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Current Issues in Rangeland Resource Economics

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CURRENT ISSUES IN RANGELAND RESOURCE ECONOMICS

A Series of Papers Written by Members and Associates of

Western Regional Coordinating Committee 55

"Rangeland Resource Economics"

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CURRENT ISSUES IN RANGELAND RESOURCE ECONOMICS

Foreword

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Six of the papers papers presented at the Economics Session of the Society for Range Management (SRM) 1990 Annual Meeting in Reno, Nevada, were prepared by members of Western Regional Coordinating Committee 55 (WRCC-55) and their associates. Discussion drafts of four of the six papers had been previously presented and discussed at the 1989 Annual Meeting of WRCC-55 in San Antonio, Texas. Based on this earlier presentation and discussion, the four papers were revised for presentation at the SRM Annual Meeting.

The four papers in question dealt with alternative sides of two issues with which range and ranch economists seem to be continually involved--whether or not domestic livestock grazing should be permitted on public lands, and the use of traditional versus more sophisticated methodologies in range and ranch economics research. The remaining two papers concerned issues of current interest--resistance to the use of economics in decision processes within the Bureau of Land Management and the future of the stewardship approach to public land management.

Introduction to the Economics Session

Society for Range Management 1990 Annual Meeting
Reno, Nevada

by

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Range economics is a subdiscipline of agricultural and resource economics. It is loosely subdivided into two areas of inquiry, neither of which is independent of the other--rangeland resource economics and ranch economics. Both areas of emphasis draw heavily, in their applications, on the knowledge base of range science and related disciplines such as animal science and wildlife science.

Many of these applications address management issues that are contentious in nature. Contention characterizes the various issues addressed in the six papers presented at the Economics Session of the 1990 Annual Meeting of the Society for Range Management.

The first of these contentious issues addressed in the following papers is that of livestock grazing on public lands. Is that use of public lands defensible? E. Bruce Godfrey of Utah State University and C. Arden Pope III of Brigham Young University present the case, as argued by others but not necessarily themselves, against permitted grazing of domestic livestock on public lands. Countering their arguments are Thomas M. Quigley of the Forest Service and E. T. Bartlett of Colorado State University who present a reasonable defense of livestock grazing as a legitimate public land use.

The second issue for debate is one of long standing in rangeland economics research--the relative merits and weaknesses of older and more traditional versus recent and more sophisticated analytic tools in range and ranch (but not resource) economics research. Arguing in favor of the newer sophisticated methodologies are Daniel J. Bernardo of Oklahoma State University and J. Richard Conner of Texas A&M University. Advocating more traditional methods of static economic analysis are L. Allen Torell of New Mexico State University and John A. Tanaka of Oregon State University.

In one of the two remaining papers, R. K. Davis of the University of Colorado and E. G. Parsons of the Bureau of Land Management examine the possible reasons for the resistance to the use of economic efficiency analysis by Bureau field personnel. In the final paper, Neil R. Rimbey and Lee A. Sharp, both of the University of Idaho, summarize the accomplishments of the Bureau of Land Management's Challis Area Experimental Stewardship Program while questioning the resistance to broader acceptance of that cooperative management approach within the federal land management agencies.

The Future of Domestic Livestock Grazing on Public Lands

"Cattle free by '93?" Godfrey and Pope present "The Case for Removing Livestock from Public Lands." Some, but not all, of their arguments are rebutted by Quigley and Bartlett in their paper, "Livestock on Public Lands: Yes!"

Those who would reduce, or in the extreme eliminate, domestic livestock grazing on public lands base their case on three lines of reasoning. First, domestic livestock grazing has detrimental effects, i.e., imposes negative externalities, on public land resources and thus on alternative (and often more highly valued) uses. Second, ranchers who enjoy public land grazing privileges are unfairly subsidized, and at the American taxpayers' expense. Third, public lands provide, from a national perspective, a trivial portion of the aggregate supply of livestock forage. Hence, their removal from the food chain would have negligible effects on red meat supplies and/or retail prices.

Godfrey and Pope cite a considerable body of literature in support of each of these lines of reasoning. As examples of the negative externalities associated with public land livestock grazing, they point toward riparian area damage, soil erosion, water contamination, competition with wildlife for habitat and food supplies, damage to recreation sites and areas, and harm to aesthetic environmental qualities. Implicitly, these arguments suggest that the benefits attached to these adversely affected resources in their various nongrazing uses (opportunity costs) exceed the benefits gained from continued domestic livestock grazing on public lands. This line of reasoning leads to the conclusion that the net social value stemming from all uses of public land resources is reduced if domestic livestock grazing is permitted.

Moreover, monetary value is purported to be lost through grazing use. Public land livestock grazing fees are argued to be administratively set at levels below their "fair market value" resulting in excessive grazing pressure on the public forage resource and leading to deteriorating range conditions. Low grazing fees represent a direct subsidy to privileged ranchers and place them in a position of unfair competitive advantage relative to other livestock producers. In addition, from a budgetary standpoint the public land livestock grazing programs of the Forest Service and the Bureau of Land Management are cost ineffective, with administrative program costs well in excess of grazing fee receipts.

Finally, Godfrey and Pope reiterate the claims that public lands contribute little, if at all, to the national supply of red meat while concurrently consumer demand for red meat continues to decline. Private feed and forage supplies are far larger than total permitted AUMs on federal lands; most permittees run small hobby or part-time livestock operations; and the public land portion of the domestic livestock sector is of little economic consequence. In short, the opposition argues that the use of public lands for domestic livestock grazing is inefficient, unfair, and unneeded.

Quigley and Bartlett counter by acknowledging that domestic livestock grazing on public lands can generate social and environmental costs. However, when considering the public policy issue of domestic livestock grazing on public lands, neither the benefits attributable to livestock grazing nor the notion of equity for both public land ranchers and their rural communities should be overlooked. Among the relevant benefits are preservation of a traditional way of life in the American West (an "existence" value); contribution to the maintenance and stability of both small rural communities (a "monetary" value) and ranch units that otherwise would be forced out of business (a "capital" value); and the complementary use value of domestic livestock as a vegetative management tool on public lands.

The case against domestic livestock grazing on public lands is seen to be less clear cut than detractors' claim. Seasonal public land forage dependency is high in many areas. When coupled with the fact that most public land ranchers run cow-calf operations, this means that potential red meat supply and retail meat price impacts from reduced public land livestock grazing would be much greater than the national forage supply aggregates would imply. Grazing fee levels are shown to have little bearing on grazing pressure on public land forage resources. Certain types of grazing management systems and practices can lead to improvement in riparian areas and range condition. The actual net cost to the federal Treasury of Forest Service and Bureau of Land Management grazing programs is grossly overstated and misses the real point--more consideration should be given to joint production/multiple output opportunities with domestic livestock grazing as one part of the management equation.

Quigley and Bartlett conclude that domestic livestock grazing is an economically and environmentally justified use of public lands. Through range improvements and careful management ranchers and agency personnel have made a positive contribution to the public rangeland resource. They acknowledge, however, that problems remain--particularly the grazing fee, range condition, and riparian area issues. Until research results conclusively reveal what observation suggests, the supporters of domestic livestock grazing on public lands will continue to be on the defensive, even though continued grazing use of the public land resource is inevitable.

The Roles of Contemporary and Traditional Methodologies in Range and Ranch Economics Research

Most agricultural and resource economists, certainly all interested in range and ranch economics research, are familiar with an exchange of professional opinion that occurred in the early '70s. Writing in the *American Journal of Agricultural Economics*, Oscar Burt proposed that a dynamic programming approach be used to analyze the timing of capital investments in range improvements. Unfortunately, he had little or no useable data. Bill Martin responded with a healthy dose of skepticism, aptly captured in the title of his subsequent paper appearing in the same journal: "More Sophisticated Tools for Less Important Problems: The History of Range Improvement Research--A Comment."

Bernardo and Conner, the authors of "Contemporary Methodologies in Range Economics Research" and Torell and Tanaka, the authors of "Opportunities for Traditional Methodology in Range and Ranch Economics" are much closer in their positions. All agree that there are legitimate roles in range and ranch economics research for both traditional and more recent analytic tools. Their differences are a matter of relatively modest emphasis.

Both sets of authors agree on the fundamental nature of the rangeland ecosystem in interaction with domestic livestock under the managerial control of the rancher.

The rangeland ecosystem is complex and dynamic, subject to modification by livestock, influencing the performance of livestock and hence the financial status of the livestock operation, and manipulatable through both animal husbandry and range management practices. Thus, domestic livestock combine with the rangeland ecosystem in an interactive rangeland livestock system that is most appropriately viewed as a set of intra-seasonal, inter-seasonal, multiple year, multiple output, staged production/consumption relationships. Few complete physical or biological data sets are available reflecting this view of the rangeland livestock system--hence empirical economic research opportunities are limited at best.

Given these common grounds, the authors of the two papers put their best feet forward in defense of both conventional and newer analytic approaches to range and ranch economics research. Bernardo and Conner believe that there are productive opportunities for process oriented research--particularly biophysical simulation, and to a lesser extent dynamic optimization and artificial intelligence (expert systems). Torell and Tanaka hold that newer is not necessarily better, especially given the data constraints. The tried and true methods of marginal analysis, ranch and enterprise budgets, capital and partial budgets, cash-flow budgets, and linear programming still have legitimate places in the range economics researcher's tool kit.

Bernardo and Conner present an excellent review of the nature and applications of four categories of potentially useful methodologies in range and ranch economics research. These include operations research techniques, biophysical simulation models, dynamic optimization models including optimal control theory, and knowledge-based or expert systems.

The operations research techniques discussed by the two authors are mathematical programming and firm simulation. Early mathematical programming techniques are concluded to be of limited usefulness due to their basic linearity and deterministic characteristics. Similarly, data constraints and the absence of macroeconomic control policies in the rangeland livestock sector limit the applicability of firm simulation models.

Biophysical simulation is seen as holding considerable promise. Bernardo and Conner note that economists traditionally have shunned such models because many of their parameters are not statistically estimated, and the models are characteristically constructed in a nonoptimizing framework. Another drawback is that many biophysical simulation models are narrow in application, frequently focusing on a single homogeneous output--unlike the heterogeneous nature of the rangeland livestock system. However, they argue that through active participation by economists in the construction of management-oriented, quasi-normative, biophysical simulation models, these limitations can be overcome. If so, "biophysical models hold the potential to provide response information, the lack of which has severely constrained our ability to conduct meaningful decision analysis for ranchers."

Dynamic optimization models have been widely used in range and ranch economics research, largely because they are well suited for the analysis of multiperiod dynamic decision problems. Historically, the major difficulty in the application of such models has been specification of underlying physical and biological production/consumption relationships. The models are well suited for the <u>identification</u> of needed relationships, parameters, and biophysical data. By "pointing the way" to data needs, dynamic optimization models are seen to have a valid place in range and ranch economics research. Even more fruitful opportunities may exist for applications of stochastic optimal control theory models solved using nonlinear optimization techniques.

Expert systems, a special form of artificial intelligence, when used as a "stand-alone" technique are best suited for Extension education activities--as a means of transferring problem solving knowledge from professional researchers to on-the-ground managers. In the research mode, the fact that expert systems require prior knowledge of the logic and methodology of problem solving limits their usefulness as analytic tools. They can be helpful in framing range and ranch research designs, in transferring the results obtained using other techniques, and/or as components of larger range livestock system models.

Bernardo and Conner conclude that the paucity of existing empirical knowledge of the rangeland livestock system leaves research economists with three choices. They may abandon range and ranch economics research efforts, continue to try to apply traditional static models using whatever data exists, or attempt to cooperate with range and animal scientists in the construction and application of meaningful rangeland livestock system models. The two authors prefer the third, discount the second, and discard the first alternative.

Torell and Tanaka similarly dismiss the notion of abandoning range and ranch economics research. Given the existing data constraints, they pragmatically conclude that relatively greater emphasis should be placed on traditional methodologies, but that efforts to apply more sophisticated techniques should continue. An underlying theme in their arguments is that practical, decision aiding information is needed by ranchers and range managers--the type of information typically obtained from traditional static models. More sophisticated knowledge is less urgently needed, and is instead sought by research economists because it is favored by the professional reward system.

Torell and Tanaka provide numerous examples of appropriate applications of traditional methods of economic analysis. These include the use of marginal analysis in determining optimal resource use rates and optimal input and output levels. Whole farm or ranch plans are seen as useful aids in the managerial decision making process. Enterprise budgets help managers analyze and select alternatives, not all of which need to relate directly to livestock. Partial and capital budgets are well suited for range improvement feasibility analysis. Cash-flow budgets similarly are applicable for improvement and other ranch investment analyses. Most of these practical information needs also can be adequately addressed using conventional deterministic linear programming.

The authors do recognize that the assumptions underlying the traditional static approaches are violated when the models are used in the analysis of dynamic rangeland livestock system interactions. They argue, however, that the net effects of errors introduced through violation of underlying assumptions are quite small. Therefore, given the near absence of relevant biophysical data, traditional methods should continue to be used in range and ranch economics research.

Torell and Tanaka do not believe that strong multidisciplinary research teams are the answer to the rangeland resource data problem. They maintain that the research objectives of economists differ from the objectives of range and animal scientists, who in turn view economics as the "dismal science" with an appropriate role only at the tail end of multiple year research programs. Even if these perceived obstacles to multidisciplinary rangeland livestock system research could be overcome, the authors conclude that the greater need in range and ranch economics research remains the practical knowledge most appropriately obtained using traditional economic methodologies.

Resistance to the Use of Rangeland Economics Research Results

In their paper, "BLM's New Rangeland Investment Analysis Package," Davis and Parsons explore the various causes of the continued resistance within that public land management agency to the use of economic information, no matter how it may be obtained, in range improvement and investment analysis. They attribute that resistance more to the lack of economic training among agency personnel, coupled with the absence of a specific legislative mandate for benefit-cost analysis, than to insufficient economic information on the values of relevant costs and benefits.

Davis and Parsons describe the evolution of BLM range improvement and investment policy, noting that efforts to include economic efficiency analysis in Bureau range and watershed investment programs have a 25 year history. However, specific internal requirements and procedures for economic analysis date only from 1982, and were the result of demands by the Office of Management and Budget and by the staff of the policy and budget office in the Department of the Interior for increased use of economic data in the expenditure of improvement dollars.

The procedures for efficiency analysis have been computerized and refined in recent years, but little progress has been made in overcoming internal resistance. The authors offer several reasons for that resistance. The computer program initially developed (SageRam) was placed on the BLM's Denver office mainframe, accessed through telephone lines from field stations. In was not user friendly and required staff to furnish their own estimates of many nonmarket values. A newer, more friendly, version for use on personal computers (IAM) has been developed but is still being field tested.

Davis and Parsons doubt whether the newer program will meet with substantially better acceptance among field staff. In addition to a prevailing lack of economic training, staff tend to believe that efficiency analysis should justify their prior decisions as professional resource managers rather than serve as one of several inputs in the decision process. They lack confidence in the value estimates provided to them by BLM economists, trusting instead in the "natural" values of improving range condition and wildlife populations instilled in them through their biological training and reinforced in the agency's institutional culture.

The authors conclude with the faint hope that through improved computer literacy, economic training, and managerial commitment economic efficiency analysis will become an accepted part of the public rangeland improvement process. If not, they suggest that, just as happened with the Forest Service, Congress may take the issue in its own hands and through legislation specifically require that the Bureau incorporate economic analysis in all of its public land management decision making processes.

Taking Institutionalization One Step Farther

Rimbey and Sharp in their paper, "CRMP-Stewardship: An Economic Viewpoint," echo the suggestion of Davis and Parsons that public land management agencies change their ways or risk being directed to do so by Congress. Their subject is not really economic analysis, however. Rather, the authors detail the success of the Challis Experimental Stewardship Program, one of three such successful programs established under the auspices of Section 12 of the Public Rangeland Improvement Act of 1978 (PRIA). They question, given the success of these cooperative, coordinated approaches to public rangeland management, continued bureaucratic resistance to broader implementation of the stewardship approach.

Rimbey and Sharp summarize the political history of the Experimental Stewardship Program emphasizing that the political climate in the Challis area of Idaho was right when PRIA was enacted. Significant reductions in permitted livestock AUMs on BLM lands in the local area had been proposed. Local ranchers and community leaders were at odds with public land management agency personnel. Idaho Senators, the Governor, livestock associations, and environmental organizations were in conflict. Section 12 of PRIA provided an opportunity for cooperation and consensus in rangeland resource management and decision making. The opportunity was seized, and a broadly representative private/public coordinating group was created. Over the next seven years, conflicts were resolved, range improvements benefitting multiple uses and users were made, and the time required for planning and implementing coordinated public land management plans was significantly reduced.

The authors present empirical evidence of the economic efficiency and cost effectiveness of rangeland and watershed improvements made in the course of the Challis Experimental Stewardship Program. Perhaps more importantly, they document the remarkably smaller incidence of protests of the BLM Challis Area EIS prepared as part of the Stewardship Program relative to other Idaho BLM EISs prepared during the same time frame. They conclude that from all points of view the stewardship approach to public land management has been successful in Idaho. Left to be resolved is the lingering resistance to broader agency acceptance of that approach, with the authors asking the basic question, "Is there a fear that the agencies will relinquish their decision authority [if the stewardship approach to public land management is more widely adopted]?"

LIVESTOCK ON PUBLIC LANDS: YES!

Thomas M. Quigley and E. T. Bartlett[1]
Western Regional Coordinating Committee (WRCC 55)
on Range Economics

Grazing on the western "open" (Federal) ranges is historic, exceeding the century mark. Why would such a long-standing traditional use of the range be under pressure to be nullified as a legitimate use of the public land? The cry for "cattle free by '93" is beginning to be echoed by some special interest groups and sentiments of concern are being expressed by others. At least one group has taken the cry far enough to establish sabotage plans for disabling or destroying range improvements and structures associated with grazing on Federal land. Grazing livestock on Federal lands is not the only controversy. The issues include old-growth timber and the spotted owl, harvesting aspen, wildlife habitat, global change, ecological continuity, and options for the future, among others. Is livestock grazing an artifact of the other issues associated with environmental consciousness?

The laws are very clear that the Federal land is to be managed for the benefit of society and that there are recognized legitimate uses of Federal land. Grazing is a legitimate use. This is clearly not sufficient cause to stop any further discussion because the laws have been enacted to reflect the broad values of society which are continually changing. An examination of these values and the merits of arguments against grazing helps bring the issues into focus.

Arguments Against Livestock Grazing

Rangelands represent approximately 34 percent of the area of the United States and 43 percent of this area is under Federal management. Rangeland is not the only source of forage for livestock grazing. Approximately 17 percent of the nation's forest land is grazed by livestock (Joyce 1989). Combined, the Forest Service and the Bureau of Land Management provide approximately 29 million AUM's of grazing annually. Nationally this constitutes only seven percent of the total grazed forages, but regional supplies vary from four percent to 34 percent of the regional totals (Joyce 1989). One argument for the elimination of public land grazing is that its contribution to the national grazing resource is small and its loss would not significantly impact the livestock industry.

Although the total amount of forage provided by the public lands appears small in comparison to the national forage base, the public lands are grazed primarily by cow/calf pairs. The significance of this is that a substantial portion (20-22 percent) of the yearlings that are consuming forage nationwide originate or spend some portion of their life on public lands.

Seasonal public land forage dependency varies regionally. For many operators it is the sole source of forage during the summer grazing season. One cannot dismiss the importance of Federal forage simply by demonstrating that the total forage is small compared to the national need. Seasonal use is an important element of the debate on the importance of public land grazing.

Grazing Fee

Controversy abounds concerning the Federal grazing fee (Gardner 1989). Debate continues and will as long as some special interest groups believe that the relatively low fee reflects a "subsidy" to the livestock industry and causes overgrazing (Quigley et al. 1988, Workman 1988). The perception of subsidy is strong enough to convince many that as long as the "subsidy" continues it constitutes a valid reason to stop Federal land grazing (Ferguson and Ferguson 1983).

Antigrazing groups argue that fees far below private lease rates cause excessive use. Counter arguments are that the level of grazing use is determined by agencies considering only the carrying capacity of the range resource, that nonfee costs are higher on Federal lands, and that grazing users have invested in permits. Gardner (1989) concluded that raising fees would decrease grazing use, but that demand for grazing would exist. Thus, increasing fees would not likely provide the elimination of public land grazing. Likewise, because fees are only a small portion of the cost of grazing on public land, it is unclear that reducing the fee would result in substantial increased pressure for more grazing.

Range Condition

The condition of Federal rangeland is another point of discussion among advocates of decreased grazing. The trend is up for the majority of Federal grazing land and in 1986 the BLM reported 18 percent of its rangeland was in

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[1] Authors are range scientist, Forestry and Range Sciences Laboratory, Pacific Northwest Research Station, La Grande, OR and professor, Range Science Department, Colorado State University, Fort Collins, CO.

poor condition, while the National Forests reported 20 percent of the rangeland in an unsatisfactory management situation (Joyce 1989). Advocates of eliminating public land grazing argue any land in unsatisfactory condition is an unacceptable position.

Riparian Management

Recent controversy about riparian allocations and conditions are a driving force behind some groups pressing for elimination of public land grazing. The principle users of riparian areas consider themselves in direct competition for the riparian resources. The battle lines that are drawn from such an argument pit user against user. The underlying concept is that the true conflict maybe between users, rather than the perceived conflict between uses.

It is not difficult to understand why the current controversy is raging. The question remains as to whether the reasons for continued public land grazing outweigh the opposing reasons.

Arguments for Livestock Grazing

Tradition

Tradition may be a very poor reason to perpetuate a given management practice or use. The traditional aspects associated with public land grazing use cannot be ignored. This is particularly true when one considers the economic consequences of complete elimination. Many ranches would no longer constitute a viable production unit and would, sooner or later, leave the market. The contribution of livestock grazing on Federal land to local economies is obvious. It may be the case that many of the communities that thrive in the sparsely populated portions of the west would be uninhabited if it were not for a viable livestock industry. The livestock industry is yearlong, rather than seasonal, and thereby contributes to the stability of the economy.

An issue that should be addressed under any proposal to eliminate grazing on Federal land is the impact that changes in the agricultural base for the rural mountainous areas of the west would have on water and fisheries. Changes could have an adverse impact on water production and timing because of a decrease in irrigation of mountain meadows.

Forage as an Economic Resource

Range forage is an intermediate good that has the capability to contribute to the production of livestock and wildlife. The relationship of two or more products can be described by a production possibilities curve. This representation depicts total amounts of livestock and other resource uses that are possible when produced together. The selection of the optimal level of each depends on the relative values of the two resources. If the unit value of grazing livestock were large compared to that of the other resource uses, the optimal level of grazing would be greater than if the reverse were true. Resource uses have some value; therefore, the production of some combination of uses, including livestock grazing, is the economic optimum.

In a recent survey of Forest Service employees it was found that their perception of the public values associated with grazing on Federal land were not nearly zero compared to the other multiple-use values. Grazing was found to contribute about 10 percent of the total value associated with the multiple uses, timber 15 percent, and water, recreation, and wildlife 25 percent each (Quigley 1989). This would indicate that grazing represents a substantial value as compared to the other uses and elimination would be inappropriate. Loomis and others (1989) have developed commensurate values for livestock and wildlife use of range that can be used to determine optimal combinations of different grazing animals.

There may be specific instances where removal of livestock is the only acceptable resolution. It does not follow that all public lands require such drastic measures.

Complementary Relationships

Recent research has demonstrated that livestock grazing has potential as a silvicultural tool (Doescher et al. 1987, Krueger 1987, and Pearson 1987). Grazing has been found to be an effective technique of brush control, seedbed preparation under timber stands, and as an effective technique to obtain income from timber land between harvest cycles (Ritters et al. 1982). Transitory range constitutes a substantial untapped source of forage potential. Productivity can be as much as 10 times that of open rangeland.

Livestock can be used to manipulate the range resource for other uses. Livestock grazing can increase the availability of good quality forage for big game (Anderson 1989). National Parks have requested livestock operators to graze selected areas of National Parks to remove dense-coarse forage from areas frequented by recreationists.

These complementary relationships provide justification for continued use of livestock grazing on the public lands. As more detailed knowledge is gained other benefits from grazing, as well as other grazing techniques, are likely to arise.

Comparative Advantage

Local economies where public land grazing constitutes a significant portion of the total grazing resource may have a comparative advantage in the wise use of the resource for livestock production purposes. With considerable interest being generated nationally concerning rural economic development, it is important that the local communities and rural areas that have a comparative advantage in raising livestock be permitted to produce livestock products. Removing livestock grazing from Federal land would have a destabilizing affect on these local economies.

Obstacles to Achieving Harmony Among Uses

There are obstacles that must be overcome before the issues associated with livestock use on public land are resolved.

Grazing Fees

Grazing fees are perceived by many as being a subsidy to the livestock industry. Fees have been at the forefront of controversy in the public grazing forum for many years (Workman 1988). Removing the subsidy "stigma" is vital to the credibility of livestock use on public land. Some progress has been made, but considerable room exists for improvement (Quigley and Thomas 1989).

Range Condition

The abuses of the past must be corrected to adequately address the viability of the future of grazing on public land. Advances have been made in the reversal of downward trends in condition, but much work remains. A key to this rests with adequate funding to allow planning, management, and administration to occur. Cattle are not the only animal that requires management on rangelands. In many instances the recovery of rangeland is dependent on management of wild horses and burros as well as wildlife. The potential for deterioration of rangeland exists in the absence of livestock.

Deteriorated Riparian Areas

The public is demanding that attention be given the areas adjacent to streams and standing water. Solutions to riparian use conflicts must be determined locally, no national fix is going to resolve the concern. New and innovative techniques to control livestock hold promise to help in this resolution (Quigley et al. [in press]), as does new fencing techniques and coalitions of interest groups. With changes in grazing management, riparian areas can be improved for multiple purposes while producing livestock (Elmore and Beschta 1987).

Focus on Issues

The focus of discussion must be centered on the conflict that users are espousing. Techniques to resolve the conflicts through the formation of partnerships and coalitions among interested groups with concerns about the range resource are essential for continued use of the public land by livestock.

Increase Knowledge

The knowledge base for production possibilities in a multiple use concept is lacking. Research can focus on the joint production processes possible under varying circumstances as shown by Standiford and Howitt (1989). Under what conditions can the joint production of timber and forage for livestock yield greater benefits for society than producing either individually or with one being dominate to the other in priority? What management scenarios result in recreation, wildlife, and grazing benefits simultaneously being greater than attempting single or dominant use management approaches? These and other similar questions are unanswered, yet the knowledge may provide additional evidence concerning the viability of livestock grazing on the public land.

Discussion

Marion Clawson presented five criteria that must be considered in any discussion of forest-range policy (Clawson 1975).

- Physical and biological feasibility and consequences
- Economic efficiency
- Economic equity
- Social acceptability
- Operational practicality

Clawson points out that not all conditions are mutually exclusive, nor will the lack of a policy meeting all criteria result in rejection of the policy. He provides the list as important criteria to consider in any policy decision.

Applying Clawson's criteria to the continuance of livestock grazing on public land results in mixed signals on some lands. The consequences and biological feasibility of continued grazing of some tracts of land in poor condition would certainly be a questionable practice unless it could be demonstrated that the trend is upward and management is in place to continue that trend. It must be remembered that 80 percent of National Forest rangeland is in satisfactory range condition and that 35 percent of BLM rangeland is in good or better range condition (Joyce 1989). One must be careful not to judge the fate of all public land by the small portion that may be in poor condition or receiving inadequate management.

From an economic efficiency argument one must consider the costs and benefits of continued grazing. Opportunities for joint production with multiple outputs should be considered. Too often simple comparisons of revenues to the treasury and costs of administration are made rather than societal benefits and costs being the yardstick for comparisons. The equity considerations of removing livestock from public land cannot be ignored. Is society prepared to provide payments to the ranchers who are displaced? The considerable investment ranchers have made in improvements and permits cannot be ignored.

Is it socially acceptable to remove all livestock from public land? Given the strong lobby that exists for the livestock industry, it is unlikely rural communities would stand silently by as their economic base is destroyed.

The operational practicality of the proposal to remove all livestock from public land is questionable. Solutions to difficult management questions about livestock use in riparian and other sensitive areas have been demonstrated. Team, partnership, and consensus approaches have proven a viable approach to resolving conflict in these areas. Local groups, agencies, and the livestock industry have invested considerable effort and resources into creating successful management on many public grazing areas. The base of support is large and a national push to dismantle the work would be opposed.

Lasswell (1958) has stated that politics are the process of determining who gets what, where, and when. The vital questions of economics deal with the distribution of scarce resources among competing uses and users. The obvious similarity of the political goal and the economic process demonstrate that many questions will not be resolved strictly through the application of economic principles, yet economics has the capability of recommending solutions. The resolution to the level of livestock grazing on public land is ultimately a political decision, tempered by information from the varied disciplines that have interest in public lands. It seems unlikely that society will decide that the costs of public land grazing outweigh the benefits.

A combination of products, including livestock grazing, will be produced from Federal range. The mix of these products will continue to change as their values to society change over time. The question is not if there will be livestock grazing on public lands, but what the level of grazing will be.

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THE CASE FOR REMOVING LIVESTOCK FROM PUBLIC LANDS

by

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"Livestock free in 93" and "No more moo in 92" are recent slogans that have been adopted by those who are advocating the abolition of grazing by domestic livestock on lands administered by the federal government. Most of these lands are administered by either the Forest Service (FS) or the Bureau of Land Management (BLM). While the above slogans are currently popular, this is not the first time that interested parties have advocated the removal of livestock from public lands. The pressure for the removal of livestock has become more intense since the early 1970s, however. This paper is written with the hope of increasing the level of discussion and to encourage fruitful evaluation of this position. By design, this paper will take the position that livestock should be removed from public lands. A case can be made for their retention (see the paper by Quigley and Bartlett 1990). The authors of this paper may not always agree with some of the arguments found in the remainder of this paper. But, we have tried to summarize the arguments commonly used by others without making a judgment as to their validity.[1] It is recognized that some of the reasons for the removal of livestock from public lands may be reduced with careful management but it is not obvious that management can or will overcome all of these reasons. Furthermore, as discussed later, there are incentives that may lead to the voluntary removal of livestock from public lands. Some of these incentives are beyond the control of private as well as public land managers.

We think that most of the primary arguments for the removal of livestock are outlined below. The reasons given for the removal of livestock generally fall into five major categories--grazing programs are not cost effective, negative externalities, the value of alternative uses, this use is not needed, and unfair competition with other operators. These basic areas provide the focus of this paper.

Monetary Costs

Concern for the burgeoning federal debt has caused a number of people to propose ways to reduce deficit spending and the resultant debt. Expenditure reductions in the management of America's public lands is one of the alternatives being considered especially for those uses where the revenues received do not cover management costs. Several authors (Nelson 1979; LeBaron et al. 1980) have shown that the amount of revenue generated from public lands is less than the administrative costs (Table 1). These data indicate that most uses of BLM administered lands[2] do not "pay." One of these uses is grazing. Nelson has shown for example, that the cost of producing public forage on rangelands administered by the Department of Interior was $91.4 million[3] in 1978 while the grazing fees collected were $16.2 million--a difference of more than $75 million.[4]

All of the costs outlined in Nelson's estimates would not necessarily be eliminated if livestock were removed. However, many costs would be reduced if livestock grazing programs were to be eliminated. For example, range managers would not be needed to enforce grazing regulations, construct and maintain facilities (e.g., fences and cattle guards) needed to allow grazing programs, or to meet with ranchers concerning utilization. The correct analysis of this alternative would involve estimating the costs and returns <u>with</u> livestock grazing versus the costs and returns <u>without</u> livestock grazing. One estimate of these costs (with versus without livestock grazing) was made for 1983 (USDA Grazing Fee Review and Evaluation, 1986) and are shown in Table 2.[5] These estimates indicate that even when just considering the direct costs of livestock grazing, the costs of livestock grazing on the public lands is, on the average, higher than the revenues received in the form of grazing fees.[6] If these deficits are to be reduced one must increase revenues and/or reduce costs. If fees were increased to a level that the cost of administration were covered and use declined it would provide evidence that the value of grazing not taken was not worth the cost of providing this activity.

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Table 1. 1978 Revenues and Costs in 13 Western States, by Type of Output (millions).

Type of Public Land Output	Revenues	Costs
Timber		
Public Domain, Except Oregon	$2.9	$11.6
Public Domain, Oregon	7.3	1.6
O&C Lands (Oregon)	185.2	34.0
Subtotal	195.4	47.2
Rangeland Forage Production	16.2	91.4
Recreation and Wildlife		
BLM Lands	0.4	61.1
National Wildlife Refuge System	1.2	20.8
National Park System	15.9	186.4
Subtotal	17.5	268.3
Oil and Gas (on shore)	353.5	38.7
Coal	11.3	39.1
Other Leasable Minerals	37.8	8.4
Nonleasable Minerals	1.8	19.6

Taken from: Nelson (1979).

Table 2. BLM Rangeland Program Cost "With and Without" Livestock Grazing (thousands of dollars), 1983.

	Rangeland Program Costs	Without Livestock Grazing	Real Cost of Livestock Grazing
Grazing Administration	$ 34,754	$ 13,901	$ 20,853
General Administration	9,384	3,753	5,631
Range Improvements	11,200	0	11,200
Totals	55,338	17,654	37,684
User Maintenance Savings			- 5,665
Net Cost of Livestock Grazing			32,019
Unit Cost per AUM	$32,019 divided by 13,105 = $2.44/AUM		

Source: 1986 Grazing Fee Review and Evaluation, page 6.

Negative Externalities

Perhaps the most pervasive reason for removing livestock from federal lands is due to the existence of negative externalities. A negative externality exists whenever, the actions of one group or individual has a negative impact on the production or satisfaction of another group or individual (see the discussions by Buchanan and Stubblebine 1962; Randall 1983; Bator 1958; Coase 1960). Numerous examples involving livestock grazing can be given but the most common instances cited by critics of livestock grazing are outlined below.

Riparian Habitat

The use of riparian areas[1] by domestic livestock has become one of the most controversial issues associated with the use of grazing lands (Platts 1978, 1981, 1986; Platts et al. 1987). Cattle, in particular, tend to congregate near water, especially when it is hot. This commonly results in detrimental impacts on vegetation, soils, streambanks and water quality in these areas. Heavy use near water has the effect of reducing forage which in turn tends to increase erosion and the temperature of streams. As a result, fisheries biologists and ornithologists have been particularly critical of livestock use in riparian areas. While very little empirical work has been done which documents the degree that livestock use of riparian areas increases the turbidity and temperature of streams and the resultant impact on fish populations (or changes in bird populations associated with reduced cover), it is generally conceded that these impacts are relatively important. As a result, if livestock were to be excluded from the use of many riparian areas, there would probably be benefits to fisheries, bird populations and water quality.

Competition With Other Grazing Animals

Numerous studies have been conducted over time that show the overlap in dietary preferences between domestic livestock and other grazing animals (see the general discussions in Stoddard et al. 1975; Heady 1975; Holechek et al. 1989). The competition is generally considered severe when animals have similar preferences (e.g., cattle and bison). To the degree that these competitive uses have a higher value than livestock and that livestock use leads to decreased use or numbers of other animals, livestock use may justifiably be reduced or eliminated (see the section below on valuation).

Recreation Visitation

Anyone who has found livestock in a favorite camping spot recognizes that recreation and livestock grazing are not compatible in these areas. No one wants to put their tent, sleeping bag or trailer on a manure pile or sheep bedding ground. Outdoor recreation participants often complain that on most public lands there is no place to go without fences, cattle guards and the sight, smell and sound of domestic livestock. Even sheepherders and riders for grazing associations either use areas away[2] from the livestock they tend or they fence areas where livestock use can be eliminated. Other areas where recreation oriented uses tend to be competitive include the construction of fences needed for the control of livestock (especially cattle) in areas used by ORVs (e.g., "three wheelers" and snowmobiles), hikers, fishermen and other recreation users. Sometimes these users use fence posts as firewood and leave gates open which commonly infuriates cattlemen but this represents a classic case of reciprocal externalities.

Water Quality

Livestock may directly (as opposed to indirect affects associated with the use of riparian areas) affect the quality of water. Anyone who has bent down to take a drink from a spring and found manure in the stream has questioned why livestock were allowed to graze these areas. Those familiar with western rangelands also recognize the fact that many animals go near water sources to die. As a result, the potential for bacterial pollution of streams is not zero when livestock are allowed to graze public lands. Numerous studies (see the summary in Moore et al. 1979) have demonstrated that livestock grazing can result in increased erosion and sedimentation. Although management of grazing may reduce or eliminate this problem, the results generally would be reduced livestock numbers and/or increased management costs.

Roads and Trails

Many roads and trails would not exist in many areas of the west were it not for livestock operators who have either built or continue to maintain these areas. Some of these transportation facilities are poorly constructed. As a result, they often result in increased erosion. Furthermore, it is often necessary to travel these roads and trails to check on livestock when they are muddy or in disrepair.[3] This also results in sedimentation and deep ruts that may be difficult to traverse. These can become "eye sores" on an otherwise natural landscape.

Natural Uses

One reason why some users object to the use of public lands stems from the fact that they are an exotic or introduced specie. As a result, some users suggest that they should not receive forage that is "meant" for "indigenous" species. To the degree that exotic species take forage from indigenous species and if "naturalness" is preferred, then livestock use may be reduced.

The above conflicts have been outlined by others (e.g., Ferguson and Ferguson 1983; Voigt 1976; Trueblood 1980; Fradkin 1979; Gallizoli 1977; Wuerthner 1989; Johnson 1978) and are some of the more powerful reasons for removing livestock from using public lands. These conflicts in use also suggest that other uses are of "greater worth" than are any perceived benefits associated with grazing. These negative impacts on other uses/users are not the only reasons that can be given for removing livestock from public lands but they do represent an area where one must determine which use(s) are most valuable.

Value of Alternative Uses

All of the arguments indicated above with respect to negative externalities ultimately involve some judgment as to the relative worth of livestock grazing versus other uses of the federal lands. This represents a classic case of Coasian theorum (Coase 1960) and represents a need to identify who has what property rights (if any). To the degree that no use has any property rights (the usual case), the choice of which use has preference is a matter of resource allocation. As a result, these decisions ought to be the "bread and butter" of applied economic analysis. However, there are few cases in the literature that compare the relative value of alternative uses on federal lands because the data needed to make these evaluations are difficult to obtain (Godfrey 1982). Those studies that have been conducted (e.g., Keith and Lyon 1985; Loomis, et al. 1989; Martin et al. 1978; Cory and Martin 1985) generally show that livestock grazing does not have as great a benefit as some other alternative uses (the studies cited all emphasize wildlife and livestock).

One of the reasons why other uses are often more valuable than livestock stems from the fact that livestock grazing in most areas of the west is not highly profitable. Some indication of these returns are shown in Table 3. These data[4] show that the net returns obtained by livestock producers who use Forest Service lands are generally negative (revenues or sales are less than total costs). Furthermore, in some cases and in some years the returns are less than cash costs. If low returns continue to occur one would expect the demand for using these lands by livestock to diminish as long as they were used for livestock production as opposed to recreational or hobby ranching.

Table 3. Estimated Costs and Returns per Cow for Cow-Calf Operators in Various Forest Service Regions on the U.S., 1986.

Region	Total Sales	Total Costs	Returns Above
1	258.59	560.51	-306.59
2	280.28	651.49	-371.42
3	209.35	468.67	-259.42
4	243.24	616.02	-372.78
5	270.96	578.38	-300.33
6	267.67	728.33	-463.44
8	213.23	802.19	-586.80
9	288.06	694.74	-406.68

Source: Hahn et al.

All of the reasons cited above involve a proposed reduction in the use of public lands by livestock in favor of some other use(s). While these allocation problems are important, additional research concerning these issues is needed before it can be clearly understood what is being gained and given up. However, these allocation questions may be less difficult to resolve in the future if the following macro oriented trends continue because they suggest that livestock grazing of public lands may become less important in the future. In addition, these trends are generally beyond the control of public as well as private land managers.

Diminished Demand for Public Land Forage

Several reasons may be given for not needing forage from public lands. Some of these arguments are outlined below.

Forage Available From Other Areas

Whenever the grazing fee issue has become a topic of debate, the need for grazing public lands has become an issue. As a result several government publications have estimated the dependence of livestock operators on public lands. Some of these estimates are shown in Tables 4 and 5. For example, the data in Table 4 shows that livestock operators having permits to graze public lands generally obtain a small portion of their forage from public lands--only cattle operators in Arizona obtained more than one-half of their forage from public lands in 1982. Moreover, it should be remembered, that not all livestock operators have grazing permits. When these operators are taken into account, it has been estimated that less than four percent of the feed needed to produce beef animals and sheep grown in the United States comes from public lands. While no perfect measure is available concerning the amount forage required by livestock in the United States,[5] the data in Table 5 suggests that less than three percent of the forage required by livestock in the U.S. comes from public lands. Even in some of the large public land states (e.g., Idaho) only a relatively small percentage of the feed comes from public lands--Nevada is the most noticeable exception to this rule. Furthermore, the data in Table 5 shows that the dependency of livestock producers on federal forage has been reduced in every state but New Mexico during the last 22 years.

Although the elimination of livestock grazing from public lands would be harmful to some operators[6] and communities, it would not eliminate the industry in any of these states as has been assumed by some studies (e.g., Martin et al. 1978). Furthermore, there is essentially no empirical evidence that supports the contention that stabilizing the flow of biological goods will stabilize an economy (Hyde and Daniels 1987; Schallau and Alston 1970; Schallau 1989; Godfrey 1978).

Table 4. Average Dependence Level of Permittee Livestock Businesses on Public Rangeland for Annual Feed Supply in 13 Western States, 1982.

State	Cattle	Sheep
	---percent---	
Arizona	60	*
California	15	24
Colorado	25	37
Idaho	23	35
Montana	11	35
Nebraska	13	*
Nevada	36	43
New Mexico	49	49
Oregon	23	27
South Dakota	12	*
Utah	35	47
Washington	13	*
Wyoming	23	29

* Sheep budgets were not prepared in these States due to low numbers of sheep grazing public rangelands.
Taken from: 1977 Grazing Fee Study.

Table 5. Percentage of Feed Coming From Federal Lands in the West and U.S., 1966 and 1988.

	Percent From Federal	
State/Area	1966	1988
Arizona	27	24
California	4	4
Colorado	6	6
Idaho	17	14
Montana	7	7
Nevada	49	43
New Mexico	17	20
Oregon	13	11
Utah	28	24
Washington	2	2
Wyoming	16	16
11 Western	12	12
U.S.	3	2.6

Source: Data from University of Idaho with Pacific Consultants, Inc. 1988 Data Estimated Using: Public Land Statistics, Forest Service Annual Graing Report, and USDA, Agricultural Statistics.

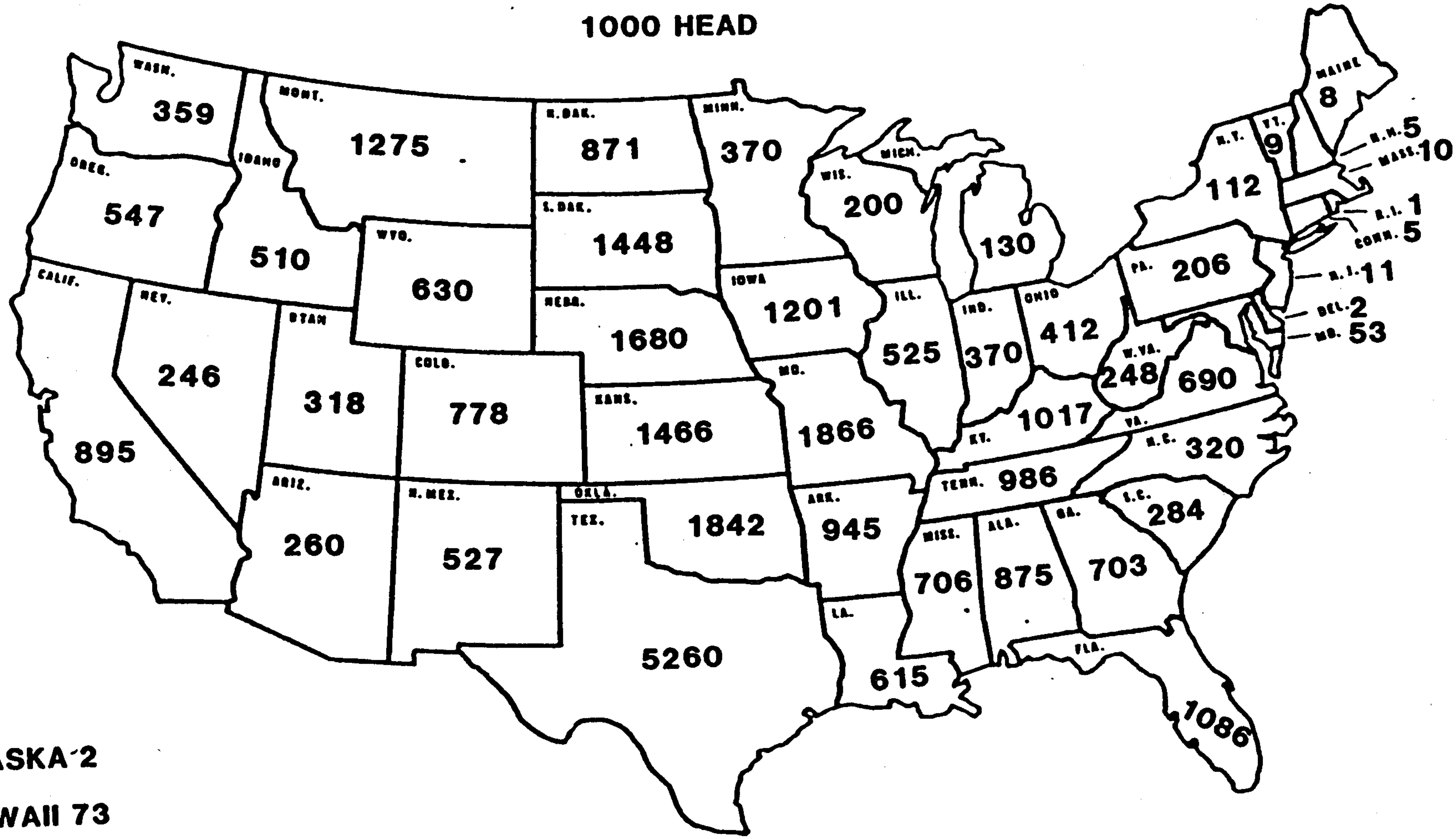
It is also clear the most of the livestock produced in the U.S. does not come from the "public land states." The data in Figure 1 indicates that most of the public land states (generally the 11 western states) have fewer beef cows than most of the states east of the Mississippi and significantly fewer than essentially all of the states in the midwest--the total number of beef cows in the 11 western states is not as great as those that exist in just Texas and Oklahoma. The "need" for public land grazing must therefore be perceived as a regional rather than a national problem. If beef production were to decline in the west, it is likely that these declines could be offset by increases in production in the private land states with little increase in the price paid by consumers.[7]

Public Land Grazing Operations Are Small

While current data are not available, the data in Tables 6-8 indicates that most livestock operators who use lands administered by the Bureau of Land Management (BLM) are not large. For example, the data in Tables 7 and 8 show that nearly 60 percent of the operators in 1978 had permits to graze fewer than 50 animals and approximately three-fourths had permits for fewer than 100 head of cows.[8] Sheep operators tended to be larger but, nearly 40 percent of the operators had permits for less than 250 head (this is roughly equivalent to a 50 head cow operation). There is also considerable variation by state. For example, the cow operators in Montana had small permits (nearly three-fourths of the permits were for 50 cows or less) while the permits in Nevada were much larger (only 15 percent of the permits were for 50 cows or less). All of this suggests that if these numbers are indicative of today's permittees, public land grazing is not supporting livestock operations that are large enough to support a farm/ranch family--a 100 cow herd does not provide enough cash flow or profit to support a family. Most operators who have grazing permits are therefore likely to be part-time and/or hobby type operators or operators who have other agricultural interest. It is therefore unlikely that the loss of federal grazing privileges will force most of these operators out of production. One might therefore conclude that the elimination of public land grazing would do little more than eliminate the least efficient operations. Furthermore, to the degree that these small operators are essentially in production for the enjoyment of the lifestyle (Pope 1987; Pope, et al. 1984; Smith and Martin 1972) one could easily contend that they should not be given preferential treatment over other recreational users of the public lands.[9]

BEEF COWS THAT HAVE CALVED
JAN 1, 1988

1000 HEAD



ALASKA 2

HAWAII 73

U S TOTAL 32958

WESTERN LIVESTOCK MARKETING INFORMATION PROJECT C-N-15

Table 6. Distribution of Cattle and Horse Operators by Herd Size, 1982.

Herd Size	Number of Permittees	(%)	Number of AUMs	(%)
Bureau of Land Management				
Less than 100	13,800	(73)	1,945,200	(18)
100 to 500	4,000	(21)	3,782,200	(35)
Over 500	1,000	(5)	5,079,200	(47)
BLM Total	18,700	(100)	10,806,200	(100)
Forest Service				
Less than 100	4,400	(35)	896,200	(11)
100 to 500	6,700	(53)	3,910,700	(48)
Over 500	1,500	(12)	3,340,400	(41)
FS Level	12,600	(100)	8,147,300	(100)
FS Total Converted to AMs*			6,789,500	
Total for Billing Purposes	31,300		17,595,800	

* Divide Forest Service AUMs by 1.2 to derive Animal Month s(AMs) for billing purposes.

Taken from: 1977 Grazing Fee Study.

Table 7. Percent of BLM Cattle Operators by Size of Permit Owned, 1978.

State/Area	Size of Permit (number of head) 1-25	26-50	51-100	101-200	201-350	351+
Arizona	46	15	14	11	6	8
California	55	12	10	9	6	8
Colorado	47	14	15	12	7	5
Idaho	27	17	19	17	10	10
Montana	61	11	11	10	4	3
New Mexico	54	15	12	10	5	4
Nevada	7	7	13	16	14	43
Oregon/Washington	40	12	13	14	8	13
Utah	29	21	22	14	7	7
Wyoming	70	12	8	5	3	2
U.S.	46	14	14	12	7	7

Table 8. Percent of BLM Sheep Operators by Size of Permit Owned, 1978.

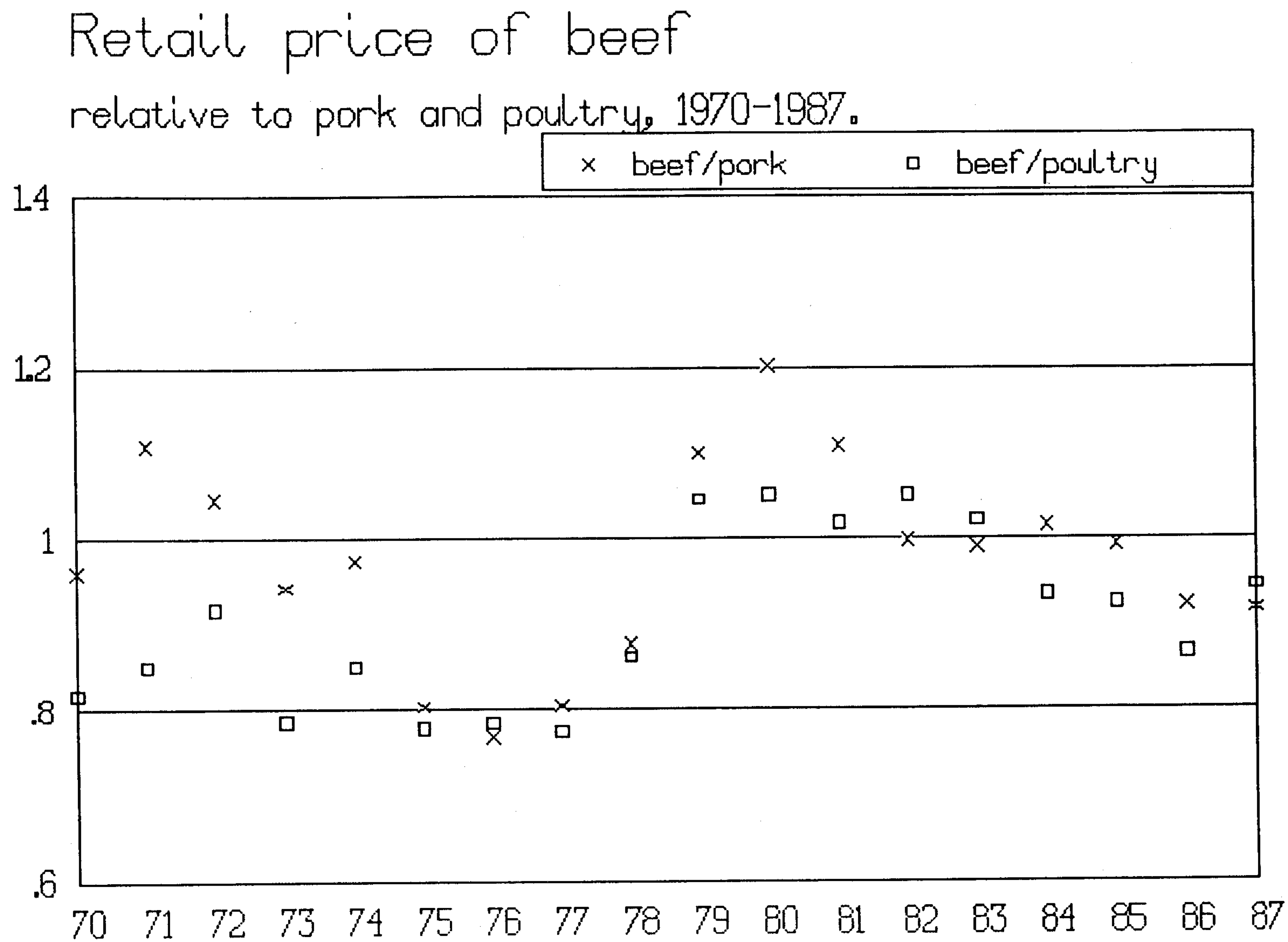
	Size of Permit (number of head)			
State/Area	< 250	251-1000	1001-5000	5000+
Arizona	8	50	42	0
California	32	16	44	8
Colorado	35	35	22	6
Idaho	21	19	43	18
Montana	50	36	14	0
New Mexico	73	18	9	0
Nevada	8	10	42	40
Oregon/Washington	50	27	18	5
Utah	24	26	42	9
Wyoming	70	14	14	2
U.S.	40	24	28	8

Meat Consumption

Researchers have examined the consumption of meat in America for a long period of time. These data (Figure 2) indicate that the per capita consumption of meat has increased over time. However, beef and sheep consumption has not kept pace with these increases. As a result, these two meats, along with pork, have a smaller proportion of the total consumption of meats in the U.S. (Figure 3). Numerous reasons have be given for this decline (e.g., cholesterol scare) but primary among the factors is the relative price. The data presented in Figure 4 indicate that beef prices have generally increased relative to poultry products during the 1970 through the 1987 period. There is also some evidence that the demand for beef has shifted to the left and has become less elastic (Figure 5). This suggests that consumers are shifting away from beef. Furthermore, because beef is a relatively inefficient animal in converting feeds to meat (pounds of feed consumed per pound of gain) the cost of producing beef will remain relatively high. As a result, it is likely that the consumer trend from beef to other meats will not be easily reversed. As a result, beef consumption as a percent of total meat consumption will probably decline in the future.

While the above represents a fairly gloomy picture for beef operators it is not as gloomy as sheep/lamb consumption forecasts. Sheep consumption has become very low over time--the per capita consumption of lamb has declined from 3.1 pounds in 1967 to 1.4 pounds in 1988 (Stillman et al. 1989). The 1987 per capita consumption of lamb and mutton is about ten percent of the per capita consumption of fish. It appears that imports have had a negative impact on domestic production (Whipple et al. 1989) and consumption of lamb. But, lamb consumption must now be viewed essentially as a specialty product that is primarily consumed by specific ethnic groups.

Figure 2.


Retail price of beef
relative to pork and poultry, 1970-1987.
× beef/pork
□ beef/poultry
1.4
1.2
1
.8
.6
70
71
72
73
74
75
76
77
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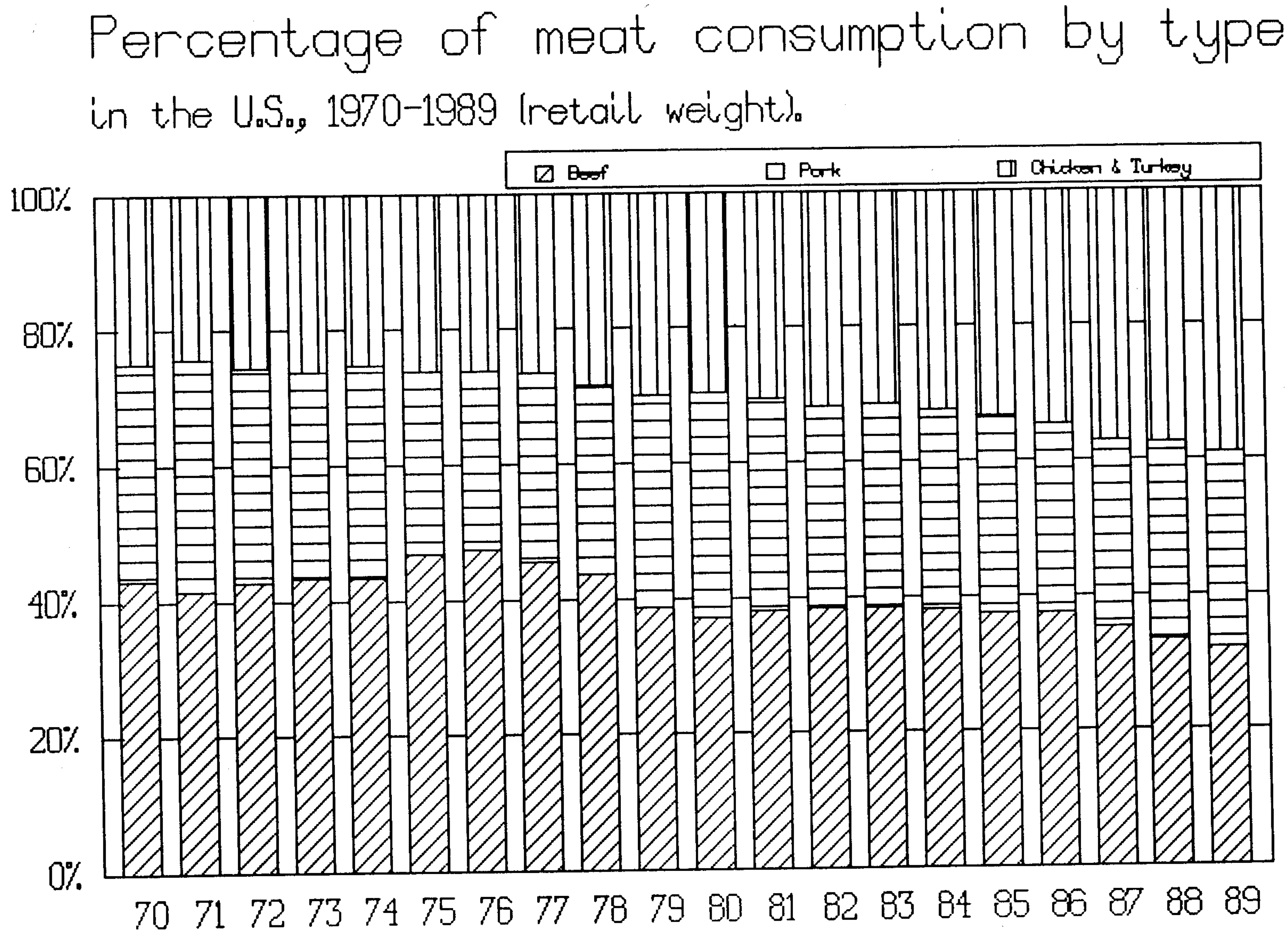
86
87

Figure 3.



Percentage of meat consumption by type
in the U.S., 1970-1989 (retail weight).
Beef
Pork
Chicken & Turkey
100%
80%
60%
40%
20%
0%
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89

Figure 4.

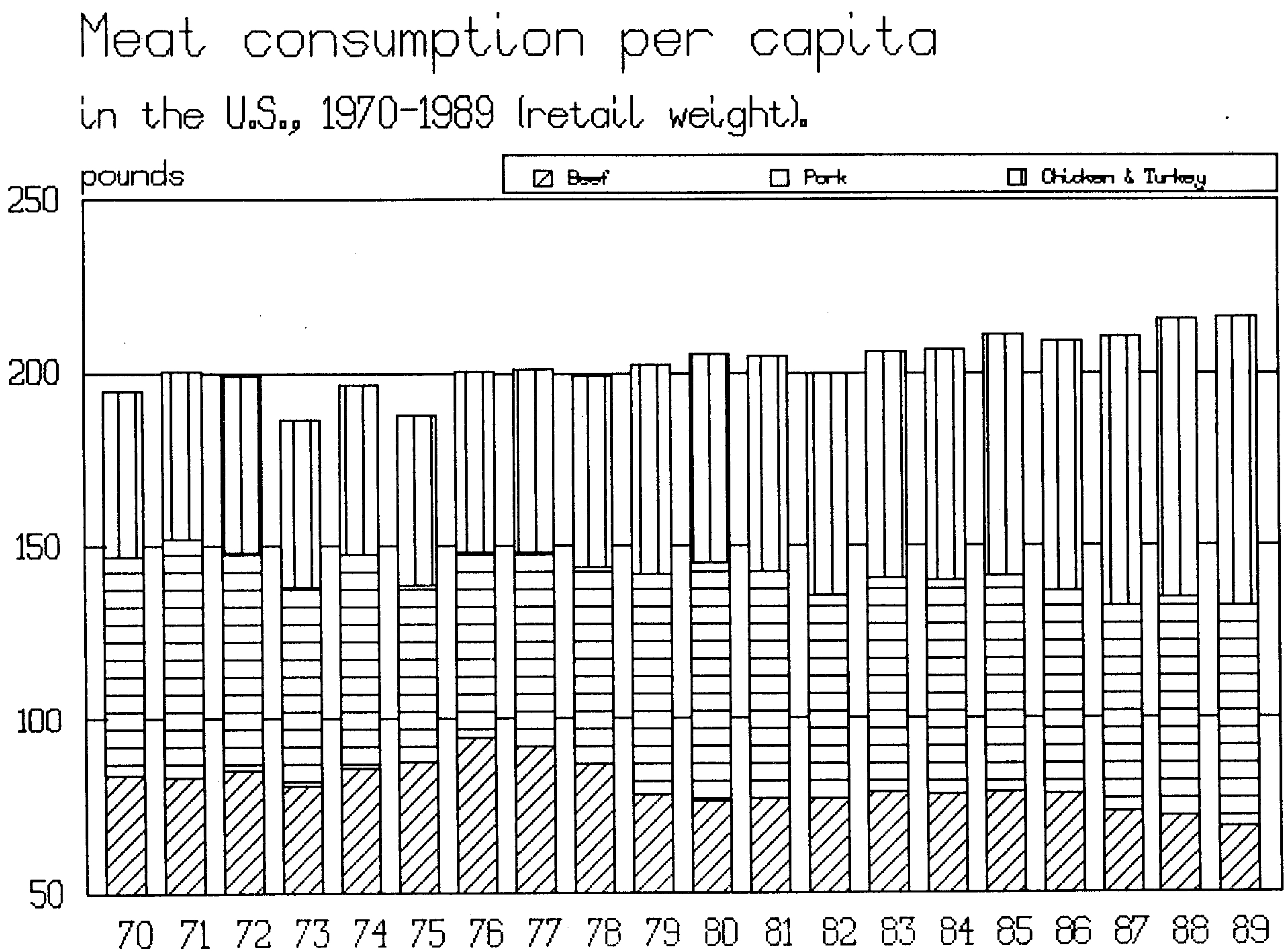
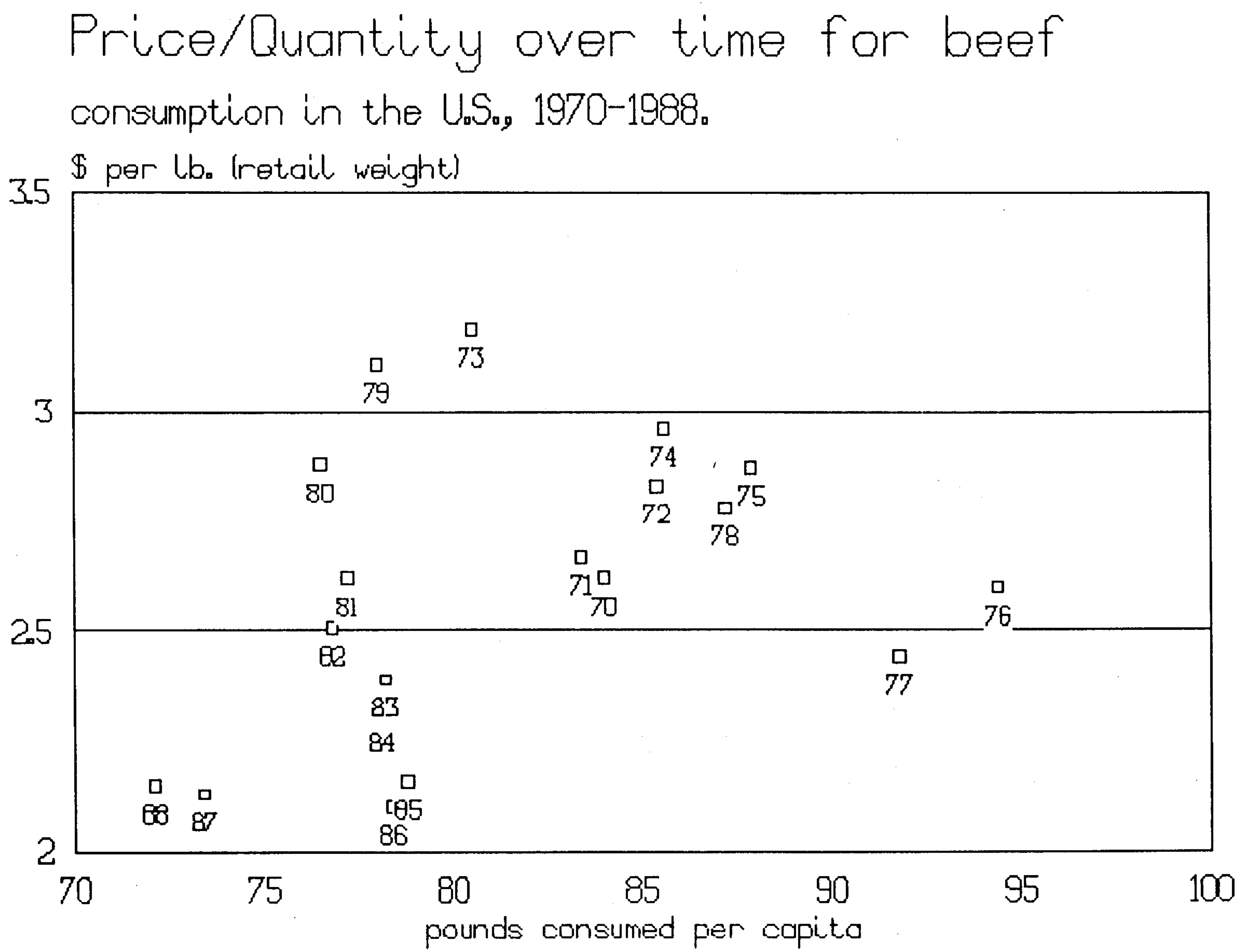

Meat consumption per capita
in the U.S., 1970-1989 (retail weight).
pounds
Beef
Pork
Chicken & Turkey
250
200
150
100
50
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89

Figure 5.



Price/Quantity over time for beef
consumption in the U.S., 1970-1988.
$ per lb. (retail weight)
3.5
3
2.5
2
73
79
80
74
72
75
78
71
70
81
76
82
77
83
84
88
87
85
86
70
75
80
85
90
95
100
pounds consumed per capita

Relative price trends coupled with the desire for "light" meats (primarily fish and poultry) suggests that the consumption of beef and sheep as a percent of total meat consumption will probably decline in the future. This will diminish the need for forages on public lands. Furthermore, Carver (1989) has shown that excess grazing capacity exists at the present time and that it is likely to increase when Conservation Reserve Program (CRP) lands can be legally grazed. All of these factors suggest a decreasing demand for public forage.

Unfair Competition

While the above suggests the demand for livestock may decline in the future this will not be the only "outside influence" affecting livestock producers in the public land states. Livestock producers who commonly only use private lands, especially those from private land states, often view producers who have permits to graze public lands as competitors. If this perception grows it is likely that the influence of public land operators will diminish in organizations such as the National Wool Growers Association and the National Cattlemen's Association. As a result, operators in private land states may encourage policies that are not conducive to continued use of public land by livestock. This pressure may also come from producers in the public land states because as the data in Table 9 shows only a small percentage of the livestock operators in the western states have grazing permits--again, Nevada is the primary exception.

A number of reasons can be given concerning why livestock producers who do not have federal permits may object to the use of federal lands by other users who have federal grazing permits. Some of these reasons are outlined below.

Subsidized Grazing

The grazing fee issue has a long and colorful history. There has probably been more written on this one issue than any other in the area of rangeland policy (see for example, the following selected references Nielsen 1982; 1977 Grazing Fee Study; 1985 Grazing Fee Study; Workman 1988; Gardner 1989; Quigley and Thomas 1989). While it is beyond the scope of this paper to review all of the ramifications associated with this issue, it can be said that as long as the capitalized value of the permits are not included in the cost of grazing public lands,[10] public land grazers do not pay fees that are competitive with users of private lands. As long as these "subsidies" continue and the agencies allow permits to be exchanged, the permits will continue to have value (see the recent articles by Gardner 1989; Quigley and Thomas 1989; and Pope 1989 that outline different ways to allocate public forage). This allows a relative comparative advantage[11] to public land users in the production of livestock that would not exist if public land forage were to be competitively priced (competitive pricing would eliminate permit values which is an equity not an efficiency problem).

Ability to Capture Other Benefits

Some ranchers who have permits to graze public lands are also able to capture other benefits. Some of these include operation of "dude ranches" that use neighboring federal lands, outfitting and guiding operations, and the sale of "access fees" to hunt game animals on private lands that obtain a major portion of their feed from public lands. All of these benefits are obtained at low or zero costs and represent benefits to these operations that occur as a result of access and/or location. Differences in location often cause significant discrepancies in ranchers with respect to the distribution of benefits and costs (Nielsen and McBride 1989 provide a useful summary of these issues) associated with the capture of wildlife related benefits. Furthermore, permittees may be able to have an "unfair" advantage in capturing these benefits because their knowledge of an area is greater than other users who are not "on these lands" on a regular basis.

Sometimes the differences that exist between ranches with respect to location also result in the capitalization of benefits into the value of the base property. While the research that has been conducted to date indicates that the proportion of a ranches feed coming from federal lands generally has no effect on the value of the base property (King 1985; Winter and Whittaker 1979), the location of the ranch to "recreational" opportunities (primarily associated with close public lands) has a significant positive impact on the value of ranches sold (Collins and Rowan).

Conclusions

All of the above arguments suggest that the future of livestock grazing on federal lands is not bright. There may be reasons for retaining this use in some areas but it is likely that the historic trend of reductions in use can often be justified. Perhaps livestock grazing is "going, going, gone?" but for reasons that differ from those suggested earlier by Godfrey (1979). If this is true one might also question the need for more "range managers." Is this then a reason why the range profession is considering a name change that would not emphasize livestock and why many no longer view range management as having anything to do with livestock but as an applied area of ecology?

Table 9. Number and Percent of Livestock Producers in the 16 Western States with Forest Service and BLM Grazing, 1983.

State	Total Producers[1]	Number of Producers with Federal Grazing FS	BLM	Total Federal	Adjusted Federal[2]	Federal % of Total[3]
Arizona	3,792	625	931	1,556	1,323	35
California	26,579	953	1,009	1,962	1,668	6
Colorado	16,127	1,842	1,908	3,750	3,188	20
Idaho	15,980	1,640	2,383	4,023	3,420	21
Kansas	47,008	------	11	11	11	*
Montana	15,980	1,308	4,023	5,340	4,539	29
Nebraska	39,555	114	39	153	153	*
Nevada	1,786	320	716	1,036	881	49
New Mexico	9,189	1,285	2,626	3,911	3,324	36
North Dakota	18,548	------	100	100	100	*
Oklahoma	58,236	28	11	39	39	*
Oregon	21,811	762	1,357	2,119	1,801	8
South Dakota	27,000	416	474	890	756	3
Utah	8,757	1,683	1,887	3,570	3,035	35
Washington	20,147	232	474	706	600	3
Wyoming	6,428	886	1,004	1,890	1,607	25
Total	336,765				26,445	8

[1] 1982 Census of Agriculture, Table 11, pp. 218-224. Number of farms with cattle and calves.
[2] Fifteen percent of permittees have both FS and BLM grazing.
[3] Percent of producers/State with federal permits.

* Less than one percent.

Source: Committee or Government Operations.

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ENDNOTES

1. One issue that has not been resolved concerns the definition of riparian areas. In this paper these areas are generally considered to be those areas "near" streams and reservoirs.

2. These areas tend to be fairly close but separate from the animals being tended.

3. Livestock operators are often blamed for much of the travel on remote roads. Recreation oriented travel may however, be more intense and damaging. This is especially true if use is during period when the roads are wet and are used by vehicles that get "mired in the muck". Hunting season represents one of these periods when this will commonly happen. Recreational users view these roads and trails positively because they provide access to areas that may not have been as accessible had these roads/trails been constructed to facilitate livestock (or mining or timber) use.

4. The study by Libbin and Torell suggests that these budgets may be suspect and not reflective of many operators.

5. This estimate will vary over time because animal numbers vary as does the forage available from federal lands. Furthermore, the estimates may not reflect needs in a state because the numbers are estimated as of 1 January.

6. Some operators are very dependent on federal forages because they use these lands throughout the year. Most operators are not that dependent. Nielsen and Workman provide a dated but careful analysis of these dependency measures.

7. The study by Godfrey (in press) suggests that most of the changes in production that have occurred over time has shifted livestock production from the west to the northeast. It should also be noted, that no empirical studies of the possible impacts associated with reduced use of all public lands by livestock have been conducted from a national point of view.

8. These data are subject to some error and are no longer being collected by BLM personnel. Agency personnel did try to eliminate users who had permits to graze more than one area so little "double counting" occurred. It should also be noted that the size distribution reported in these tables is generally quite similar to the size distribution of all cattle operators in these states (Census of Agriculture). This suggests that permittees may not be dissimilar from cattle producers throughout any of these states.

9. Another alternative would be to charge these users fees that are reflective of their recreational rather than productive value. Recreational values associated with grazing may also be one reason why permits and ranches are sold at values that do not yield competitive rates of return on the dollars invested in these operations.

10. This is essentially the major issue associated with the grazing fee issue. If permit values are not ignored then, essentially by definition, livestock operators pay "fair market fees."

11. This advantage exists if permit values are ignored.

CONTEMPORARY METHODOLOGIES IN RANGE ECONOMICS RESEARCH

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Introduction

Because of the size and diversity of the range resource, considerable research effort has been directed toward its management. Agricultural economists have addressed a variety of issues including allocation among competing uses, range resource valuation, estimation of fundamental production relationships, and evaluation of alternative management practices. However, despite the extent of the past and present range research agenda, economists have generally had less impact on range management practices and processes than in other areas, such as crop farm management. Many of the shortcomings of previous range economics research may be attributed to a lack of success in applying traditional research methodologies to the analysis of rangeland production systems.

At the root of range economist's past frustrations has been an inability to accurately represent the complexities that characterize the rangeland production system. Several features set rangeland apart from other production resources. Rangeland is by definition land not suited for more intensive uses; typically it is either too rocky, too shallow, or too dry for use in more intensive production systems. As a result of its extensive management, rangeland productivity is considerably less controllable than production in cultivated agricultural systems. The limited ability of the manager to manipulate the system is compounded by the temporal and spatial diversity of the range resource. Each management unit is characterized by a diverse set of plant species whose composition and productivity change both within as well as across production seasons. Also, because range productivity is driven primarily by ecological principles as opposed to cultural practices, long-term, multiple production period responses are more important than in cultivated agriculture.

These unique characteristics of the range resource interact to create a challenging set of problems for the applied researcher. First, range production is characterized by a greater interdependence of risk and dynamic response than crop production; failure to represent these influences can limit the empirical validity of range analyses. Also, in most cases range forage is an intermediate product. Intermediate product problems have always presented a challenge to economists, and in this case, the issue is complicated by the complex interactions involved in converting forage to livestock product. Finally, and perhaps most importantly, the same factors that make rangeland unique also make it difficult and expensive to obtain adequate information to conduct empirical analyses. This lack of adequate response data has contributed more to range economists' past frustrations than any other factor.

It is beyond the scope of a single paper to address the complete set of methodological issues involved in range-related research. This paper will focus on the "ranch management" side of range economics, leaving the discussion of public resource management issues to the remaining papers of the session. Research in this area has been primarily directed toward long-term (inter-seasonal) management of the range resource. Undoubtedly, the issue receiving the most attention has been the economic evaluation of range resource improvements (e.g., chemical and mechanical brush control). Other important inter-seasonal management decisions include selection of breeding herd replacement (culling) practices, allocation of rangeland among competing uses, and adoption of grazing systems. Within this long-run decision environment lie several intra-seasonal decisions related to the efficient utilization of range forage produced through the year. Important controls involved in intra-seasonal management include decisions concerning enterprise selection, stocking rate, grazing duration, and supplementation. These decisions also have long-run implications since improper range utilization can affect the future productivity of the range site.

Range economists have applied numerous research methodologies in an attempt to address these issues. This paper seeks to summarize methodological advancements of significance to range economics and evaluate their contribution to the improved understanding and representation of the range-livestock production system. Do these advancements offer greater potential for improved specification of rangeland production, or

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alternatively, are we still faced with the same data limitations and ignorance of the underlying production relationships that plagued earlier research efforts?

This discussion will concentrate on four methodological approaches of significance to past and present range research efforts: (1) operations research techniques, (2) biophysical simulation models, (3) dynamic optimization models, and (4) knowledge-based or expert systems. Attention will be focused on the potential of each approach in representing the unique characteristics of rangeland production in addressing the decision problems identified above.

Operations Research

Operations research is a general term applied to any approach to, or methodology used for, decision making which incorporates specific outcome objectives and information about controllable and uncontrollable factors which may impact the outcomes in a quantitative model of the decision process (Richmond 1968). One of the oldest and most commonly used operations research techniques is mathematical programming. Specifically, linear programming (LP) has been used extensively in agriculture since World War II. Extensions of linear programming used in agricultural decision analysis include dynamic LP (also called multiple period or serial LP), recursive LP, and risk programming. Simulation models represent another important operations research technique and may be defined as quantitative models of sequential, stochastic and interactive aspects of decision processes which illustrate the impact on an outcome of specified levels and combinations of controllable and uncontrollable factors.

Mathematical Programming

In one of the first documented discussions of the use of linear programming in range economics research, McCorkel (1954) indicated two general problem areas where LP could be beneficial: (1) evaluating the feasibility of range resource improvements, and (2) selecting among alternative uses of rangeland. He also noted that problems of adequate data on outputs (production response), temporal relationships and resource heterogeneity limited the effectiveness of LP in solving range-related problems.

Since McCorkel's paper, several studies have used LP to address both types of problems. Relatively fewer applications of LP to problems related to range improvement decisions have been undertaken. Among the first examples were studies by Barr and Plaxico (1961) and Sharp and Boykin (1967). These studies used multiple-period LP models as a means of dealing with the dynamic production response characteristic of range improvement practices. Multiple period (serial) LP models have since been used by several others, both in problems related to range improvement (Freeman et al. 1978; VanTassell and Conner 1986) and resource allocation (Bartlett et al.). Recursive linear programming models, where resource constraints were updated based upon range investment decisions in previous periods, were also proposed as a means of more realistically modeling production response to range improvements (Spielman and Shane 1985). However, the practical usefulness of these models as well as multi-period LP in analyzing range improvement investments has been greatly limited by their deterministic structure, simplistic representation of forage dynamics, and cumbersome size.

During the last three decades, LP has been used in a variety of research efforts directed at intra-seasonal management decisions (optimal use of rangeland, optimal enterprise mix), eg., Nielsen et al. (1966), Navon (1967), D'Aquino (1974), and Woodworth (1973). A principal limitation of these studies, as well as the range improvement analyses referenced above, was their inability to accurately represent the complexities that characterize range-livestock interactions. Most studies employed a simple forage balance procedure to allocate available forage among alternative livestock enterprises. However, such a static approach does not represent the dynamic relationships between forage availability, forage quality, intake, and livestock performance. Such relationships are far from linear and simply cannot be specified accurately within the rigid structure of linear programming models. A more recent non-linear programming formulation of nutrient requirements and feed intake for cattle proposed by Apland (1985) does address some of these concerns.

The deterministic aspects inherent to the LP procedure have also limited the empirical validity of the above approaches. Quadratic (risk) programming was initially used as a means of incorporating variance of income into the optimization process in analysis of range related problems in the 1970s (Whitson et al. 1976). Later, Minimization of Total Absolute Deviations (MOTAD) LP models were utilized to evaluate expected profit-risk trade-offs in livestock and forage enterprise selection problems (Gebremeskel and Shumway 1979, Glover and Conner 1989). While quadratic programming and/or MOTAD techniques offer a means of incorporating risk and multiple time periods into the optimization process, their application to range related decisions has been limited by lack of sufficient data to adequately estimate variance. Livestock producers face uncertainties in the quantity, quality and timing of forage production, as well as converting this production to final output. Thus, quantification of production risk is considerably more complex than in crop applications. Also, the commingling of different sources of variation, i.e., production levels and prices (costs), can lead to significant problems in interpreting results.

Firm Simulation

In a 1964 address to the AAEA, Suttor and Crom listed several advantages and disadvantages of simulation. Among the advantages were a) simulation models can be much more complex and realistic than conventional (programming) models, b) simulation allows incorporation of qualitative aspects of human decision making, and c) simulation facilitates aggregation of representative firms, households, etc. Disadvantages listed included a) simulation models tend to be complex, making it difficult to explain all built-in assumptions, b) models tend to be problem (situation) specific which may result in a proliferation of models, and c) costs of computing, data collection and estimation will likely be high. Probable uses of simulation in applied agricultural economics research identified in the address included policy analysis, studies of alternative decision rules for firm managers, and regional and multi-sector analysis. In the area of range economics, most applications have focused on evaluating the affects of applying alternative management strategies over a multiple-year time horizon.

The first and best known use of simulation analysis of a rangeland-livestock production system was conducted by Halter and Dean (1965). They modeled the decision process of a large California ranch-feedlot to assess alternative decision rules related to buying stocker and feeder cattle and the transfer of cattle from rangeland to feedlot. The model allowed for the simultaneous variation of range condition (forage production) and stocker, feeder and fat cattle prices. They concluded that simulation was a promising tool for problems where uncertainty characterized the decision making environment and a large number of time-related interrelationships existed among variables.

Despite the recommendation of Halter and Dean there were few, if any, other applications of whole-firm simulation models to problems related to the range-livestock industry until the 1980s. This dearth is surprising in light of the uses of simulation in other areas of agricultural economics, eg., Patrick and Eisgruber (1968) and Hutton and Hinman (1971).

In 1982, Beck et al. reported the use of simulation to assess the risks and returns to an Australian cow-calf producer from improving pasture by re-seeding and fertilizing. The model incorporated functional relationships between stocking rates, climatic conditions and calf productions. Cattle prices and climatic conditions were stochastic variables in the model.

In 1986, a simulation model of a Texas cow-calf operation was used to assess the economic consequences of alternative stocking rate adjustment decision rules (Riechers et al. 1989). The model included climatic conditions and cattle prices as stochastic variables and included functional relationships among climatic conditions, forage production, beef production and feeding costs. VanTassell (1987) recently adapted the Firm Level Income and Policy Simulator (FLIPSIM) (Richardson and Nixon 1986) to represent range-livestock production systems. The modified FLIPSIM was used to evaluate the impacts of implementing alternative range improvement practices and grazing systems on firm success and survivability. Another recently developed simulation model was used to assess economic impacts of range improvements on a stocker cattle enterprise (Bernardo et al. 1988).

Firm simulation has generally proven to be less useful in range-related research than originally anticipated. In crop production agriculture, simulation has been very useful in evaluating impacts of policy (program) alternatives on production acreage, income distribution, etc. However, in range-livestock production no general production and/or marketing control policies exist. The use of simulation in the analysis of range-livestock production has also been hindered by a lack of sufficient forage and livestock production response data to estimate probability distributions. This problem is exacerbated by the complexity of the range forage-livestock production relationship. Even where sufficient data are available to estimate variability in forage production and forage quality, difficulties are encountered in translating this information into estimates of variability in livestock performance (eg., weight gain, weaning percent, etc.). Range economists have been forced to incorporate rather simplistic biological models in firm simulators to represent these interactions. Significant future use of firm simulation models in the range-livestock area will likely depend on the availability and adaptability of more process oriented biophysical simulation models

Biophysical Simulation

Interest and use of biophysical simulation in agricultural research has increased significantly over the past two decades and continues to accelerate. For our purposes, biophysical simulation models will be defined as computerized models that focus on and characterize the interaction of weather, soil, and biological and/or physical processes in agricultural production. To some degree, biophysical simulation has been shunned by agricultural economists because of its non-optimizing nature and employment of non-statistically based parameters. More recently, agricultural economists have recognized the descriptive value of these models in representing physical processes in the analysis of agricultural production systems.

Despite the proliferation of applications in the analysis of crop production, considerably fewer applications of biophysical models have occurred in the area of livestock management, particularly with respect to rangeland production. Two factors that have impeded the application of biophysical models to rangeland decision making are the limited focus of current biophysical range models and problems associated with applying these models in normative economic analysis.

One of the most perplexing problems in the development and use of biophysical models centers around the scale of their focus. Some models focus on a specific crop or animal component (e.g., the animal rumen or a single plant) with little attention given to how these results can be aggregated to an economic unit. The result is a model well-suited for explaining a particular biological process, but too myopic and data intensive for economic application. This problem is particularly acute in rangeland applications because of the large data requirements necessary to describe complex range-livestock production systems. Most models of crop and tame pasture systems have focused on a single plant and assumed a homogeneous plant population to aggregate results to field level. Given the heterogeneity that characterizes the range resource, such an approach is not possible, thus increasing the data requirements of biophysical range models. The difficulties and expense of collecting rangeland data exacerbates this problem making transfer of models to new locations and the necessary validation extremely difficult and time consuming.

Another factor limiting application of biophysical models in range economics research has been the independence of modeling efforts by animal and range scientists. A long-held objective of animal scientists has been the prediction of animal performance given a fixed feed resource. Developers of biophysical livestock models have often taken a similar tact, developing formulations to simulate production under specified assumptions of feed quantity and quality. Sanders and Cartwright (1979), Brorsen et al. (1983), and Fox and Black (1977) are all examples of cattle simulation models employing this 'fix one - predict one' approach. While useful in the controlled environment of a feedlot, such models ignore a number of the fundamental plant-animal interactions comprising the range-livestock production system. Because the quantity and quality of available forage does not respond to consumption by livestock, the models cannot adequately represent the consequences of management adjustments of interest to range economists (eg., variation in stocking rate, types of livestock, etc.). A separate line of biophysical models designed to simulate the growth and development of range plants has also evolved. These models ignore livestock production, and thus, are of limited use to production economists evaluating the effects of management adjustments on economic output.

The future of biophysical simulation in range economics research greatly depends upon the fusion of these two lines of research. A small number of models integrating range and livestock components have been developed; however, their extreme complexity and large data requirements have prevented economic application. Range economists must take an active role in multi-disciplinary research efforts aimed at constructing more management-oriented simulation models. Obviously, such an effort will require a considerable time investment on the part of individual scientists; however, the potential gains from such a commitment are significant.

An additional problem, common to all economic applications of biophysical models, concerns how they may be incorporated into decision analysis. To date, there exists no well-defined, generally accepted theory around the use of such models, as is available with production functions and neoclassical theory. Because the calculus of maximization no longer provides a workable means of finding a solution, the researcher is left without many traditional methods of analysis. Two general approaches have been used by economists in applying biophysical models in empirical analyses.

One approach involves simulating alternatives in a non-optimizing framework to evaluate the economic consequences of various management practices under alternative environmental conditions. Such an approach supports Musser and Tew's (1984) contention that "simulation does not propose to identify optimal plans for managers; rather it proposes to provide information which most likely has qualitative value for managers." While such a positive approach may sometimes by viewed as ad hoc and/or unscientific by some, its contribution to the range economics discipline should not be overlooked. Simulation provides a large step forward in understanding the dynamic processes of rangeland production and provides an opportunity for more meaningful treatment of risk in ranch decision analysis. Biophysical models hold the potential to provide response information, the lack of which has severely constrained our ability to conduct meaningful decision analysis for ranchers.

Some degree of normativism can be introduced into these analyses by simulating a variety of strategies and applying some economic criteria to rank the outcomes. This criteria may be deterministic (eg., profit maximization) or stochastic (eg., stochastic dominance and generalized stochastic dominance). Such an approach is common in crop applications where biophysical models have been run for series of alternative strategies and the resulting net return distributions ranked using stochastic dominance techniques. Similar applications in the area of livestock management are less prevalent, although evaluation of grazing systems on improved pasture has been conducted using these procedures (e.g., Parsh and Loewer 1987).

An alternative approach offering considerable promise in incorporating biophysical simulation in production economics research involves the direct optimization of biophysical models. Such an approach requires the coupling of the biophysical model with some form of search algorithm or control theory technique to explicitly represent the sequential characteristics of the decision problem. Trapp and Walker (1986) envisioned the development of a "New Theory of Production Economics" when biophysical simulation models and dynamic optimization theory were properly wedded. This alternative approach is addressed in the following section.

Dynamic Optimization Models

As discussed earlier, many of the unique features of rangeland production interact to form a truly dynamic system. Range researchers recognized the importance of dynamics in representing range-livestock production and sought alternatives to traditional static approaches. The decisions facing rangeland managers can be conceptualized within a framework proposed by Antle (1983) which describes the production model as a sequence of "stage production functions" whose output feeds forward as input for the following production stages. Multiperiod dynamic decision problems may be differentiated from single period problems by three characteristics: (1) sequential dependence of decisions, (2) information feedback between production periods, and (3) revision of previous decisions as new information becomes available. This information, ignored in most approaches discussed thus far, plays a major role in both the inter- and intra-seasonal decisions facing range managers.

In the December 1982 issue of the *Western Journal of Agricultural Economics*, the proceedings of an invited paper session discussing the relative merits of dynamic programming and optimal control theory are presented (Burt, Zilberman, Talpaz, Howitt). It is interesting to read this discussion in light of developments that have occurred in dynamic analysis since that time. Although differing in their reasoning, all of the authors conceded numerical solution of empirical applications of optimal control theory to be a rarity at the time. Burt argued that the discrete characteristics of dynamic programming make it more realistic in agricultural applications, as well as more operational. In espousing the merits of control theory, Talpaz stated that applied solutions of control theory models may become increasingly feasible as advances in non-linear optimization algorithms are made. Applications of dynamic optimization methods to range management decision making have followed these insights. Most range applications to date have employed dynamic programing; however, limited use of control theory has occurred and additional applications appear eminent. Important empirical contributions have been made in the application of dynamic optimization models to both inter-year as well as intra-year decision problems in range management.

Most early applications of dynamic optimization methods in range economics focused on intra-seasonal decision making, specifically, optimal timing of long-term range improvements. In 1971, Burt published the first application of dynamic programming to the range investment problem. In an earlier study, Cotner (1963) had characterized the problem of determining the optimal timing of range improvements as an extension of the classic replacement problem. Burt (1971) formulated the problem in a dynamic programming framework and applied the model to the analysis of pinyon-juniper control. This paper provided the impetus for some lively debate concerning the appropriateness of applying dynamic models to the analysis of complex biological phenomena, such as forage response to range improvements. In response to the article, Martin (1972) stated: "The overwhelming lack of response data has produced an evolutionary change (of rangeland economics) to complete mathematical purity." Burt (1972) rebutted these conclusions by stating that lack of data is insufficient reason to write-off range research as futile; logical correctness in economic analysis requires that dynamic problems be analyzed as such.

This dialogue is illustrative of a fundamental controversy concerning the application of dynamic optimization models in range research. Now, nearly two decades later, can we make any more conclusive statements concerning our ability to represent dynamic phenomena in range investment analyses? A brief review of some more recent applications of dynamic programming to the range investment problem may shed some light on this situation.

Important issues not considered in Burt's seminal work were the interaction of grazing and brush encroachment and the influence of uncertainty on range improvement decisions. More recent research has addressed these issues. For example, Torell (1984) used dynamic programming to determine optimal stocking rates and retreatment schedules for crested wheatgrass stands. Results indicated grazing intensity did affect the rate of sagebrush encroachment and should be considered in timing range improvements. Karp and Pope (1984) used stochastic dynamic programming to simultaneously determine stocking rates and the frequency of brush control investments. Stochastic properties of range response were incorporated into the decision framework via finite Markov chains. By the authors' own admission, specification of the transition probability matrices was based upon sparse data, thus limiting the generality of the optimal control rules derived. In a more recent treatment, Bernardo (1987) used stochastic dynamic programming to determine the optimal frequency of chemical treatments and prescribed burns, as well as accompanying stocking rates. In a revised version of the model, a range site simulation model was used to estimate the required transition probability matrices. Such an approach offers promise for improving the stochastic specification of inter-seasonal forage dynamics.

One application of optimal control theory to inter-year decision making is Standiford and Howitt's (1989) recent treatment of multiple-use management of California's hardwood rangelands. Equations of motion for oak density, forage production, and livestock density as well as several production functions were estimated based upon several empirical studies. The discrete optimal control model was solved using nonlinear optimization techniques to evaluate optimal management for firewood production, livestock production, and commercial hunting. This initial phase of the research was deterministic; however, a stochastic adaptation of the model is forthcoming.

Over the past several years, considerable development in the empirical sophistication of dynamic range investment models has occurred; however, range economists still struggle to specify the production relationships underlying these models. During this time, little has been achieved in increasing the availability of experimental data reporting vegetative and/or livestock response to range improvement. Given the high cost of range improvement experiments and the limited transferability of their findings, future prospects for obtaining these data also appear limited. Biophysical simulation provides some potential for overcoming this problem; range economists may need to adopt a more mechanistic (non-statistical) approach in deriving relationships describing vegetative response through time. Despite difficulties in validating empirical results from dynamic range investment models, range economists have gained much from such efforts. In addition to providing insights into rangeland dynamics not available from static models, past dynamic programming applications have been useful in identifying important data necessary for economic evaluation of range improvements.

Perhaps a more interesting problem in economic dynamics is that of intra-seasonal management of rangeland production systems. A recent application of dynamic programming to intra-seasonal decision making is that of Rodriguez and Taylor (1988). These authors developed a stochastic dynamic programming model to evaluate supplemental feeding and marketing strategies for the production of yearling cattle on rangeland. Three state variables -- forage standing crop, livestock weight and livestock density -- were used to describe the production system. Forage dynamics were represented by first estimating forage production in each two-week subperiod as a function of stochastic rainfall, then determining standing crop as a function of subperiod production and livestock intake. This research provides direction for future dynamic programming applications in this area. To maintain computational tractability, a relatively simple representation of forage dynamics was employed. More complete descriptions of forage response and the range-livestock interface will almost certainly be the focus of future intra-seasonal range management models.

Recently, several applications of optimal control theory to the analysis of livestock production systems have been conducted. For example, Chavas et al. (1985) developed and applied a differential equation specification of a biological growth model for swine to derive optimal input use and replacement policies. Trapp (1988) used a gradient search technique to analyze the cow replacement problem and tied the method to control theory in a subsequent comment. Hertzler employed a six equation continuous model of animal growth to analyze optimal feeding strategies in feedlot management. This research indicates that the profession is achieving an enhanced ability to consider larger, more complex, and hopefully, more realistic, representations of dynamic production systems in optimal control models. While none of these applications address the question of intra-seasonal allocation of range resources, they do provide direction for future applications in the range area. Such studies appear to be examples of what Trapp and Walker (1986) were envisioning in their "New Theory of Production Economics." In actuality, these works do not represent a "new theory", but rather a more complete representation of underlying production relationships in dynamic optimization models.

Knowledge-Based (Expert) Systems

Expert systems are one of several subdisciplines or branches of artificial intelligence. Other subdisciplines include theorem proving, game playing, machine learning, pattern recognition, natural language processing, robotics and machine cognition (Barrett et al. 1985). Expert systems are designed to diagnose and solve problems based on soft data or heuristics through construction of intelligent knowledge bases elicited from domain experts in the problem area (Harmon and King 1985). Although they work best on narrowly focused problems with a well structured knowledge domain, expert systems are useful in overcoming the qualitative deficiencies of reductionist problem investigation and prediction methodology. Capabilities of expert systems include analysis, symbolic logic, diagnosis, design and decision support. For a complete guide to the design, development and use of expert systems see Waterman (1986) or Harmon and King (1985).

Blank and Gum (1987) indicate that by their very nature, expert systems will play a larger role in education than in research. Although they are designed for problem solving, they will be of limited research use because the logic and methodology for solving the problem must be developed before the expert system can be built (Garson 1987). In short, expert systems provide a powerful way to transfer problem solving knowledge to non-experts. Given the shortcomings of past range economics research in this area, a brief discussion of possible applications of expert systems in the range area is given.

According to Barret et al. (1985), uses of expert systems in agriculture will likely be in two primary areas; decision support and troubleshooting (diagnostics). Specific areas of application proposed include resource, financial, pest and personnel management; marketing support and program evaluation. Whittaker et al. (1986) offer a more detailed list of potential uses for expert systems in agriculture which also includes resource conservation, animal production management, and enterprise mix and expansion planning.

Expert systems may fill a decision support role as either the primary (or only) technique applied to analysis of a problem or as a secondary or supportive technique within a larger decision support system. Starfield and Bleloch (1983) contend that the context of a (simulation or optimization) model; i.e., what it addresses, what is assumes, when it should be used (what situation) and the interpretation of its output; are important details which are usually slighted in most analytical reports. They suggest that context details are slighted because details of the model can be presented within a conventional algorithmic structure while no formal structure exists for addressing questions of context. They propose the use of expert systems as "front-ends" or "back-ends" to the conventional models; the former to insure their proper use, and the latter to enhance interpretation of output. An alternative approach would be to include imbedded expert systems as components of larger models that could be used to solve specific subproblems within a decision support system.

To date, relatively few expert systems related to problems associated with range-livestock systems are available, although some applications in this area are reportedly under development (McGrann and Fredricks 1986). One example of those reported to date which relates to range-livestock production is an expert system developed by McGrann and Powell (1986)to facilitate evaluation of a farm or ranch's financial condition. Another example, more directly related to range management, is provided by Ekblad et al. (1989). This system was developed to assist range management specialists in assessing a ranch manager's ability to implement specific range improvement practices and achieve the levels of economic returns predicted from technical production response data and capital budgeting. This expert system functions as a "back end" on a large decision support system designed to assist ranchers in strategic planning involving investment analysis of alternative range improvement and grazing management practices. The system solicits information on the managerial environment, past experience and other aspects to rate the manager's chances of success.

While these two examples are not indicative of the spectrum of range-livestock problems for which expert systems are being, or will soon be, addressed, they are indicative of some characteristics which will undoubtedly be evident in most expert systems related to range economics. First, they are targeted to assist ranchers or service agency/industry personnel as opposed to researchers. This targeting is consistent with the predominance of the knowledge transfer role of expert systems mentioned earlier and may foretell an era in which economists will be better able to positively impact range management practices and processes. Second, the two examples illustrate the positive role that expert systems can play in the integration and enhancement of other traditional analytical and/or diagnostic methodologies used by economists. With the aid of expert systems as "front-ends" and "back-ends", many of the problems encountered in applying traditional operations research models to range management decision making could be alleviated. Finally, expert systems offer a structured means of obtaining and using "expert knowledge" of technical production response in situations where hard data or simulated data are not available. In the Ekblad model, the expert knowledge was solicited only from "management experts"; however, similar processes could be used to obtain and imbed knowledge from brush management experts, range wildlife specialists, etc. Such a function could be particularly important in range applications, given the problems data limitations have presented in the past.

Conclusions

Range economists have continually struggled with representing the range-livestock production system in economic models, thus limiting their influence on both public and private range policies and decisions. Several unique characteristics of the range resource interact to form a complex decision making environment, much of which has not been adequately addressed using traditional modeling approaches. Economists have been further frustrated by a lack of experimental data reporting livestock and/or forage response to management practices and environmental influences. In light of these problems, economists are faced with three alternatives: (1) declare range economics research as futile, (2) continue efforts to apply traditional, static operations research methods in range analyses, or (3) attempt to model the system as what it truly is -- a dynamic, sequential production process.

Obviously, we favor the latter alternative. The first alternative is clearly unacceptable, while alternative two may be discounted by the fact that little progress has been made over the last three decades in overcoming the data limitations referenced earlier. Clearly, a change of approach is in order, and in actuality, such an evolution has been gradually occurring for several years. Range economists must adopt a more process-oriented approach to representing the range-livestock production system. The dearth of production data encountered by range economists does not imply a lack of knowledge of the underlying production processes, but rather an inavailability of data that can be fit into the narrow confines of traditional research methods. By focusing their attention on production processes, rather than more aggregated static response models, range economists should be able to establish better lines of communication with range and animal scientists.

Recent advancements in the areas of biophysical simulation, dynamic optimization, and expert systems offer significant opportunities for improving the empirical validity of range analyses. Application of biophysical models should prove particularly beneficial in understanding production processes underlying intra-seasonal management decisions. Improved solution techniques and greater understanding of dynamic production processes should increase the number and quality of dynamic optimization applications to inter- and intra-seasonal management issues. Both methods are process oriented and are more compatible with the research approach and findings of range scientists. Finally, advances in expert systems offer new opportunities for transferring research findings to range managers.

It is recognized that these approaches are not a panacea for all of range economists' past ills. Application of these techniques requires an increased commitment on the part of range economists to better understand the underlying processes of the range production system. In addition, such an approach is not without data needs; in fact, research methods such as biophysical simulation and dynamic optimization are probably more data intensive than traditional methods. The difference lies in the compatibility of these data with what is available from the range science profession.

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OPPORTUNITIES FOR TRADITIONAL METHODOLOGY IN RANGE AND RANCH ECONOMICS

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A great deal of research has been and is being conducted to develop new technologies for rangeland improvement and management. Unfortunately, little research is being conducted to answer the question of whether these new technologies are economically worthwhile for the affected ranches. This is evident by the small number of economists working on range and ranch economic problems, and the relatively small number of publications on this topic in either range or economic journals. With few exceptions, no more than 1 or 2 researchers in each of the western states dedicate time to range economic research. In addition, much of what is being done is directed toward public policy issues.

Why is so little research effort expended on the economics and management of rangeland? In the short time we have been in the agricultural economics profession, our observation is that agricultural economists have forgotten about the practical economic problems that farmers and ranchers need answers to every day. The university reward system (and we suspect other researcher's reward systems as well) has placed an increased emphasis on journal article publication as opposed to applied research results published in experiment station bulletins and reports, and extension guides. At the same time, economic journals have become more mathematical and model building has become the purpose of much agricultural economics research. Solutions to practical problems, such as the questions of "will range improvements pay," "how many cattle should be optimally stocked," and "which management options are economically best" have been largely forgotten in the ever increasing mathematical sophistication of the agricultural economics profession.

In this paper, we examine why range economic research is lacking. We evaluate the appropriateness of traditional tools of range and ranch economic research and explore the major limitations of improved economic decision making. From this appraisal we conclude that there are two major factors limiting improved economic planning for rangeland resources. First, lack of sound physical and biological data collected in the format necessary for economic analysis is the primary factor limiting application of both traditional and contemporary economic research methodologies. Second, regardless of data availability, range and ranch economic research is not being conducted at the problem solving and applied level. We explore reasons for this and discuss why range economic research, especially multidisciplinary research providing sound biological data for economic analysis, is not being widely conducted.

Traditional Tools Of Range Economic Research

The traditional tools of range economic research include: 1) application of marginal economic principles, 2) whole-farm or ranch plans and budgets, 3) enterprise budgets, 4) partial budgets and 5) cash flow budgets. These five research tools and economic models have been around for years and have been widely applied to range and ranch economic problems. In addition, mathematical programming models, especially linear programming (LP) models, have been routinely used to estimate profit maximizing or cost minimizing production alternatives and could be considered a traditional research method. For clarity, we follow the same categorization used by Bernardo and Conner (1989) and define dynamic programming, risk programming, quadratic programming, optimal control models, firm simulation models, biophysical simulation models, and expert systems to be more contemporary research tools reflecting the state-of-the-art in range economic research.

The use of each of the traditional tools has been described by Libbin (1984) and/or Cook and Stubbendieck (1986). In addition, each method has been applied in a variety of studies over the years. We will cite a few examples of each tool's use. This review will not attempt to be exhaustive, only illustrative.

Marginal Economic Principles

Application of marginal economic principles, the evaluation of added costs versus added returns, is more a way of thinking than a specific tool of range economic

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research. However, marginality forms the basis for most range and ranch economic studies, and it therefore seems justifiable to consider the application of these basic principles as a traditional research tool. Production economic models applying the marginal principles have been used to determine optimal stocking rates on rangeland (Workman 1986, Hildreth and Riewe 1963, Torell and Hart 1988), optimal rangeland fertilization rates (Workman and Quigley 1974), and optimal control of big sagebrush (Tanaka and Workman 1988).

Application to Ranch and Range Economics: Optimal resource use rates, optimal output levels, optimal input use levels.

Whole Farm or Ranch Plan

A detailed listing of resources of the entire business, along with a plan for use of these resources to achieve short- and long-term goals. As used in research, either a case study or survey approach has been used. The former relies on one operation to represent ranches facing the same problem under study. The latter relies on a composite picture of a typical ranch operation that is used to evaluate alternative management scenarios. Either method allows the analyst to consider the complex interactions of management decisions on the ranch operation (Capps and Workman 1982, Dickie and Workman 1987, Torell et al. 1985b).

Applications to Ranch and Range Economics: ranch and resource planning.

Enterprise Budgets

This is typically a physical and financial plan for a specific crop or livestock enterprise. The enterprise budget estimates expenses and receipts for a specific period of time using a specified set of production practices. Many land grant universities have produced typical operation enterprise budgets for various types of livestock operations (Torell et al. 1989a,b, Sonnemann et al. 1981, Myer and Hackett 1981, Guiterrez et al. 1987).

Enterprise budgets can be prepared for alternative uses of rangeland resources, such as wildlife enterprises, but these applications are rare. Past economic studies have, in general, ignored non-livestock uses of resources on the ranch and secondary impacts that enterprise changes may have on income.

Applications to Ranch and Range Economics: enterprise feasibility and analysis of management alternatives.

Partial and Capital Budgets

Used to help the resource manager evaluate the economic effect of minor adjustments in some portion of the business. Only costs and returns that change among alternatives are considered in the analysis (Nielsen 1967, Torell et al. 1985a, Tanaka et al. 1987).

Applications to Ranch and Range Economics: feasibility of range improvements and alternative management strategies.

Cash-Flow Budget

Used to estimate and control the cash needs of a business over a specified planning period, usually a year. Most applications of cash-flow budgeting are for specific ranches and used to evaluate how or if range and ranch improvements could be paid for from annual ranch receipts. Another major application is the evaluation of loan repayment potential.

Applications to Ranch and Range Economics: cash flow planning.

Linear Programming (LP)

Used to estimate the best combination of resource use subject to resource limitations and constraints (Evans 1978). Of all the traditional methods described, LP is the only one that leads to an "optimal" solution. That is, it can be used to estimate what the profit maximizing combination of resource use would be given certain assumptions. The other methods only describe results for the particular enterprise or ranch under consideration with no indication of what changes would lead to profit maximization (or maximization of some other goal).

LP has been used to estimate optimal production strategies in ranch planning (Torell et al. 1985, Ethridge et al. 1987) and for valuation of resources using dual LP solutions (Kehmeier et al. 1987).

Applications to Ranch and Range Economics: feasibility of range improvements, enterprise selection, selecting among alternative rangeland uses.

Limitations of Traditional Research Tools

The major limitation to application of traditional research methodologies to range and ranch management has been their static, single-period nature. In the past, traditional ranch budgets and linear programming models have been developed for one-year planning periods without consideration of the intertemporal dependence of management decisions. If a multiperiod analysis was needed, then each year of the planning period was considered without interdependence of production and management decisions between years. For example, the forage response curve for a range improvement practice was estimated over multiple years. The potential change in income over the planning period was then estimated, the income stream discounted to present value and the result compared to treatment costs (Workman 1986).

This traditional net present value (NPV) analysis provides a relatively simple decision rule for evaluating the economics of alternative management options with benefits measured over a number of years. It is appropriate when decisions during the current year do not influence production and management decisions during subsequent years. However, if decisions about current period stocking rates reduce future forage production and stocking rates, for example, then a more detailed definition of dynamic relationships using contemporary research tools would be needed as in Karp and Pope (1984), Pope and McBryde (1984), Torell (1984), Torell et al. (1989c), Riechers et al. (1989), and Standiford and Howitt (1989).

Are more Sophisticated Economic Models Always Needed?

Because of the spatial and temporal diversity of the rangeland resource and the dynamic nature and intertemporal forage impacts of livestock grazing, it would seem obvious that the rangeland system must be modeled as a dynamic, sequential production process. This may be the correct representation. However, if traditional research tools can be used to estimate a nearly optimal decision rule that gives results understandable by the decision maker for which the analysis was targeted, then rangeland managers may be better served by the simpler but "incorrect" model specification. This would follow Occam's razor that states "that descriptions be kept simple until proved inadequate" (Newman 1956, p. 1247).

Few economic studies that have used more sophisticated dynamic models have compared model results with those obtained using traditional decision rules. One study by Torell et al. (1989c) did make this comparison and concluded that optimal production strategies were only slightly different when the dynamics of the system were incorporated into the decision about optimal rangeland stocking rates.

Torell et al. (1989c) considered the interaction between grazing, brush encroachment and rangeland productivity in an optimal control framework. The Net Present Value (NPV) of income from grazing was calculated when stocking rate decisions made during the current year affect current period livestock production (i.e. weight gains) and forage production potential in all future periods. The traditional stocking rate model driven only by current period livestock performance impacts of grazing was also solved. This relatively simple decision rule of equating the value of the marginal product (VMP) of adding another steer to the pasture to the marginal factor cost (MFC) of putting it there (e.g., Workman 1986, Hildreth and Riewe 1963) was a much simpler model formulation.

Results of the model application to a prairie range site in eastern Colorado indicated that by considering both livestock and forage impacts within a dynamic framework, NPV would only be about $2.00/ha more than if the simpler VMP = MFC rule was sequentially applied during each time period over a 40 year planning horizon. Further, rangeland production did not significantly deteriorate in either case under economically optimal prescribed stocking rates. Optimal stocking rates differed in the two model specifications by only 4 steer days per metric ton of forage produced. This similarity of model results may not always hold, but it does illustrate that even in applications such as this one where a sophisticated dynamic model would appear to be appropriate, simpler decision rules using traditional research tools may yield a nearly optimal management prescription.

Does Biological Data Support More Sophisticated Economic Models?

In the past decade, considerable development has occurred in computerized solution techniques and empirical sophistication of dynamic economic models. However, as noted by Bernardo and Conner (1989), range economists still struggle to specify the production relationships underlying these models and it is unlikely that these data will be forthcoming. A valid question will continue to be whether an economic analysis is better conducted using traditional research tools and with an analysis supported (or nearly supported) by available data defining production relationships, or whether a more sophisticated and theoretically correct model lacking sufficient supporting data is a better option.

This question formed the basis of a debate taking place nearly 20 years ago in the *American Journal of Agricultural Economics*. In 1971, Burt made an early attempt to use dynamic programming to analyze the range investment problem and to more correctly model the proper decision rule for making rangeland investments. This complex mathematical representation of the investment problem led to a lively debate about the appropriateness of more sophisticated models when biological response data were not adequately defined and/or designed to support the complex modeling effort for which they have been applied (Martin 1972). The same question of "correct" model specification and data tradeoffs remains today and will likely continue into the future.

Overcoming Data Limitations

Bernardo and Conner (1989) also recognize that lack of adequate biological response data has contributed to the lack of success of range economic research. They argue that because agricultural economists have been unable to overcome these data limitations, traditional research methodologies must be discounted and that economists must evolve to a more process-oriented (e.g. simulation modeling) approach to represent the range-livestock production system. By understanding how weather, soils, and biological and/or physical processes interact, Bernardo and Conner (1989) contend that data limitations may be overcome (minimized) and that this means that more sophisticated process models leading to this understanding are the answer.

The question then becomes how this process model "pseudo data" is going to be verified. Only by collecting even more complex field data for multiple interacting treatments and over multiple years can one tell if simulated model results are valid.[1] Additionally, process models such as SPUR (Wight and Skiles 1987) still require large amounts of data to define site specific simulation parameters.

A major reason more applications of contemporary research tools have not been made for range and ranch economic problems is obviously the lack of supporting data. We contend that reduced data requirements are an advantage of traditional research methodologies, not a reason to adopt even more sophisticated research tools. As agricultural economists, the most logical solution to the "no data problem" is to develop and cultivate multidisciplinary research efforts where possible, to become involved in the design and implementation of studies with the primary objective of supplying sound biological data for economic analysis and management decisions, and to participate in the time consuming task of collecting this data. Only by actively participating in collecting the data we (agricultural economists) need can we realistically expect to eliminate the no data problem.

Multidisciplinary Research

Several authors have considered the reasons why multidisciplinary range/economic research efforts are not more common and why those that have been initiated have met only limited success (Dobbs 1987, Nielsen 1989, Parsch and Torell 1989). Some of the major reasons given, including our own observations, include the following:

1. *Divergent Research Objectives.* Different disciplines have different objectives in conducting research. Researchers in the physical and biological sciences may have as an objective the advancement of disciplinary knowledge by enhancing the understanding of the response of the range resource to alternative management prescriptions. The research design and key field measurements to answer this type of question are substantially different than the research design necessary to consider the economics of alternative management options. With grazing trial research, for example, range and animal scientists need relatively few treatments with numerous replications to measure statistical difference (Bransby 1989). To identify the most profitable grazing system, the experimental design should include a broad range of treatment levels (stocking rates) so that response can be measured over the range of all possible economic stocking rates (Parsch and Torell 1989). While this latter design may require sacrificing replications, it would provide the required information for improved management decisions. These same types of statements can be made when dealing with range improvements such as sagebrush control as well (Tanaka and Workman 1988).

2. *Economics as the Dismal Science.* While most natural science disciplines view their role in positive terms (developing basic scientific breakthroughs and new technologies to benefit the range resource and resource users) the economists emphasis is on resource limitations and tradeoffs (Dobbs 1987). Nothing is more disheartening than for a range scientist to develop a range management plan that would be good for the resource and to have an economist come along and conclude it will not pay.

3. *Late Entry.* Many multidisciplinary research efforts get off on the wrong foot. Nielsen (1989) describes the typical scenario as one where "a range scientist has worked on the problem of range improvements for the past 25 years. After collecting all the field notes, publications and summary sheets and dumping them on an economist's desk, the question is asked, 'do range improvements pay?'" This involvement of the economist during the late stages of the project does not help the researchers develop a good working relationship, assure an adequate research design is used for answering economic questions, nor develop trust and respect for what the other researcher can contribute. The economist is viewed as a freeloader on the project benefiting from first authorship on a paper largely drawn from tediously collected data without the economist's participation.

4. *Personalities.* Not everyone can get along and when administrators say "you will work together" without considering the personalities involved then the likelihood of success is greatly diminished.

5. *Mundane Research.* Many of the economic answers desired from research projects are nothing more complicated than the question of "does it pay?" Relatively unsophisticated research tools and data collection and analysis procedures can be used. One only need to review recent economic journals to conclude the avenues for publishing these types of studies within a refereed agricultural economics (or range) journal are limited. The agricultural economics disciplinary focus now tends to emphasize either new and different methodologies or fine-tuning particular methods and models (Dobbs 1987). Multidisciplinary research does not generally fit within this research agenda and discipline purists fail to recognize the value of this type of time consuming research.

These limitations for conducting multidisciplinary research, as well as others discussed by Dobbs (1987) and Nielsen (1989) are basically people problems. To overcome the no data problem of range economic research basically means we must work at working with others. This may mean getting down on our knees to clip forage plots, spending days in the hot sun weighing cattle, or showing our ignorance at identifying range plants.

Do More Sophisticated Economic Models Improve Management Decisions?

Additional rigor and "correctness" of model specification cannot be obtained without giving up some degree of simplicity and understanding by those not trained in dynamic optimization and other complex mathematical modeling techniques. In fact, the main advantage of the traditional tools of range economic research is that they are generally understandable and usable by farmers, ranchers and professionals not specifically trained in economics. While agricultural economist's build their complex mathematical models, farmers and ranchers continue to do their economic planning on the back of a snuff can using, unbeknown to most of them, traditional tools of economic analysis. As humorously highlighted by Levins (1988) using statements found in the agricultural economic journals about the motivation and behavior of farmers and ranchers, "farmers don't solve equations." Farmers and ranchers use published research information when available and applicable, but by and large the decision to implement a range improvement practice or adopt a new management strategy comes from a gut feeling that it will pay coupled with a relatively unsophisticated budgeting of expected costs and benefits.

Those pure researchers that do not have an extension appointment or who do not regularly work with farmers and ranchers may feel that we have not given agricultural producers enough credit. Nor will they agree with our observation that farmers and ranchers have not yet achieved the level of sophistication necessary to use mathematical models reported in leading economic journals as the basis for decision making. Those who regularly work at the decision making level are probably inclined to confirm our observations and agree that traditional tools of economic research provide ample sophistication and rigor for the typical range resource manager. At this practical level, it is not the sophistication of the research tools that is the problem but rather a basic understanding and lack of application of even the most basic economic concepts.

For farmers and ranchers, we would contend that the biggest contribution economists could make would not be by increasing the complexity of their economic models but rather in providing answers to very basic questions dealing with the economics of alternative management options. Western livestock producers continue to make management decisions based on little if any direction from the agricultural economics profession as to economic feasibility.

Discussion

Bernardo and Conner (1989) suggest that "economists are faced with three alternatives: 1) declare range economics research as futile, 2) continue efforts to apply traditional, static operations research methods in range analyses, or 3) attempt to model the system as what it truly is--a dynamic, sequential production process." They conclude, as we do, that the first alternative is clearly unacceptable. Bernardo and Conner (1989) discount the second alternative because of long standing and expected continuation of data limitations and suggest that the only alternative is to adopt a more process-oriented approach to represent the range-livestock production system.

We would not be so quick to discount the second alternative. If traditional research tools must be totally discounted because of data limitations then the third alternative is an impossibility. More sophisticated process models are even more data intensive, at least for necessary model validation. Economic models applied using generated "pseudo data" may handle the many dynamic interactions that traditional research tools have not been able to consider, but, without validation, these models and their results will be suspect.

We believe the agricultural economics profession has moved too far away from its practical, problem solving roots. As an example of this, consider the debate that took place in the *American Journal of Agricultural Economics* regarding a paper by Hall and Norgaard (1973) dealing with optimal pest management strategies. First developed by Stern et al. (1959), the concept of the "economic threshold" which computes how many pests it takes before a control program is economically justified, has been widely used in developing pest control strategies. Hall and Norgaard (1973) added mathematical rigor and expanded the economic threshold concept to include decisions about proper timing and amount of pesticide to apply. This greatly increased model complexity and removed the simple management prescriptions that could be made. Subsequent criticism by Borosh and Talpaz (1974) led to the reply that "we never meant for our model to be applied. Our paper was a basic exploration of the definition of the (economic) threshold" (Hall and Norgaard 1974, p. 644).

This same attitude of model building without real purpose or practical application is becoming more prevalent. A sophisticated model that is publishable in a leading economic journal has become the desired output rather than a solution to practical research problems. If this is what adopting more contemporary methodologies in range economic research means then we as a profession should be concerned.

Traditional economic tools have their limits and, with adequate data, contemporary methodologies would be more appropriate. The advantages of these old standbys, however, are reduced data requirements, understandability by non-economists and applicability to a wide range of economic problems. It is not the sophistication of the tools that limits range economic research, it is sound biological data upon which to base an economic evaluation of management options. As agricultural economists, we should be most concerned with improving data for economic studies and increasing the use of economics in decision making, and not be over critical as to whether the analysis is as mathematically rigorous as it could be. More sophisticated models are not always needed.

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Endnotes

1. Caswell (1976) has suggested that only predictive models (such as regressions) can be validated. Mankin et al. (1975) defined a valid model as one in which model output agrees with measured ecosystem variables. Similarly, Overton (1977) defined the validation process as one that if model results do not agree with measured results, the model or parts thereof are rejected or reformulated until results converge to actual field measurements.

BLM's NEW RANGELAND INVESTMENT ANALYSIS PACKAGE

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The BLM Package

The Bureau of Land Management (BLM) has long recognized the need for economic analysis of proposed renewable resource improvements and treatments. Over the years policy and procedural guidance have been issued requiring that proposed improvement projects either represent the most net beneficial means of achieving resource management objectives or represent the least costly means of achieving specific objectives when some or most of the benefits are difficult to measure in economic terms. The guidance for BLM's investment analysis is contained in Manual Section 1740 and the principal analytic tool has been a computer program called SageRam which ran on the Denver mainframe computer.

In 1987 BLM issued an updated version of its investment analysis procedures and in 1989 it released a simpler, easier to use software package called IAM (Investment Analysis Model) which is designed to run on personal computers.

The BLM procedures for economic analysis are outlined in Manual Handbook H-1740-1 (BLM 1987a). This publication, which is entitled *Renewable Resource Improvement and Treatment Guidelines and Procedures*, specifies the economic analysis procedures to be used in BLM range, soil and water, wild horse and burro, forestry and wildlife investments. There are detailed procedures for range and wildlife investments and more generalized procedures for the other renewable resource programs. The handbook also contains instructions on project planning and documentation, rules for the use of appropriated and contributed funds, guidelines for project maintenance and reconstruction or abandonment and guidance for dealing with unauthorized improvements. In this paper we are concerned with the procedures for investment analysis.

The logic of BLM's approach is laid out in section I of the H-1740 manual. The general thought process for project evaluation emphasizes such questions as:

- Have the management objectives been identified?
- Will the proposed project achieve the objectives?
- Have all the alternatives been considered:
  - * changes in management rather than structural changes?
  - * other types of activities?
- How do the costs of the alternatives compare?
- Will the expected benefits equal or exceed the costs?
- Do the costs include mitigation of adverse impacts?
- Will funds be available for project installation, maintenance and reconstruction when needed?
- What priority does the proposed project have?
- Are funds being allocated to projects that yield the highest return to on-the-ground investments?

These common sense principles are too reasonable to generate controversy but the criteria for allocating investment funds may be something of a shock to resource managers who have not had experience with economics. The manual declares the purpose of the procedures is to guide allocation of funds to those projects that yield the greatest amount of on-the ground resource benefits. In other words, funds are to be allocated to those projects that yield the highest return on investment. A benefit-cost ratio of less than 1.0 is a signal that an allotment proposal should be revised and reevaluated. "Improvements that will not generate benefits equal to costs should be dropped from consideration unless resource, legal, or other criteria provide rationale for further consideration" (BLM 1987a:A1-6).

We will discuss some of the background and further details of the investment analysis package and then review the institutional problems surrounding economic analysis of range improvements.

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Background: 1982 Final Rangeland Improvement Policy

In 1982 the Bureau of Land Management (BLM) issued instructions requiring benefit-cost analysis of investments in rangeland improvements and treatments. BLM's procedures are the result of 25 years of evolution in methods for investment analysis of range improvements and watershed programs. Basic instructions for current procedures were issued in 1982 as a part of "Final Rangeland Improvement Policy" and made BLM managers accountable for "assuring that these procedures for evaluating, ranking and scheduling improvements are followed" (BLM 1982). The procedures required the SageRam computer program be used to provide "a consistent basis for cost/benefit and related analysis and to generate information that must be kept in allotment files."

OMB and the Office of the Secretary

The Office of Management and Budget (OMB) and the staff in policy and budget in the Office of the Secretary of the Interior played important roles in BLM's use of economic analysis. In 1975 OMB, with the concurrence of the policy and budget offices in the Department of the Interior requested that BLM analyze the benefits and costs of range investments. An interagency work group was formed to evaluate some allotment management plans. A participant recalls "most of the investment plans examined...had benefits which exceeded their costs" (Nelson 1984:56). Influenced by this unexpected result, and with continued encouragement and technical support from the offices of policy and budget, BLM in 1976 decided to require benefit-cost analysis of all range investments, saying "AMPs must be not only technically and environmentally acceptable, but also realistic, feasible and economically justifiable" (Nelson 1984:56).

The passage of PRIA (Public Rangelands Improvement Act) in 1978 had also opened the door to authorization of additional funds for range improvement. By 1979 BLM had produced a number of grazing EIS'S, which, when added up, called for large investments in range improvement. All of this again raised doubts in OMB about the economic justification of range investment. OMB's doubts fueled further efforts by BLM to refine its investment analysis, develop a computer program for benefit-cost analysis, issue instructions and provide training in the procedures.

The Role of Computers

Modern computers make investment analysis feasible. In the late 1970s numerous computer models of varying quality were developed in BLM to facilitate benefit-cost calculations. In 1982 BLM introduced a mainframe computer program, SageRam, for performing benefit-cost analysis with data entered from the field office via phone wire connection. SageRam was to be the one correct, consistent system for benefit cost analysis. Field offices were expected to connect with the Denver computer and run SageRam for their investment analyses, if the data and time were available (BLM 1987a:A1-5). The model was conceptually and arithmetically correct but the problems in using SageRam were legion. Phone wire hookups were unreliable. The format for entering data was intolerant of the smallest errors. Data on fish and wildlife user days and soil and water benefits was hard to find. Although many could agree with the importance of investment analysis, the time required to get it done was an obstacle.

The IAM program released in 1989 for field testing and available for general use in 1990 is substantially more user friendly than the mainframe version but it still requires specific data and time to run. It is too early to know if it will have better acceptance than SageRam.

The Experience with Training

After the 1982 range improvement policy and SageRam were released, workshops for resource specialists were held in each state. The teaching was based on real life examples. The Phoenix Training Center also conducted courses in SageRam investment analysis but the training encountered problems of perception which were never really resolved. Investment analysis was viewed as a game and managers sometimes wanted favorable results on demand. Followup was inconsistent and too frequently offices relied on economists, a disappearing breed, for the calculations. The latest training effort was conducted for biologists in 1987 to introduce a select cadre to the wildlife economic and productivity procedures released in manual H-1740-1. The trainees were supposed to become teachers in their own states but two years later most biologists had not heard of the new procedures and almost none were using them. The lesson may be that the range and wildlife procedures are not yet simple enough to be used by BLM's range cons and biologists.

The Academic Workshops

In 1980 and 1981 the National Research Council conducted a series of workshops at BLM's request to examine the scientific and methodological issues that arise from BLM's stewardship role under FLPMA. A workshop of leading academics held May 11-12, 1981, examined BLM's economic and social analysis procedures. Criticism and support voiced at this workshop and published in *Strategies for Rangeland Improvement* (National Research Council 1984:1427) helped to improve the procedures. In particular, the procedures no longer advocate ranking allotments both by benefit-cost ratio and ecological condition and averaging the two results for final ranking. Also, some questionable double counting and addition of incommensurables has been dropped. Further progress has been made in incorporating ecological and other nonmarket values into the benefit-cost calculus and in the inclusion of induced private costs as part of project costs.

The Congressional Concern with Prudent Investment

There is no unambiguous instruction from Congress that tells BLM it must use investment analysis in allocating its range, watershed, and wildlife improvement funds. The Director knows after testifying at a Congressional hearing on the budget or responding to a GAO audit that BLM is expected to justify its allocation of funds but it is not unknown for individual members of Congress or interest groups to push for projects that are not justified economically. FLPMA decrees the use of a "systematic, interdisciplinary approach to...integrate...physical, biological, economic and other sciences" (P. L. 94-579: 202[c][2]) which is hardly an admonition to be efficient. PRIA comes closer to a concern for economic efficiency by establishing and reaffirming "a national policy and commitment to... manage, maintain and improve the condition of the public rangelands so that they become as productive as feasible for all rangeland values" (P. L. 95-514:2[b][2]). The most consistent interpretation of the word "feasible" is that it recognizes economic limits to rangeland improvement, implying that rangeland investments should be economically justifiable.

As part of the 1980's concern with waste, fraud and abuse Congress passed the Federal Managers Financial Integrity Act (P. L. 97-255). An amendment of the Accounting and Auditing Act of 1950, FMFIA requires an ongoing evaluation of the systems of internal accounting and administrative controls of each agency. OMB (1983) has issued instructions for performing Internal Control Reviews to comply with the act. While not concerned directly with an economic justification of discretionary investments, the act and OMB instructions are evidence that in an atmosphere of tightening controls, a benefit-cost analysis is a tool available to managers for demonstrating fiscal responsibility. Recently the Office of the Inspector General conducted a review of BLM's range improvement program in which it recommended that the Director insure that required benefit-cost analyses are prepared (Department of the Interior 1986). Fiscal responsibility is not the same thing as economic efficiency but the two concepts are related.

BLM's Performance

A number of conditions have changed since BLM made its 1982 commitment to economic analysis. At the end of the 1980's the purchasing power of BLM's range management budget has dropped to 70 percent of its 1982 level, the interests of OMB and the Office of Policy Analysis have shifted, BLM is placing a great deal more emphasis on monitoring of resource conditions than in 1982. Against this background we will examine the acceptance of investment analysis.

The Institutional Culture

In his heart the true BLMer feels that 'it is morally, ethically and professionally right to institute management practices that stop erosion, grow better forage and vegetation, and improve rangeland condition and trend. We should not have to economically justify these management practices.'(Nelson 1984:55).

Although a survey of BLM offices in New Mexico found nearly 100 percent of range improvement projects subjected to a benefit-cost analysis and the results deposited in the allotment files, a majority don't trust the results and believe the benefit-cost analysis should be done away with (BLM 1987b). In a recent survey of 40 resource specialists attending a workshop on riparian area management 80 percent believed resource specialists needed investment analysis to know the value of their programs but half or more could not accept the criteria and principles of BLM investment analysis. A majority did not believe that funds should be invested only in projects having benefit-cost ratios greater than 1.0 nor that benefits should be evaluated on a willingness-to-pay basis. Only half thought funds should normally be allocated first to those projects that will yield the highest return on investment and nearly half disagreed with the statement that benefits should count the same regardless of to whom they accrue (Davis 1989).

SageRam, the computer program which has performed benefit-cost calculations for BLM, is invariably linked with benefit-cost analysis. Negative comments recorded on "SageRam benefit-cost analysis" in the 1987 survey are that it contains too many variables, it can be manipulated to give any result desired, it is not realistic in field application, it is only used because Bureau policy dictates it will be done, it does not give an accurate and reliable result for project ranking and managers don't actually use it for ranking projects. In what may be the ruling premise, it is frequently said that if the funds are available, projects will be built anyway, regardless of what SageRam says.

It is difficult to sort out the different strands in the reaction of the BLM culture to benefit-cost analysis. Certainly an aversion to paper work and computers is part of it. Belief in the goodness of range management and wildlife conservation practices also contributes to the disaffection with BLM's investment analysis procedures because benefit-cost analysis seems to question the plans and projects of the wildlife biologists and range conservationists.

Lack of confidence in the ability to predict the physical and biological results of projects may also be a major problem. When asked in the 1989 survey at the riparian workshop about their degree of comfort with BLM's ability to project physical and biological responses of range improvements, of those trained in range management 70 percent said they were most comfortable with the range procedures but only 10 percent of those trained in fish and wildlife said they were most comfortable with their procedures. When asked which procedures they were least comfortable with, equal numbers (44 percent) nominated soil and water and fish and wildlife and only 12 percent nominated range procedures. The problem may be that SageRam benefit-cost analysis requires quantification of benefits, whereas most professional resource managers are more accustomed to dealing qualitatively with the benefits of resource improvements.

It may also be that public rangeland managers are having difficulty getting favorable results when they use SageRam. The published results of economic evaluation of public rangeland improvements in Oregon and Nevada show the difficulties of getting benefit/cost ratios above 1.0 (Heady 1988), (Torell et al. 1985). Godfrey (1986) demonstrates the problems in finding economic justification for crested wheatgrass seedings. We suspect economic analysis is used more often to justify projects than to design them. Unwilling to back up and redesign their projects and lacking in the confidence or ability to estimate the soil, water and wildlife benefits, most range managers, when the news is bad, may want to shoot the messenger. SageRam is the messenger.

To the extent that the economic analysis is expected to determine the fate of projects, the economic criteria tend to replace the land manager as the final, effective decisionmaker. Land managers who suspect this are not very supportive of economic benefit-cost studies. BLM makes it fairly easy to escape domination by benefit-cost analysis by excusing the requirement for investment analysis when data or time do not permit and also devising procedures that make the benefit-cost ratio one of seven or more criteria which are to be used in ranking allotment plans (BLM 1987a:A1-6). In light of the balance and flexibility in use of benefit-cost analysis, it is surprising to find such strong negative reactions to the practice.

Development of a Counter Culture

Given the persistent reluctance to accept SageRam benefit-cost analysis, it is inevitable that alternative approaches will be explored. Roswell District (NM) is testing a simplified benefit-cost analysis under the aegis of the pilot productivity program which encourages BLM offices to find better ways of doing things. The stripped down analysis is found in the H-1740 manual as the prudent investor test for classifying allotments and screening allotment plans. The Roswell District analysis has been automated by programming it for spreadsheet software. The procedure simply multiplies the increase in value of the AUMs by a present value factor ranging from 11 to 20, which, at a discount rate of 9 percent, implies a range of zero to $.82 of watershed and wildlife benefits per dollar of grazing benefits. The procedure also bypasses the projection of conditions on the allotment without the improvement, in effect making only a before and after comparison of benefits and costs. If the prudent investor test is the future of investment analysis in BLM, it foretells a future devoid of most of the analytic refinements developed in the last 30 years of benefit-cost analysis.

Evaluation and Assessment

The BLM investment analysis has developed amidst numerous policy directions for the expenditure of range improvement and habitat management funds. It inherits numerous prescriptions for managing the range out of consideration for the user and reflects a need to impose the considerations of discipline and order on tendencies to broadcast range funds randomly. Historically it reflects the strengths and weaknesses of BLM's multiple use, multiple user mandate.

The positive side of the procedures, when compared to the recommendations of the National Research Council workshop of 1981, reveals progress. BLM uses the willingness-to-pay principle in evaluating benefits, uses the with and without principle in projecting benefits, is progressing in the evaluation of nonmarket benefits and in the inclusion of ecological values in the benefit-cost analysis. BLM uses the benefit-cost ratio as the prime economic ranking criterion supplemented with present net value as a check on the rankings.

On the negative side one can still say that there are too many qualifications and compromises to the rigorous application of a benefit-cost test or screen. To begin with, allotments are classified prior to planning and economic analysis into custodial, maintain and improve categories. This is implicitly an economic classification which says the improve category yields the best return on investment and the custodial the worst. Although not based on a complete economic analysis, use of the prudent investor test is encouraged. In the second place priorities for the use of funds are assigned first to the operation, maintenance, and reconstruction of existing improvements and treatments, second to the design and construction of projects and treatments that will complete partially implemented plans, and third to the initiation of new plans (BLM 1987a:I-3). Economic considerations are not the basis for setting these priorities although they can be used in deciding when to abandon projects.

Finally, it can still be charged that the numerous criteria in addition to benefit-cost analysis which are used to rank projects and allotments allow BLM to do almost anything it wishes to do and to justify it with economic analysis. On the other hand, it is clear that the benefit-cost ratio cannot be the only consideration in ranking projects.

Some Areas for Improvement

The biggest challenge BLM faces may be in overcoming the blocks people have toward economic analysis involving computers. This may be partly a training problem, partly a management problem and partly a problem of simplifying and making the procedures user friendly. The management problem is the key. Management has to want something before it will be done consistently and well. It is probably fair to say that management's intentions regarding investment analysis have become ambiguous and somewhat muffled by all of the other priorities which occupy the agency. OMB and the Office of Policy Analysis have gone on to other things. It is also fair to say that every state and local government, private interest group and profession involved with BLM, save economists, would express skepticism and reservations about making a commitment to investment analysis until each were assured that more rigorous analysis would not threaten their interests. Nelson (1984:75) wrote that BLM has reaffirmed a commitment to economics as part of its planning by issuing the 1982 procedures. Little has happened to maintain that commitment beyond continuation of efforts to refine the instructions and computer programs. Until there is continuing reaffirmation that BLM management is committed to sound investment analysis and confidence the procedures are capable of considering all costs and benefits, the interest groups and management itself will remain skeptical. This skepticism reinforces the doubts professional staff may have about economic analysis. BLM management enjoys a relative freedom from legislative requirements which have caused the Forest Service to require economic efficiency analysis in the National Forest Management Plans (U. S. Forest Service 1988). One way to preserve that freedom is stronger voluntary commitment to investment analysis.

If management is committed to investment analysis, then training and education become the essential elements in the success of BLM's investment analysis package primarily because most BLMers have not had enough education in economics to believe in its usefulness. The resource management degrees most possess did not require much if any economics and most received their training before economists had much to say about public lands and nonmarket resource values. It is only recently that a text in range economics has addressed public lands and wildlife economics (Workman 1986). Wildlife management training is even farther behind in economics and partly for that reason the wildlife economic procedures BLM has developed have not percolated very far in the organization. BLM has a major task in assigning appropriate importance to training in investment analysis and then achieving the goal set out. We think the goal should be to get economic procedures in use when resource improvements and treatments are being planned instead of waiting until the final stage when plans need to be justified for decisionmaking.

BLM has wildlife economic procedures in the new package which go a long way toward filling a serious void (BLM 1987a:VI-4). The procedures estimate the effects of changes in habitat on the abundance of a particular species, say mule deer, by requiring a biologist to run through a limiting factors analysis using worksheets BLM has developed. The next task, estimating the effects of a change in the population of a species on user days of recreation, is also done with worksheets, but may be a bit cumbersome for biologists. (The willingness-to-pay prices for user-days are included in the computer files.) Soil and water procedures are not yet fully specified and need much more work. The soil and water program is similar to the horse and burro program in the lack of estimated prices which can readily be assigned to the results of projects but lacks the emphatic legislative mandate. Specifying the physical effects of soil and water management on watersheds is a challenge and estimating the willingness-to-pay values of soil retention and reduced flooding is a greater challenge.

The new IAM program for personal computers has not been available long enough to have been thoroughly tested but BLM is planning for an outside review and critique which will include both a look at the theoretical soundness of the analysis and the user friendliness of the program. There is a continuing need to use computers to make the entire process less formidable and more productive without sacrificing conceptual correctness and analytical thoroughness.

It should be a goal of all the resource management agencies to incorporate as much of the nonquantitative information as possible into investment analysis. This means striving to quantify existence and preservation values. The attention given by laws to threatened and endangered species, areas of critical environmental concern, wilderness, wild rivers, archeological and cultural resources, and wild horses and burros is ample evidence of the importance of these values in public land management.

We don't hold out much hope that in the near future the economic values of existence and preservation can be quantified with the precision of willingess-to-pay for recreation but this is an area BLM should continue to work on both for including these considerations in allotment plans and projects and for quantifying the willingness-to-pay for existence and preservation.

Summary and Conclusions

BLM has made substantial progress since 1976 in developing a conceptually sound and well integrated package of procedures for investment analysis of range, wildlife, soil and water resource improvements and treatments. A majority of BLM resource specialists believe investment analysis is important but do not accept the principles and procedures of benefit-cost analysis. With few economists to conduct the analysis, BLM must find ways to train and motivate employees to accept and use correct economic procedures in planning and management and to convince the skeptics inside and outside the organization that economic analysis is consistent with stewardship of natural resources and effective management of the range. More detailed procedures for analysis of soil, water, and general recreational resources are needed. More effective treatment of existence and preservation values should be pursued. Above all else, management needs to reaffirm a continuing commitment to investment analysis.

There is no specific legislative requirement that BLM conduct benefit-cost analysis, but the need for efficiency in public expenditures has not evaporated and there are continuing pressures for BLM to demonstrate net benefits to the nation in the current use, management and improvement of the public domain. We will not debate the desirability of a more specific legislative requirement for economic analysis of public land management except to say that if BLM falls far short of meeting the challenge, the likelihood of having such a requirement will increase.

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CRMP-STEWARDSHIP: AN ECONOMIC VIEWPOINT

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Coordinated Resource Management Planning (CRMP) and the Experimental Stewardship Program have been at the forefront of resolving resource use conflicts for many years. In many people's eyes, these efforts are confined to specific situations and are not applicable to general rangeland management. Often heard in natural resource management circles are cries of "CRMP takes too big of a time commitment to apply it to other areas;" or, "The Experimental Stewardship Program is fine in Challis, Modoc-Washoe and East Pioneer, but we cannot see opening it up to other areas and issues." To date, we have heard very little about the physical accomplishments and economic consequences of these efforts. In fact, early reports from the experimental programs, stressed the fact that they were finally cooperating and communicating (Challis Stewardship Group, 1979-1983 and USDA/FS and USDA/BLM, 1985). This paper presents background information relative to the establishment of the Experimental Stewardship Program, a brief explanation of the consensus process used, and physical and economic accomplishments after ten years under the Challis Experimental Stewardship Program.

Public Rangeland Improvement Act

In October of 1978, the United States Congress passed the Public Rangeland Improvement Act (PRIA, 43 USC 1901, Public Law 95-514). This bill addresses many important issues concerning management of public lands. Grazing fees for livestock on public lands is one area of PRIA that has received much publicity. Wild horses and burros and their management were also addressed in PRIA. Congress mandated that the secretaries of Agriculture and Interior develop and maintain an inventory of range condition and trend on public ranges (Section 4). The opportunity for mediation of conflicts over the development of allotment management plans was set forth in Section 8. Rangeland conditions were also found to be less than satisfactory and authorization was given for additional appropriations for range improvements. Interestingly, these appropriations have never been funded.

One of the more obscure sections of PRIA is Section 12. However, out of this obscurity arose one of the more important concepts for public land management since the Taylor Grazing Act of 1934. This section deals with management and resolution of conflicts on public lands and was shepherded through the legislative process by Idaho senators Church and McClure. Their interest in this approach was apparently brought about by calls for help by their constituency in central Idaho who were wondering how to deal with an Environmental Impact Statement (EIS) underway on Bureau of Land Management (BLM) lands in the Challis area. Other areas of the state were also dealing with the EIS issue and were concerned about rumored reductions in livestock grazing.

Section 12 reads:

"(a) The Secretaries of Interior and Agriculture are hereby authorized and directed to develop and implement, on an experimental basis on selected areas of the public rangelands which are representative of the broad spectrum of range condition, trends, and forage values, a program which provides incentives to, or rewards for, the holders of grazing permits and leases whose stewardship results in an improvement of the range condition of lands under permit or lease. Such program shall explore innovative grazing management policies and systems which might provide incentives to improve range conditions. These may include, but need not be limited to-

(1) cooperative range management projects designed to foster a greater degree of cooperation and coordination between the Federal and State agencies charged with the management of the rangelands and with local private range users,

(2) the payment of up to 50 percentum of the amount due the Federal Government from grazing permittees in the form of range improvement work.

(3) such other incentives as he may deem appropriate.

(b) No later than December 31, 1985, the Secretaries shall report to the Congress the results of such experimental program, their evaluation of the fee established in section 6 of this Act and other grazing fee

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options, and their recommendations to implement a grazing fee schedule for the 1986 and subsequent grazing years."

Section 12 set the legal framework for the establishment of the Experimental Stewardship Program within the federal land management agencies. Policies within the agencies were drafted shortly after the enactment of the legislation to allow the program to develop at the local level. Experimental programs were established in three areas of the western United States: the Challis Area in southcentral Idaho, the Modoc-Washoe Area in northwestern Nevada and northeastern California and the East Pioneer Area in southwestern Montana.

History of the Challis Stewardship Program

Conflict

The initial Challis Grazing EIS was published in 1977 (USDI, 1977). This was the first EIS undertaken following the settlement of the Natural Resources Defense Council (NRDC) suit against the Secretary of Interior. The report found severe conflicts existing between livestock grazing and fish and wildlife production, serious resource issues concerning erosion and water quality and several other issues. The proposed action involved a reduction of about 7,000 animal unit months (AUMs) of livestock use on BLM rangelands which had been supporting about 17,000 AUMs of livestock use per year. Obviously, this caused quite a bit of animosity between the local ranching community and the BLM. According to some literature (Morgan, 1972), conflicts may have been there long before the EIS was written.

From the passage of PRIA in October of 1978 to the time the Challis Stewardship Program was implemented in early 1979, the progression of events was rather rapid. Sharp (1982) provides an overview of the historical development of the Stewardship Program. This summary also provides background on the National Environmental Policy Act (NEPA), the Natural Resources Defense Council (NRDC) suit and other legal and agency policy developments. The underlying contention of this piece is that these conflicts resulted in the need for a cooperative management approach, which eventually led to the development of the Stewardship Program. Sharp also presents an excellent overview of the historical development and organizational structure of the other two experimental programs.

Several things occurred in late 1978 and early 1979 which led to the rapid implementation of the Challis program. On December 13, 1978, Governor John Evans requested that the Idaho Rangeland Committee assist in developing the Challis Program. Members of Senator Church's and Governor Evans' respective staffs and the Challis National Forest Supervisor met with members of the Tri-County Cattlemen's Association in late 1978 to inform them of the provisions in Section 12.

A meeting on December 20, 1978, with local ranchers and representatives from the Forest Service and BLM resulted in unanimous support for forming a steering group to start an Experimental Stewardship Program in Challis. Senator Church issued a statement on December 21, 1978, that urged the Secretaries of Interior and Agriculture to initiate a cooperative management program in the Challis area. The next day, Tom Chivers, Chair of the Public Lands Committee of the Tri-County Cattlemen's Association sent a letter to the Secretary of Interior, suggesting individuals to serve on a steering committee to start a Challis Stewardship Program. The Idaho Rangeland Committee undertook the request of Governor Evans on January 9, 1979, apparently after first being assured of support from the Challis group.

BLM Director Frank Gregg authorized the Idaho State Director to start the process for implementing an Experimental Stewardship Program in Challis. The first meeting of the Steering Group was held on February 6, 1979. This meeting resulted in the selection of the BLM District manager, the Challis Forest Supervisor and a representative of the Idaho Rangeland Committee to serve as co-chairs of the organization. An organizational structure that included 20 members was suggested. Suggested membership was from a fairly broad spectrum of groups and interests. The suggested representatives were from the local BLM and Forest Service, local ranchers, Idaho Rangeland Committee, Idaho Department of Fish and Game, Idaho Department of Lands, Soil Conservation Service and Soil Conservation District, Custer County Resource Committee, Idaho Wildlife Federation, Agriculture Stabilization and Conservation Service, American Horse Protection Association, American Humane Society, Custer County Extension Agent, University of Idaho and the Idaho Conservation League and/or the Idaho Environmental Council.

The rapid development and implementation of the Challis program can be traced to several factors that were taking place at that time. First, the situation in relation to the management of federal lands in the Challis area (as well as other areas in the western United States) had reached a crisis situation. The EIS's signaled the end of "business as usual" and brought many new players and groups into the management picture. Communication between the ranching community and the managing agencies broke down in many areas because of feelings of betrayal and paranoia. Over 95 percent of Custer County's land base is in public ownership (Sharp and Sanders, 1978). Management decisions made on these lands can have dramatic impacts on private land management and values of private assets. This was of great concern to the local community. They were concerned because of the limited private land resources available to absorb the brunt of the reductions proposed on federal lands. Many of the letters written in response to the final EIS published by the BLM bear out these concerns (USDI, 1978). Local people were also very concerned about losing ranches that had been in their families for many years and the potential loss of assets associated with reductions proposed on their federal grazing permits.

Second, there was a great deal of interest, support and enthusiasm for the stewardship concept at the local level. The "ax being poised over the neck" of ranching operations probably generated quite a bit of this interest. The conflict, or threat of conflict, led to interest from the agencies in resolving the situation. This interest was directed toward on-the-ground resource improvement and away from appeals and court cases. There was also concern from agency personnel about their future careers.

Lastly, this was the era of "revolts" against the intervention of "Big Brother" into the private sector. The Taxpayers' Revolt that preceded property tax limitation initiatives in California, Idaho and other states took place in the late seventies and early eighties. The Sagebrush Rebellion was at its nadir during 1979 and 1980. There were also concerns in many areas of the country that businesses were being affected by unnecessary federal regulations and agencies in dealing with issues like environmental quality, clean air and water, work conditions and many other issues. Situations that may have applied in one area of the country were only laughed at in others. The general feeling of many was probably similar to the newscaster in the motion picture "Network" who said, "We're mad as hell and we're not going to take anymore!"

This same attitude was behind much of the local interest in getting the Challis program off the ground. People interviewed concerning the early days of the program felt they were not only trying to save their livelihoods/ranches/careers, but also were trying to ensure that local voices and experience were heard in formulating management plans for grazing lands in the area. All of these factors from the public and private sectors contributed to the initial interest in the development of the Challis Stewardship Program.

Planning, Decision and Management Process

Early in 1979, the Challis Group drafted a document detailing the overall management philosophy and procedures that they would follow (Challis Stewardship Group, 1979). This paper detailed the structure and purpose of working groups, and responsibilities and procedures that would be followed within the Stewardship program.

The over-riding process that would be followed was that "the majority of business would be handled through simple consensus of the group." On some issues, where a vote was necessary, a simple majority of a quorum of at least two-thirds of the membership of the Steering Group would rule. However, in such instances, both the majority and minority positions would be represented in the record. All meetings were open to the public and any group or organization with an interest in the management approach could request representation on the Steering Group. This request would be subjected to concurrence of the group before granting membership.

In order to have a mechanism to respond to issues on fairly short notice, set agendas for meetings, prioritize proposals and other day-to-day operational procedures, an Executive Group was formed. This included the Chairperson, representatives of the BLM, Forest Service, SCS, Idaho Department of Lands, Idaho Department of Fish and Game, a local rancher and a representative from an environmental organization.

Planning Teams were created to address specific issues involving management plans, resource conflicts and other on-the-ground issues. These groups were to be designated by the Steering Group and were to include ranchers, federal and state officials responsible for the land areas under consideration, an SCS representative, a wildlife biologist and any other specialist appropriate for the particular issue. Planning teams were to be the basic work unit of the Stewardship Program. They were to develop goals for specific plans and issues, assemble and analyze information relative to the issue, develop and prepare alternatives to achieve these goals, and finally to recommend the best alternative or preferred action. In addition, they were to include schedules of implementation and evaluation of plans developed through this procedure. They were also given the charge to be experimental and go outside the conventional land tenure arrangements and existing rules and regulations.

The overall charge of consensus decisions permeates the entire structure of the Challis Group. Decisions and recommendations made at each of these levels are subject to consensus of the respective groups. Decisions made at the Planning Team level are usually subjected to consensus at the Steering Group level as well. Any management decision which comes out of the group appears to have widespread backing because of this process. In addition, the same basic model or process is followed by the Modoc-Washoe and East Pioneer Stewardship programs.

Program Results

The Challis group used the process outlined above to develop cooperative management plans for 23 grazing allotments covering over 283,000 hectares in a period of less than 2 years. All plans were developed using a consensus process and included consideration of wildlife, livestock, wild horses and other issues pertinent to each grazing allotment. Implementation involved expenditures of over $583,000 for construction of fencing, water developments, prescribed fire and seedings and riparian improvement projects. Economic analysis formed an integral part of the early evaluation of the feasibility of the plans prior to implementation.

Livestock numbers were stabilized at approximately 26,000 AUMs (BLM lands have averaged about 16,000 AUMs, with the Forest Service contributing another 10,000 AUMs). An additional 640 "new" AUMs were developed through the process. Livestock use was projected over a thirty year period based upon historic trends. Forage was divided by season of use and an average value of $12.69 per AUM was used to estimate annual benefits of the program, considering AUMs saved from reductions and "new" AUMs developed. Values were derived using private land lease rates and other hay prices (Idaho Agricultural Statistics Service, 1987) during the 8 years of the Stewardship Program to value summer and spring/winter use, respectively. This value compares with those presented in Wilson et al. 1985, using linear programming analysis in BLM EIS areas in southeastern Idaho as well as the shadow prices used by the Forest Service on a regional basis. Livestock use was also valued using BLM's AUM value of the private land lease rate, an average of $7.61 per AUM during the 8 year period. These benefits were compared with actual and projected range improvement costs associated with the management plans developed through the Stewardship program. All benefits and costs were discounted at 8 percent for thirty years. Results of this analysis are presented in Table 1. Alternative 1 involved livestock use valued on the basis of alternative forage sources (hay and private pasture leases) following recommendations in Wagstaff and Pope (1987). Alternative 2 included livestock use value at the average private land lease rate of $7.61 per AUM. Both alternatives appear to be cost-effective, although using the private lease rate pushes the analysis more towards a breakeven venture.

Table 1. Benefit/Cost Analysis Results - Challis Experimental Stewardship Program.

Alternative	B/C Ratio
1	1.6
2	1.02

Notes: Alternative 1 includes seasonal livestock value differences. I.e., winter use is valued at $24.40 per AUM and others at $7.61 per AUM, an average of $12.69 per AUM. Alternative 2 includes all livestock use at $7.61 per AUM.

Non-quantifiables, Myths and Uncertainties

In addition to the direct costs and benefits described earlier, there are several developments which are difficult to quantify in absolute terms. There are also several myths and a few uncertainties surrounding the Challis program.

Wildlife numbers have shown significant increases. Elk numbers within the Stewardship Area are estimated to have climbed from 600 head in 1975 to over 1800 head in 1985. Deer populations have risen from 7900 head to over 8300 head and antelope have increased from 1500 head to over 2100 head over the same time frame. Although many factors enter into these increases in wild game numbers, comparison with a nearby "control" unit and statewide figures indicate the management instilled on the ground has benefitted wildlife as well as livestock within the Challis Stewardship Area. Anadromous fisheries have also shown significant increases since 1975. However, much of this may be tied more to mediation measures on the lower reaches of the Snake and Columbia river systems than to riparian conditions in the hinterlands.

One of the common criticisms heard about the Stewardship program is that it has been successful only because we have "thrown a lot of money at it to mediate livestock reductions that should have been undertaken long ago." Efforts were made to determine levels of improvement funding, amounts actually expended and the number of AUMs of livestock forage available in various areas within the agencies. The result of this effort is contained in Table 2. These data indicate that total expenditures within Challis have been lower than other areas. However, expenditures per AUM of forage have been greater than in the comparison areas within Idaho. Records from the East Pioneer Stewardship Area indicate that less funding has been expended on Stewardship allotments than on non-Stewardship allotments. Information from other areas concerning investments in range improvements is needed to expand this analysis. However, from these data, it appears the contention that an inordinate amount of funding went to the Stewardship Program is not true.

Table 2. Comparison of Range Improvements per AUM/AM Forest Service and BLM - 1980-1988

Area	AUMs	Expenditure	$/AUM	Agency
Idaho				
Challis	26,024	$583,405	$22.42	BLM/FS
Area A	42,602	$746,358	$17.52	BLM
Area B	117,857	$782,364	$ 8.14	BLM
Montana East Pioneer Area*				
ESP	19,258	$26,275	$.733	FS
Non-ESP	35,970	$47,282	$.760	FS

Sources: BLM and FS Improvement Records-Challis and East Pioneer Range Program Summaries, Shoshone, 1984 and Owyhee, 1986.

* Investment per Animal Month

In the area of planning costs, the Challis Group listed the following in a 1985 Report (Challis Stewardship Group, 1985):

Table 3. Person Days Needed to Produce Environmental Analysis and AMP

Activity	With ESP	Without ESP
Meetings/ Consultation	5	15
Writing/ Reviewing	15	30
	—	—
Total	20	45

Assumes data collection is completed

This information was apparently generated by individuals involved with the Stewardship Program who also had experience in planning efforts not associated with cooperative ventures. This same document also stated that "Completion and implementation of AMPs (not using Stewardship) would have taken six years longer than with ESP" (page 29).

These data would appear to offer some hope for reducing planning and implementation costs associated with AMPs. Questions concerning these figures remain, however, and more information is needed from other areas and situations to document savings or additional costs associated with the effort. If the program has actually reduced manpower needs and not just shifted them to the private sector and other agencies, large cost savings may be possible to the agencies and the U.S. economy. If it is merely a shift to others, there still may be merit in the BLM or Forest Service pursuing the program as a means of attaining goals within the context of less budgetary resources being available.

Implementing a plan six years sooner than one developed under another method would offer substantial benefits under the concept of present value. In other words, the present value of benefits to be received in two years as opposed to those received in eight years are significantly different. The present value (at eight percent discount rate) of $100 in benefits received in year two is $85.73 and only $54.03 if they are received in year eight. This type of savings can have a very positive impact on benefit/cost ratios or net present value calculations if considered in the analysis of range improvement practices.

In an analysis of various Progress Reports from other areas within BLM of Idaho, the contentions made by the Challis Group concerning implementation would appear to have merit. Two areas in Idaho BLM went through grazing EIS's shortly after the Challis Area. The Challis Area had one protest and appeal, which amounts to 4.3 percent of the total allotments (Table 4). In contrast, Area B had 25 protests (49 percent) and 14 appeals (27.5 percent). Area A had 30 protests (32.6 percent) and two administrative appeals (2.2 percent) of management decisions. Based upon this information, there appears to be less conflict within the Stewardship Program than under conventional management approaches. However, efforts should be made to expand these observations to include other areas and agencies.

In regard to time involved in developing management plans for the allotments or management areas under consideration, the Challis Area had all AMPs completed and 18 plans (78 percent) had been fully implemented in less than four years of operation. In contrast, Area B had six AMPs developed (11.8 percent) and no indication of the number fully implemented nearly five years after the filing of the EIS. Area A had 14 AMPs (15.2 percent) developed and 19 AMPs and CRMPs implemented (20.7 percent) six years after the EIS was published. These data are summarized in Table 4.

Table 4. Stewardship and Non-Stewardship Planning and Management Reuslts - Idaho BLM, 1979-1985.

	Challis	Area A	Area B
Allotments	23	92*	51
Permittees+	28	153	178
EIS Date	7/79	3/80	10/79
AMPs	23	14	6
CRMPs	23	5	NA
Protests	1	30	25
Appeals	1	2	14
Implemented#	23	73	12

Table adapted from Challis Stewardship Group, 1985; USDI, 1984 and USDI, 1986.

* Does not include Fenced Federal Range (FFR). Indicates those implemented at date of respective Range Program Summary (RPS).
\# Includes only allotments which RPS document indicated that agreement was signed.
\+ Number of permittees is actually the number of decisions reported in the RPS for each area.
NA Not Available

Conclusions and Further Questions

This paper has detailed some of the accomplishments of the Challis Experimental Stewardship program. The program appears to have been a cost-effective venture. The program has also been quite effective in addressing issues other than livestock grazing, reduced planning and implementation time and does not appear to have garnered any more financial support than other areas within the agencies. The results presented here do not reflect those that may or may not have taken place in the other two Experimental Stewardship areas or the "individual" Stewardship areas within BLM.

Several questions remain concerning our assumptions about resource use. First, are we really dealing with a "Zero Sum Game"? Indications prior to getting into the Challis Program were that livestock and wildlife were involved in heavy competition for forage and habitat. Loomis et al. (1989) used this assumption further, in comparing economic values of livestock and wildlife in a competitive vein. Results from the Challis program would lead one to question this assumption, given the fact that both livestock and wildlife numbers have increased over time, with no apparent resource damage.

Second, if the program has been shown to be successful, why don't the agencies push the process more? The process of consensus decisions at the local level would be appear to have application to many other real or perceived conflict situations. Is there a fear that the agencies will relinquish their decision authority? Can, or should the program be institutionalized?

Finally, is it necessary to hold the "ax of reductions" or other administrative actions over the neck of people to generate participation in these types of programs? Little or nothing had taken place in Challis as far as cooperation, until the threat of livestock reductions arose.

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