducted to ensure that only actual response was statistically analyzed. Size of private landowner acreage was treated as a control variable.

Results:

A 53% response rate of useful information was attained. Large landowners comprised a majority of the respondent population. Bureau of Land Management leases averaged 437 animal unit months (AUM) and 37% of the population while Forest Service leases averaged 1,082 AUMs and 32% of the population. State administered lands accounted for 33% of the leases. Agricultural income accounted for an average of 75% of total respondent income.

Half of the respondents reported significant elk use of private lands. Big game costs, before economic returns from hunting were incorporated, averaged

$6,467 per landowner. Therefore, livestock/big game interactions were adverse because of economic impacts on private land relative to forage, soil, crop, and fence damage. Elk consumed the most forage (214 AUMs) of any big game species per landowner based on animal number, duration of private land occupancy, and animal size. The cost of forage consumed by big game averaged $5,616/landowner. Haystack damage was reported by 49% of the respondents with an average loss of 7.5 tons/landowner. Other costs associated with wildlife damage incurred by landowners included fencing and labor.

The net economic cost of big game per respondent, after economic returns from hunting were incorporated was $6,353. Four percent of landowners earned $1,000-$5,000 from hunting. Big game hunting on private lands totaled 227 days. The estimated value/day of hunting was estimated at $28. Consequently, landowners incurred a cost while providing benefits to hunters because costs associated with wildlife damage were more than income gained through hunting enterprises. Some landowners requested compensation for providing wildlife habitat and recreation.

A majority of landowners (70%) in operation for more than 10 years reported increases in whitetail deer and elk on their land. Landowners that owned large parcels of land reported more big game animals. Fewer animals were desired as the economic cost of big game increased. Fewer elk, antelope, whitetail deer, and mule deer were desired by 32%-44% of respondents. Landowners less dependant on agricultural income reported less economic impact by big game. Size of landholding and income from big game, however, were not useful explanatory variables of harmful effect on crop yields. Respondents with a high intangible value index for wildlife also reported less economic impact. Half of the respondents reported that they enjoyed big game occupancy on their lands.

Implications:

Big game can adversely impact landowner income. However, hunting opportunities used by landowners can reduce economic impacts caused by big game while improving cooperation among landowners, sportsman, and resource management agencies. Additionally, big game utilization of private forage supports the need to increase forage quantity and improve winter forage quality on public ranges. Such measures will reduce the potential for landowners to be affected by wildlife damage.

Loomis, J., D. Donnelly, and C. Sorg-Swanson. 1989. Comparing the economic value of forage on public lands for wildlife and livestock. J. Range Manage. 42:134-138.

Documented Case History

Significance:

Wildlife/livestock competition for forage on public and private land is a serious and complex issue in the western United States. Determining the value of wildlife or the forage they consume is difficult. Such an evaluation would be necessary to determine economically appropriate wildlife and livestock populations relative to forage availability. A method is proposed in this study for determining the marginal values of elk and deer and, the product value of an AUM of forage.

Methods:

The marginal value of forage was determined to establish economic values of forage for elk and deer in Challis, Idaho. Net willingness to pay for recreation and the travel cost method were used to estimate the marginal valuation of wildlife. Data for this method were collected using Idaho hunter surveys in 1982. Variation in hunter attitude toward an area was represented through demand curves. An equation involving available elk for harvest and quantity of forage was used to determine marginal productivity of forage.

Results:

Results indicated that, in two chosen units of study (36 and 36B of the Challis National Forest) elk had a $685 marginal value (MV) per animal harvested and, deer $333 MV per animal harvested. The MV and marginal value product (MVP) per AUM decreased with a 25% increase in herd size. The MVPs per AUM of both species were higher than the MVPs for cattle in the Challis area using joint US Forest Service and BLM Appraisal Report figures. Balancing wildlife and cattle forage value would require providing additional forage to wildlife until the marginal value to wildlife decreased to the marginal value of forage to livestock or, increasing wildlife herd sizes until forage values were commensurate with livestock.

Implications:

The Bureau of Land Management developed the SAGE-RAM model to estimate benefit-cost analysis on resource investments. The US Forest Service uses a model called FORPLAN to evaluate its resource tradeoffs. Using the travel cost method, this research develops marginal values of two big game species (elk and deer) and the marginal value product of an animal unit month of forage to these species. The results are suggested for use in the SAGE-RAM and FORPLAN models to improve accuracy in determining economically efficient forage allocation on public rangelands.

The authors suggest that with improved geographical and statistical precision in estimating the value of forage to wildlife and livestock, forage could be more appropriately allocated between these species on a site-specific basis. Additionally, using wildlife values, the economic feasibility of increasing forage production for wildlife could be enhanced.

Lyon, L.J. 1985. Elk and cattle on the National Forests: A simple question of allocation...or a complex management problem? West. Wild. Spring:16-19.

Scientific Synthesis

Purpose:

Successful elk/cattle interactions depend on appropriate management. Intensive research is required to facilitate appropriate management. Consequently, correct management will reduce the uncertainty concerning whether elk and cattle are competing users of natural resources. This article summarizes elk and cattle interactions regarding needed research, research progress, and implications of potential results for elk and cattle habitat relationships.

Summary:

Implementation of the Resources Planning Act predicted that livestock grazing on public lands would have increased from 213 to 310 million AUMs by 19?? (need to recopy). The Northern Region of the U.S. Forest Service anticipated an increase in AUMs from 1,405 million to 1,799 million on national lands by 2021. There was also an expected increase in pressure for greater elk hunting opportunities. Increased elk hunting opportunities would not have been possible if elk populations declined.

Direct competition for forage is a key factor in terms of elk and livestock relationships. However, results from preference studies did not confirm direct competition. Researchers then questioned whether social intolerance might be more critical than competition for forage. Studies that looked at social intolerance between elk and cattle produced contradictory results. The fact that elk and cattle could occupy common habitats without competing directly for forage or space produced emotional debates and polarization rather than solutions.

Researchers suspected that elk and cattle social interactions were a function of stocking densities, habitat quality, season, and less conspicuous factors. Competitive interactions most likely occurred during winter as forage availability decreased. However, dietary overlap was also considered beneficial for both species. The authors suggested that elk and/or cattle grazing in common areas or, on common plants could improve forage quality for either species. Grasses, however, needed a period of rest between elk or cattle foraging during early spring. Encounters between elk and cattle declined during summer and fall as preference for habitat became increasingly varied. Grazing strategies could be modified to reduce elk and cattle interactions where space was a limiting factor.

Increased knowledge about elk and cattle interactions was gained in Montana from the development of a cooperative research program in July 1982.

The primary objectives were to determine: what circumstances were driving elk away from cattle, where the elk went, and the impacts on the health of either species. Researchers monitored local changes in elk distribution, evaluated alternative habitats, and studied elk response to cattle grazing systems. Researchers felt modifications to grazing systems could be effective in addressing problems identified during their study.

Studies conducted under the cooperative program included: elk calf survival in the Little Belt Mountains, elk movement patterns as a result of cattle distribution on the Lewis and Clark National Forest, and elk and cattle distribution patterns on the Wall Creek Wildlife Management Area in the Beaverhead National Forest. Progress towards an understanding of elk/cattle interactions required detailed descriptions of elk and cattle habitat selection and use. Researchers expected to find competitive interactions between elk and cattle, but not to the extent where removal of one species would be required. Researchers also expected to describe conflict areas clearly enough to facilitate land managers in identifying signs of conflict.

Rimbey, N.R., R.L. Gardner, and P.E. Patterson. 1991. Wildlife depredation policy development. Rangelands. 13:272-275.

Documented Case History

Significance:

Hunting implications and the damage caused by wildlife on private land illustrate how elk/cattle interactions extend beyond their grazing relationship on public land. This paper reviews several options to reconcile disputes between the Idaho Department of Fish and Game (IDFG) and private landowners concerning wildlife-caused damage on private land.

Summary:

Severe drought struck southern Idaho in 1987 and 1988 forcing much wildlife onto private hay fields and crops. Utah producers reported a loss of $250,000 during that period. Most private landowners felt the IDFG was not working hard enough to reconcile the wildlife issue. Public sentiment maintained that private landowners did not possess a proper conservation ethic.

The 1989 Idaho Legislature appropriated $500,000 to the IDFG budget for complaints that occurred between July 1, 1988 and June 30, 1989. The IDFG received 204 claims totaling $1.3 million for 1988 damages and $450,000 for damages in 1989. No consistent format for filing claims was ever developed resulting in an excessive amount of compensation demand. The claims were analyzed using the Forage Consumption Method developed in Utah. The method multiplied the number of animals, by the forage amount an average animal consumed in a day, by the amount of time it resided in a specified area. The method, however, did not account for damages caused by trampling or defecation. Additionally, the number of animals and the time they occupied an area could also be debated.

The University of Idaho developed the Yield Decrement Approach for analyzing claims. The Yield Decrement Approach compared historic crop sales records from individual claimants to actual yields to derive yield decrements. A custom rate was instituted to account for indirect damage caused by wildlife. Claims were further divided in half to account for drought impacts. Four hardship claims were reduced by $230,000 as a result.

The Idaho Legislature appointed a 12-member committee to resolve future wildlife issues. Two accounts were established using the IDFG Operating Budget and the Idaho General Account. Total compensation to landowners would not exceed $500,000 in any given year using these two newly established accounts.

Before adoption of the two new accounts, statewide public testimony was given before the 12-member committee. Wildlife enthusiasts evidently miscalculated the financial burden wildlife could impose on the operations of private landowners. Wildlife supporters also became aware of the conservation ethic that ranchers and farmers possessed toward game populations. Private landowners expressed concern that the IDFG was allegedly managing wildlife for maximum game numbers without proper consideration for domestic stock forage allocation.

Several methods of resolving wildlife disputes were presented and varying levels of success were identified. Consequently, resolution of wildlife complaints requires several approaches. As the debate over wildlife issues continues, so should the development and testing of methodologies that will encourage understanding and cooperation among those interested in and affected by livestock and wildlife.

Thomas, J.W. 1984. Fee-hunting on the public's lands? An appraisal. Trans. N. Amer. Wildl. and Natur. Resour. Conf. 49:455-468.

Scientific Synthesis

Purpose:

Economic considerations are an important aspect of elk-cattle interactions. Effective economic consideration should reduce pressure by livestock producers to limit elk populations and distributions. This paper examines fee-hunting in the context of production and hunting of elk on Forest Service and Bureau of Land Management lands in the western states. Specific focus was on Oregon, Wallowa County, and the Wallowa-Whitman National Forest in northeastern Oregon. How livestock and elk production would be effected by fee-hunting impacts on big game planning is also discussed.

Summary:

In 1982, The National Research Council's Committee on Impacts of Emerging Agricultural Trends on Fish and Wildlife Habitat noted that, "the trend toward charging fees for wildlife had to increase if wildlife habitats were to be protected or developed". Fee-hunting was spreading across midwestern and western states at the time. It was more popular on privately owned lands while, in states where a majority of the land was public, fee-hunting was developing slowly. The increase in fee-hunting popularity coincided with changing views of big game hunting on public lands.

In Oregon, where more than 50% of the land was public, it was impractical for landowners to charge for hunting, although, some did. Because of perceived damages and negligence, landowners often denied access to private lands. Some landowners were concerned about competition between elk and cattle for forage. Elk populations had been increasing over the last 40 years while cattle numbers had declined. The question of competition was not detectable because of insufficient forage data, utilization, or range condition and trends. How to correct a situation in which private and public entities were mutually responsible for wildlife and their habitat became significant. Fee-hunting was proposed as a solution.

According to Forest Service and Bureau of Land Management land use projections, an inverse relationship existed between livestock and elk numbers. Elk and livestock were common topics of dispute concerning appropriate allocation of resources. The dispute involved amenity based production enthusiasts against those who perceived production from a commodity-based standpoint. The concept of equity was discussed in terms of equivalent allocation of resources for wildlife and livestock during the land-use planning phase.

Various techniques such as hunters' expenditures and travel costs were available for estimating big game value. These techniques concerned hunting and not big game or habitat. Big game value needed to be expressed as revenue in order to be considered a commodity. Demands and values of commodities were projected to grow with increased population and reduced land base. Twenty-five percent of livestock grazing receipts on Forest Service lands were paid to counties within which a Forest resided. Livestock production also promoted contributions to local economies. If livestock grazing was sacrificed at the expense of big game improvements, local communities would experience most of the lost revenue. In

1983, 17 of 21 economic sectors suffered as a result of reduced cattle grazing in Wallowa County according to a Forest Service planning alternative that favored big game hunting.

A description of the fee-hunting program was discussed. Under the fee-hunting program, hunters were required to purchase a Federal stamp that they would attach to their state hunting license for each big game species hunted on public land. However, determining full value would be difficult. The proceeds would be divided equally and allocated to counties, state and federal agencies for management of private and public lands, and to the Federal Treasury. Returns per AUM were used in contrasting land use alternatives involving forage allocation between livestock and big game.

This program benefited private landowners because AUMs were not allocated considering revenues only. Livestock numbers would also unlikely be reduced. Range improvements such as water developments and improved forage would benefit livestock, and leasing of private lands for hunting would be easier to manage. Increased prices were projected to limit hunting opportunities with this type of program. However, demand for hunting opportunities would eventually increase thus, balancing the number of hunters with the price of hunting.

Van Tassell, L.W., C. Phillips, and W.G. Hepworth. 1995. Livestock to wildlife is not a simple conversion. Rangelands. 17:191-193.

Scientific Synthesis

<u>Purpose</u>:

Balanced AUM allocation is a function of equal economic and ecologically sound allocation of forage between livestock and wildlife. This article recognized the difficulty in balancing wildlife AUMs with those of domestic livestock. The article specified the difficulties associated with unequal forage allocation in relation to habitat maintenance, private landowner conflicts, and hunting activities. The article is specific to Wyoming and common western big-game species. However, the implications were relevant specifically to elk and cattle and to a majority of the range in which they co-exist.

<u>Summary</u>:

According to the Federal Land Policy and Management Act of 1976, public lands will provide food and habitat for fish and wildlife and domestic animals. The proper allocation of resources between wildlife and domestic livestock is controversial. Increased wildlife numbers produced declines in domestic livestock from western ranges. The removal of one cow would provide enough forage for 1.4 elk.

There was concern over the maximum sum of multiple use values on public lands. Proper balances of wildlife and domestic livestock were investigated using weight conversion factors. These conversions were only minor elements required in determining proper allocations.

In Wyoming, the Game and Fish Department developed 5-year plans including population objectives for several big game species. In setting target populations, the Game and Fish Department considered habitat viability, hunting access, and landowner tolerance of wildlife on private land. These plans were implemented without consideration of federal agency objectives. Several interactions between livestock and wildlife were noted that described competitive and facultative relationships. Management agencies considered year round forage requirements of wildlife and that habitat was often intermingled on private and public lands.

Hunting was noted as a common method used for managing big game. Complications with hunter access on private land, however, must be resolved for this practice to be successfully used in management. Private lands often blocked access to public lands where these lands intermingle. Blocked access to public lands was expected to increase because of increased anti-hunting sentiment. On private lands that did allow hunting, specifically to hunting clubs, the authors suggested that economic opportunities related to hunting realized by one landowner could create big game problems for other landowners. Consequently, tolerance of wildlife became the limiting factor on population levels because of private land conflicts.

The Wyoming Fish and Game Department had attempted to resolve private land disputes by several means. They attached a landowner coupon to hunting licenses that carried a $9.00 redemption value to the landowner for every animal that was harvested on their land. Fish and Game provided compensation for wildlife damage to cooperating landowners that allowed hunting on their land. These landowners were provided with materials for crop protection and fence construction. Winter range conflicts were resolved through land purchases.

Exchange of wildlife AUMs for livestock AUMs was not sufficient for resolving forage conflicts between wildlife and livestock. Appropriate population densities of each species required consideration of what the habitat would support, and effective means, such as hunting, for achieving proper balance between wildlife and livestock numbers.

Disease Transmission

McCorquodale, S.M. and R.F. DiGiacomo. 1985. The role of wild North American ungulates in the epidemiology of bovine brucellosis: a review. J. Wildl. Dis. 21:351-357.

Scientific Synthesis

Purpose:

Brucella abortus is a bacterium that can be transmitted between wildlife and livestock causing a disease called brucellosis. Transmission of brucellosis between livestock and wildlife has been a concern since the discovery of the disease in both species in the early 1900's. The authors reviewed published scientific results to assess the potential for wildlife transmission of brucellosis to cattle, and the status of wildlife as reservoirs of *Brucella abortus.*

Summary:

Brucellosis eradication programs initiated in the 1940's treated infected cattle herds but not their wild counterparts. Elk were suspected to be highly susceptible to brucellosis because they did not evolve with the disease. Therefore, the addition of wildlife into these programs was suggested to prevent wild populations from becoming hosts for the disease. However, little evidence was available to indicate that there was active transmission of brucellosis between wild and domestic ungulates.

Various serologic tests were conducted to detect the prevalence of *Brucella* in wild populations. For this review, tested animals were considered seropositive if high levels of titers were detected in any animal of the same population. One third of 32 elk ranging near infected bison in Yellowstone National Park tested positive for Brucellosis in 1931. However, only 5% of elk outside the range of infected bison were positive. Additionally, serologic surveys from several states and Canada indicated a low likelihood of infection in most elk populations. Therefore, the greatest potential for transmission occurred when elk shared common ranges with infected cattle or bison. Elk would unlikely represent viable reservoirs for *Brucella abortus* anywhere else. However, elk were becoming suspected sources of infection in northwestern Wyoming.

Cattle brucellosis infections were uncommon between 1971 and 1980 in the west and northwestern United States. If transmissions from wildlife to cattle in natural settings occurred, the elimination of bovine brucellosis transmission would have invariably been threatened. There were, however, no documented cases of this transmission ever having occurred. Additionally, concentrations of infected cattle did not occur within the same vicinity of western Rocky Mountain elk. Elk also tended to calve in secluded areas and removed placenta after birth, thus, reducing the risk of transmitting disease. The authors concluded that wildlife do not significantly impact the occurrence of brucellosis in cattle in North America based on serologic tests and geographic distributions.

Thorne, E.T. and J.D. Herriges Jr. 1992. Brucellosis, wildlife and conflicts in the GreaterYellowstone Area. Trans. 57th N.A. Wildl. and Nat. Res. Conf. 453-465.

Scientific Synthesis

Purpose:

Disease transmission is an important aspect of elk and cattle interactions because of the economic and emotional debates that ensue. This conference paper provided a historical account of initial brucellosis transmissions between wildlife and livestock and a description of disease concerns prevalent in 1992. The authors provided information on the sources of conflict and resolution concerning brucellosis transmission and discussed approaching disease issues.

Summary:

Elk and cattle herds of Yellowstone National Park, the Greater Yellowstone Area (GYA), and some areas of neighboring states of Montana and Idaho were the focus of the paper. Development of winter feedgrounds for elk in Wyoming during the early 1900's were suspected to have led to transmission of brucellosis between livestock and wildlife. The disease was scarcely recognized in cattle, and there was no knowledge of its occurrence in wildlife before this time.

The Cooperative Brucellosis Eradication Program was developed in 1940 with the objective of eradicating *Brucella abortus*, the carrier of bovine brucellosis, in the United States. The program cost more than $1 billion in 1992 and resulted in 30 brucellosis-free western states, thus, reducing costs to livestock producers.

According to program guidelines, surveillance of cattle herds was conducted based on tests of blood or milk. Upon detection of an infected herd, all animals were tested and subsequently slaughtered if tested positive. Retesting occurred until all infected animals were removed. Vaccination of animals with the strain 19 vaccine was also a vital component of the eradication program. Herds could be quarantined or depopulated upon detection of brucellosis. Quarantine tactics were costly for the producer. Depopulation measures were also costly but rapidly and undoubtedly removed brucellosis from the herd.

The Wyoming Game and Fish Department studied the effects of brucellosis on elk at the Sybille Wildlife Research and Conservation Education Unit. Brucellosis could be transmitted from elk to livestock, primarily during periods of close association (late winter and early spring) if a cow came into contact with the placenta of an infected elk cow on a feedground. Transmission of brucellosis was extremely rare at any other time. At Sybille, elk responded similarly as cattle to the strain 19 vaccine.

The major infections of brucellosis by elk are believed to occur on feeding grounds. Blood samples from elk at feeding grounds were tested for detection of brucellosis. All feedground elk were suspected to test positive because in 18 of 23 northwest Wyoming feedgrounds elk tested positive for brucellosis. Only 1-2% of elk found outside the feedground complex but within Yellowstone was brucellosis contaminated. The disease was not believed to spread among elk found outside of feedground complexes.

Several strategies were proposed to reduce the spread of brucellosis. Some groups wished to ignore the problem while others felt it was time to address the problem. Total elimination of infected elk and/or cattle populations was proposed but undoubtedly, this measure would be met with strong resistance. The removal of elk feedgounds was denied because of expected elk pressure on private winter grounds. Wyoming Fish and Game initiated a Brucellosis-Feedground-Habitat process to reduce the potential for disease transmission at feedgrounds. Vaccination seemed the only feasible approach for controlling brucellosis in elk. However, dosages for elk could not be compared to quantities administered to cattle, thus, more research was needed. Additionally, the long-term effects of such a program were uncertain. Elk vaccination program costs ranged from $80,000 to $100,000 each year. Veterinary Services and the Wyoming Game and Fish funded the program.

Other issues discussed include the effects of government compensation to ranchers experiencing vaccination costs. Implications of the total brucellosis elimination sentiment were discussed and determined to be impractical. Brucellosis conflict management would require innovative approaches designed for free-ranging wildlife, and the approaches would need to be developed in a cooperative setting among all those involved.

Conclusions

Natural systems are dynamic spatially and temporally. That variability is reflected through constant scientific investigation. Scientific data, however, can also be quite specific in its application. Hence, resource professionals must not delay or eliminate their search for new knowledge (Marlow 2000). For example, while cattle grazing can improve elk winter forage, our understanding of the process leading to forage improvement has changed since Anderson and Scherzinger (1974). Additionally, resource professionals must realize the appropriateness of data being called upon to analyze certain situations (Kelly 2000). Increased elk depredation on private land, for example, does not necessarily justify elk population control measures or costly winter range acquisition if the cattle grazing strategy can be improved. Thus, appropriate cattle grazing studies must be examined before less practical or socially unacceptable measures are initiated.

Krueger and Kelley (2000) suggest that experimental research has greater applicability than documented case history. Most documented case histories in this bibliography are identified by diet studies or management programs, however, they provide information that will assist mangers throughout the west either by indicating which plant species to focus diet evaluations on or, approaches for reducing depredation on private land. While more scientific synthesis and professional resource papers about elk and cattle exist, perhaps more will be needed as the level of elk/cattle interaction research is created and/or enhanced. Additionally, professional resource papers will be needed to continue being written by experienced authors, thus, increasing their utility and value.

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CHAPTER IV

THE WEB PAGE: NECESSITY AND DESIGN

Introduction

The Internet presents an opportunity to effectively transfer vital, peer-reviewed elk/cattle research. Such material is necessary for managers to support range and wildlife management decisions and defend Environmental Assessments and Environmental Impact Statements. Supporting decisions and defending documents, however, is difficult because published elk/cattle literature results are not always available in usable formats by resource managers. Additionally, retrieval of elk/cattle literature in remote locations may be complicated by distance or funding (Finch and Mallory 1992).

The Internet may provide an avenue for retrieving relevant natural resource information, however several difficulties must be overcome to make this tool useful. For example, broad search terms can make it difficult to retrieve viable information about elk/cattle interactions. This is complicated by the availability of many search engines that provide dissimilar site results using the same search terms. The Overture search engine, for example, produced 160 sites using “elk and cattle” whereas only 3 were produced using the same search terms in Yahoo. The Google search engine produced 43,900. Additionally, the sites produced using “elk” are not all specific to information pertaining to *Cervus elaphus*. Consequently, some sites pertain to locations named after elk, elk breeding, antler art, etc.

Clearly, specific elk/cattle information needs to be more simply revealed. Some elk/cattle search terms produce pertinent information about their literature.

However, most sites only provide literature references without discussions about their content (http://www.rmrs.nau.edu/lab/4302/amedina.html). Some sites do provide content, however, the content relates to specific information or broad elk cattle reviews similar to those found in most range journals (http://uwadmnweb.uwyo.edu/RenewableResources/classes/Rangeland_Forage_Main.html, http://biology.usgs.gov/s+t/noframe/c273.htm). A search engine called FindArticles (http://www.findarticels.com) provides peer-reviewed scientific articles. The ability to easily identify specific elk/cattle interaction literature is, therefore, needed. Such availability will reduce the time and energy required to find pertinent information. Consequently, valuable research that would benefit land management otherwise remains idle among countless numbers of stored journal publications (Thomas and Salwasser 1989).

Web Design

This project offers categorized and summarized elk/cattle interaction research. The home page (Figure 1) briefly describes the project and how to find specific information using topic categories. The categories include: Grazing Effects on Forage Quality (Figure 2), Diet/Habitat Interactions (Figure 3), Elk Response to Grazing Systems (Figure 4), Management Programs to Reduce Elk/Cattle Conflict on Private Land (Figure 5), and Disease Transmission Between Elk and Cattle (Figure 6). The categories represent links to the page of each respective topic. Other links include: Additional References (Figure 7) and Project Background (Figure 8). Listing all the topic links on each page should facilitate navigation through the website. Additionally, every topic includes a short description of its content.

Methods

The web design was created using Microsoft Frontpage. Links are created, first, by identifying a specific word as a bookmark, and then linking to that bookmark to establish navigation among and within pages. Images may be incorporated from the software database or from specific files. The annotations were originally created as Word documents and then pasted individually into their respective topic pages.

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Figure 4.1 Home page for Elk/Cattle Interaction annotated bibliography web site. www.its.uidaho.edu/range/elk_cattle/

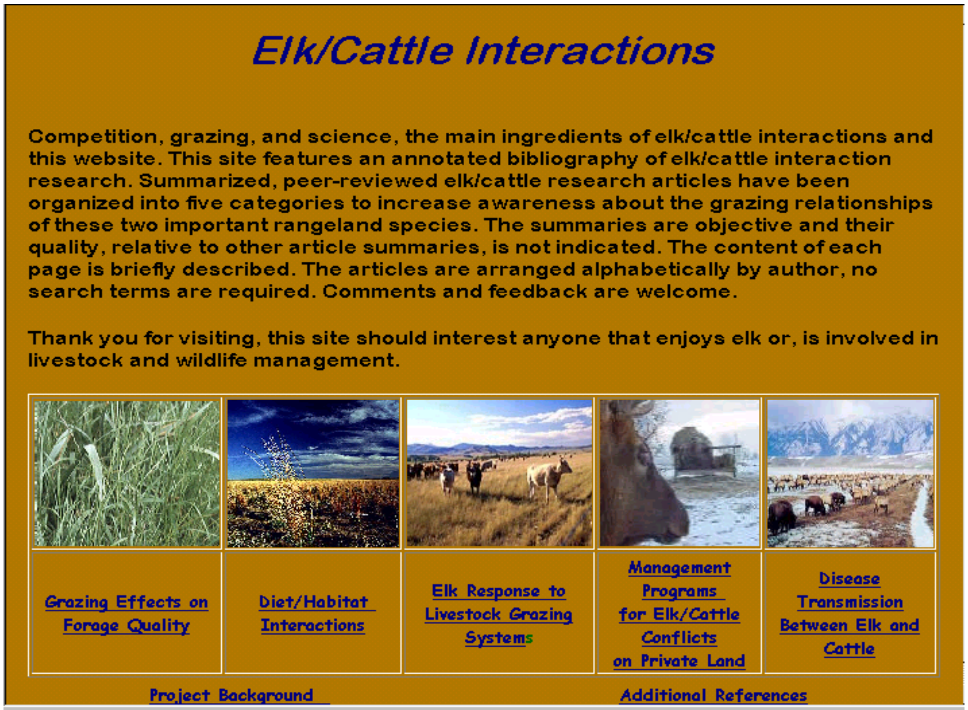
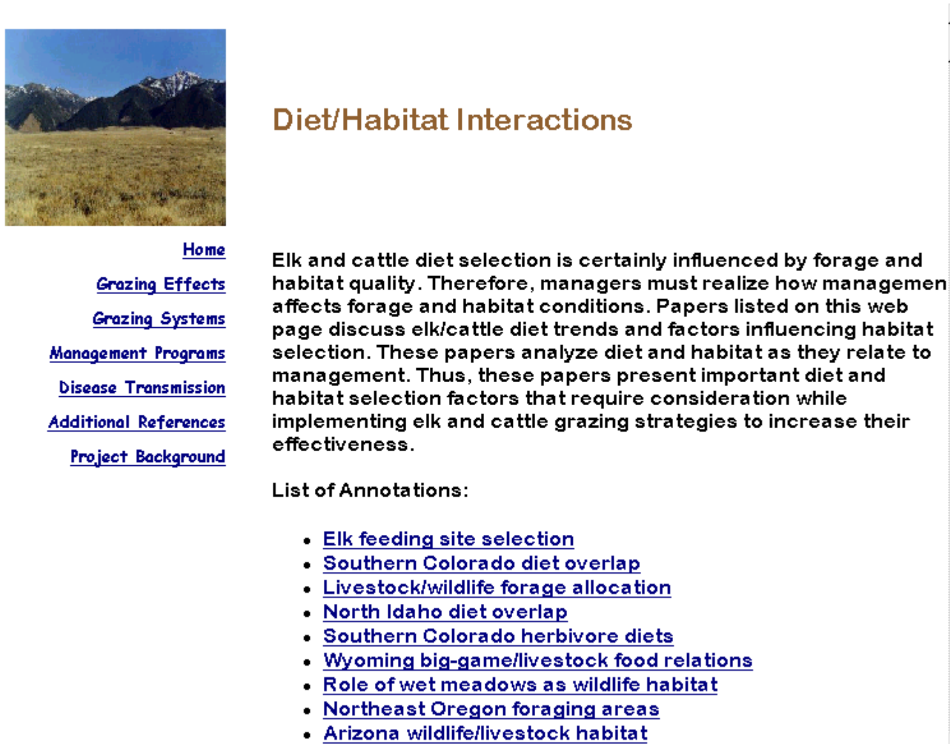


Figure 4.2 Home page for grazing effects on forage quality from the Elk/Cattle Interaction annotated bibliography web site. www.its.uidaho.edu/range/elk_cattle/

Figure 4.3 Home page for diet/habitat interactions from the Elk/Cattle Interaction annotated bibliography web site. www.its.uidaho.edu/range/elk_cattle/



Diet/Habitat Interactions

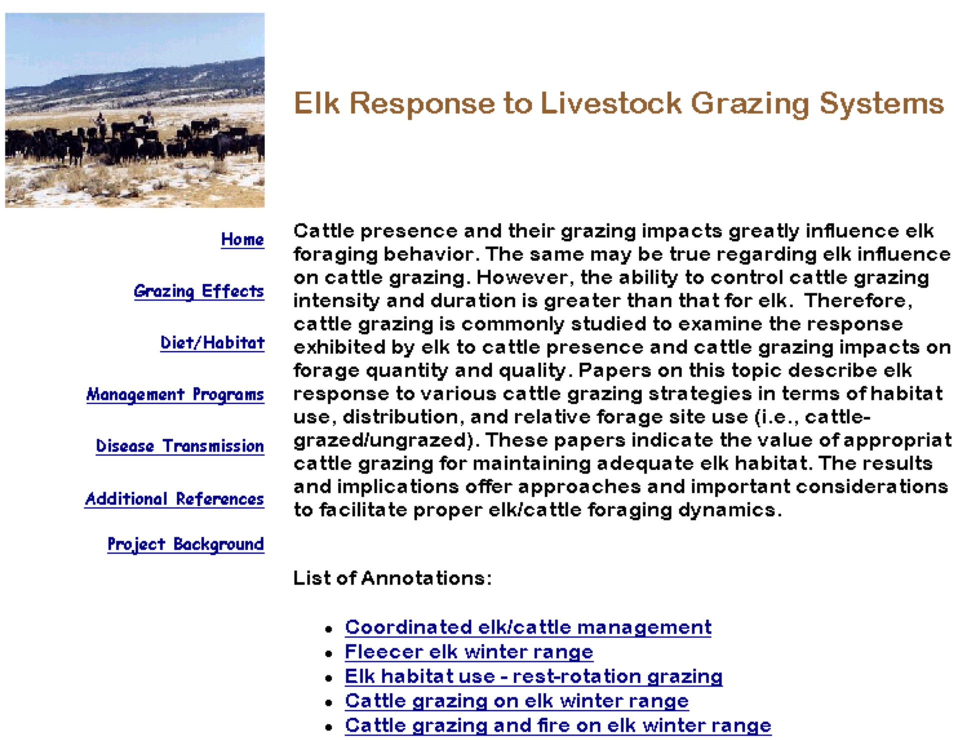
Home
Grazing Effects
Grazing Systems
Management Programs
Disease Transmission
Additional References
Project Background

Elk and cattle diet selection is certainly influenced by forage and habitat quality. Therefore, managers must realize how managemen affects forage and habitat conditions. Papers listed on this web page discuss elk/cattle diet trends and factors influencing habitat selection. These papers analyze diet and habitat as they relate to management. Thus, these papers present important diet and habitat selection factors that require consideration while implementing elk and cattle grazing strategies to increase their effectiveness.

List of Annotations:

- Elk feeding site selection
- Southern Colorado diet overlap
- Livestock/wildlife forage allocation
- North Idaho diet overlap
- Southern Colorado herbivore diets
- Wyoming big-game/livestock food relations
- Role of wet meadows as wildlife habitat
- Northeast Oregon foraging areas
- Arizona wildlife/livestock habitat

Figure 4.4 Home page for elk response to livestock grazing systems from the Elk/Cattle Interaction annotated bibliography web site. www.its.uidaho.edu/range/elk_cattle/



Elk Response to Livestock Grazing Systems

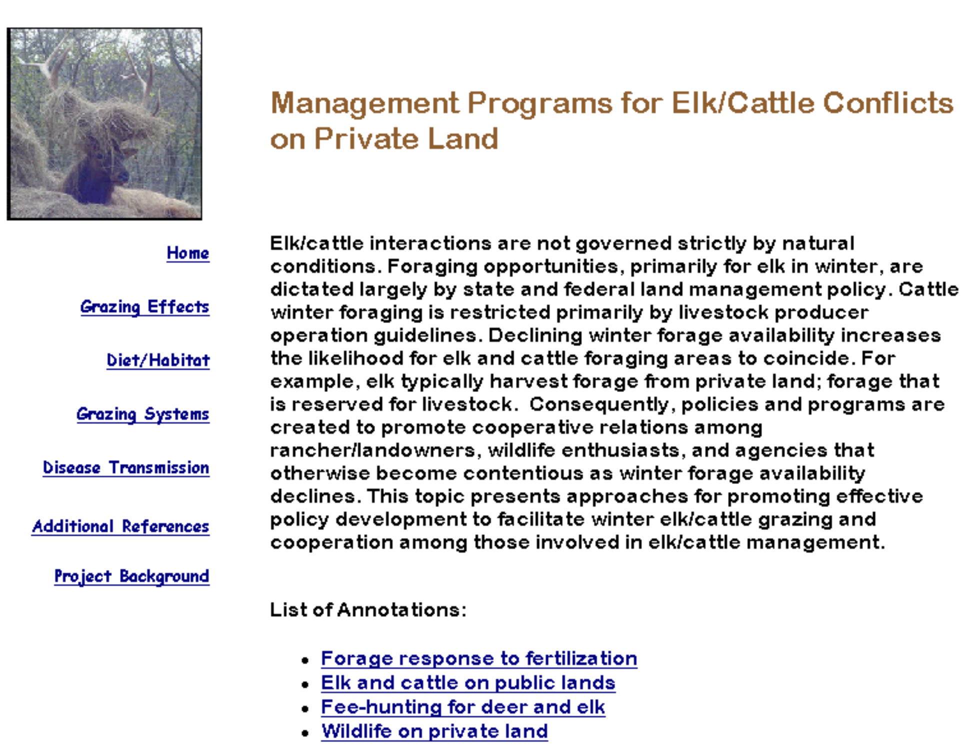
Home
Grazing Effects
Diet/Habitat
Management Programs
Disease Transmission
Additional References
Project Background

Cattle presence and their grazing impacts greatly influence elk foraging behavior. The same may be true regarding elk influence on cattle grazing. However, the ability to control cattle grazing intensity and duration is greater than that for elk. Therefore, cattle grazing is commonly studied to examine the response exhibited by elk to cattle presence and cattle grazing impacts on forage quantity and quality. Papers on this topic describe elk response to various cattle grazing strategies in terms of habitat use, distribution, and relative forage site use (i.e., cattle-grazed/ungrazed). These papers indicate the value of appropriat cattle grazing for maintaining adequate elk habitat. The results and implications offer approaches and important considerations to facilitate proper elk/cattle foraging dynamics.

List of Annotations:

- Coordinated elk/cattle management
- Fleecer elk winter range
- Elk habitat use - rest-rotation grazing
- Cattle grazing on elk winter range
- Cattle grazing and fire on elk winter range

Figure 4.5 Home page for management programs to reduce elk and cattle conflicts on private land from the Elk/Cattle Interaction annotated bibliography web site. www.its.uidaho.edu/range/elk_cattle/



Management Programs for Elk/Cattle Conflicts on Private Land

Home

Grazing Effects

Diet/Habitat

Grazing Systems

Disease Transmission

Additional References

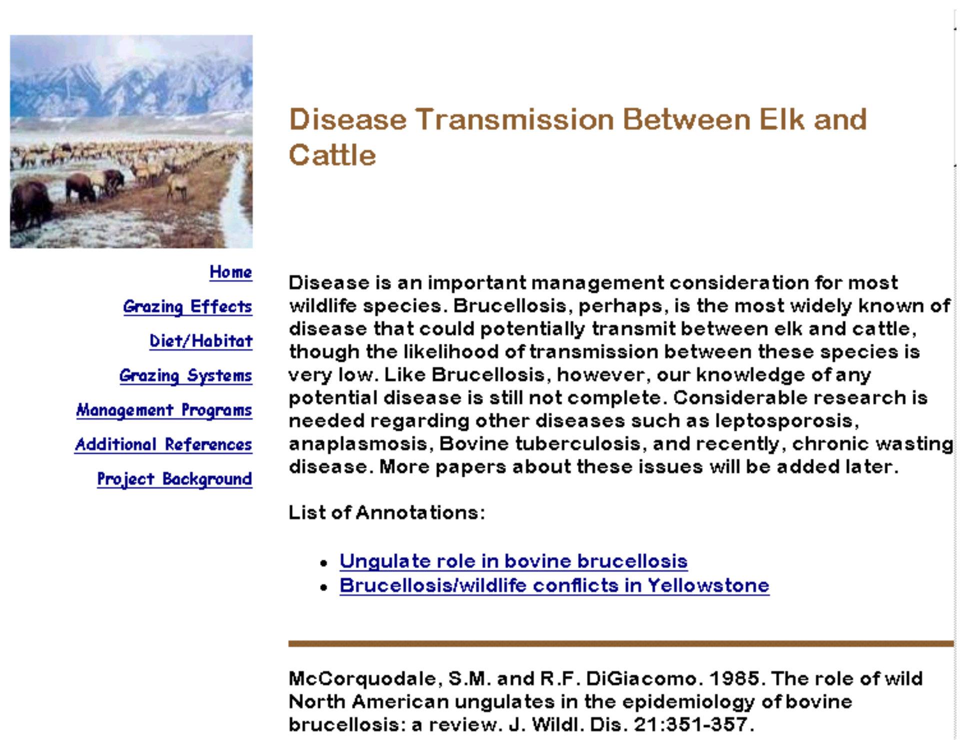
Project Background

Elk/cattle interactions are not governed strictly by natural conditions. Foraging opportunities, primarily for elk in winter, are dictated largely by state and federal land management policy. Cattle winter foraging is restricted primarily by livestock producer operation guidelines. Declining winter forage availability increases the likelihood for elk and cattle foraging areas to coincide. For example, elk typically harvest forage from private land; forage that is reserved for livestock. Consequently, policies and programs are created to promote cooperative relations among rancher/landowners, wildlife enthusiasts, and agencies that otherwise become contentious as winter forage availability declines. This topic presents approaches for promoting effective policy development to facilitate winter elk/cattle grazing and cooperation among those involved in elk/cattle management.

List of Annotations:

- Forage response to fertilization
- Elk and cattle on public lands
- Fee-hunting for deer and elk
- Wildlife on private land

Figure 4.6 Home page for disease interactions between elk and cattle from the Elk/Cattle Interaction annotated bibliography web site. www.its.uidaho.edu/range/elk_cattle/



Disease Transmission Between Elk and Cattle

Home

Grazing Effects

Diet/Habitat

Grazing Systems

Management Programs

Additional References

Project Background

Disease is an important management consideration for most wildlife species. Brucellosis, perhaps, is the most widely known of disease that could potentially transmit between elk and cattle, though the likelihood of transmission between these species is very low. Like Brucellosis, however, our knowledge of any potential disease is still not complete. Considerable research is needed regarding other diseases such as leptosporosis, anaplasmosis, Bovine tuberculosis, and recently, chronic wasting disease. More papers about these issues will be added later.

List of Annotations:

- Ungulate role in bovine brucellosis
- Brucellosis/wildlife conflicts in Yellowstone

McCorquodale, S.M. and R.F. DiGiacomo. 1985. The role of wild North American ungulates in the epidemiology of bovine brucellosis: a review. J. Wildl. Dis. 21:351-357.

Figure 4.7 Home page for the project background from the Elk/Cattle Interaction annotated bibliography web site. www.its.uidaho.edu/range/elk_cattle/

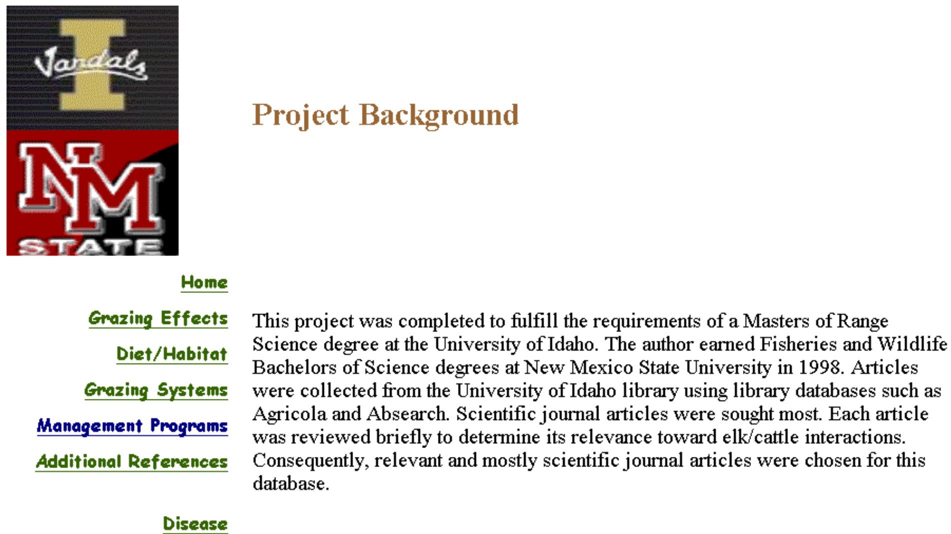
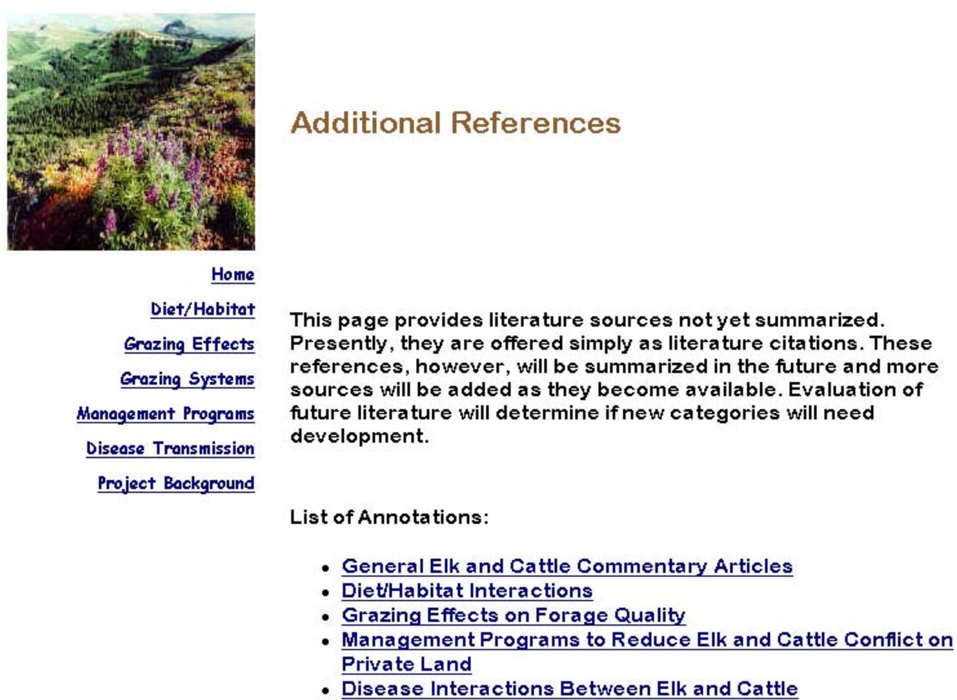


Figure 4.8 Home page for the additional references from the Elk/Cattle Interaction annotated bibliography web site. www.its.uidaho.edu/range/elk_cattle/



CHAPTER V

CONCLUSION

Many studies provide the science and experience to properly manage elk and cattle on public and private land. Clearly, improving forage quality and our understanding of influential habitat selection factors are major features of successful elk/cattle management. Policy development and big-game winter range assessment also provide approaches for reducing the severity of issues that lead to landowner, wildlife supporter, and agency conflict, such as big-game depredation and hunting on private land. The issue of competition, however, remains unsettled.

Discussion on competition can be valuable because it forces managers and researchers to examine the quality of habitat for ungulates on rangeland of the western United States. Competition, however, is difficult, if not impossible to document conclusively especially within the realm of elk/cattle interaction research and management. Thus, competition should not interfere with decision implementation, thus, reducing the effectiveness of elk/cattle management. For example, elk and/or cattle reductions should not be initiated simply because competition is perceived.

While recognizing that elk and cattle certainly compete is important, perhaps, of greater importance is that sufficient rangeland quality can be maintained in the presence of these two species. Managers should be motivated to maintain and/or improve rangeland habitat quality. Accordingly, scientists have shown the effects of livestock and/or elk grazing on forage quality and quantity. They have also shown how habitat selection is influenced by the presence and distribution of elk or cattle and/or, environmental and human induced factors. Hence, managers have drawn upon such data to develop and implement appropriate elk and cattle management strategies. Consequently, the significance of competition has been slightly reduced. However, the adverse influence of competition will continue to be reduced only if managers and researchers continue to examine the factors affecting elk and cattle dynamics.

Elk and cattle interactions are complex. Investigating elk/cattle interactions, however, produces the evidence that is necessary to facilitate their relationships on public and private land. Like investigations about the relationships of any two organisms, elk/cattle research requires thorough analysis, proper study design, and appropriate interpretation of results. Additionally, the literature that is produced from such studies needs to be clearly identified according to their scientific merit and utility. The literature also needs to be widely available.