Costs of Grazing on Federal Lands and Private Leases:

A 1991 Colorado Comparison

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INTRODUCTION

Much controversy has surrounded the grazing fee formula used to determine grazing fees on federal land. The current grazing fee formula was established by Congress in the 1978 Public Rangeland Improvement Act (PRIA) and extended by Executive Order in 1986. The grazing fee has been and is below the lease rate for private grazing land, and has been criticized as an 'unfair' subsidy to livestock producers who utilize public forage resources. Legislation has been introduced to increase the fee during the last several congressional sessions.

The current fee formula, established in PRIA, is based on a 1966 base fee of $1.23 per Animal Unit Month (AUM), a Forage Value Index, a Beef Price Index, and a Prices Paid Index. The base of $1.23/AUM was derived from the 1966 Western Livestock Grazing Survey by comparing costs of leasing private grazing to those of using federal grazing.

The 1966 Western Livestock Grazing Survey reported data on the fee and non-fee costs of grazing livestock on both private and federal lands. The fee cost is the charge or explicit lease rate of the forage. The non-fee costs are in addition to the lease charged and include all costs that a lessee incurs while using the lease. These costs include expenses such as labor, services, repairs, and supplies necessary to obtain forage for the livestock. The fee plus the non-fee costs comprise the total amount that a lessee pays to run livestock on any pasture.

The non-fee costs of grazing federal lands are subtracted from the total cost incurred by private lessees (lease charge plus non-fee costs) to obtain the apparent value of federal forage. The value, viewed as a residual, is the amount left after the additional expenses incurred by grazing on federal lands have been subtracted from private lease costs. Any cost that a rancher does not pay in non-fee costs will be included in the value of grazing on federal lands.

The costs of grazing cattle on private lands reported in the 1966 Western Livestock Grazing Survey included a $1.79/AUM lease cost and a $2.75/AUM non-lease cost for a total cost of $4.54/AUM. The non-fee cost of grazing on federal lands was $3.28/AUM. The $1.26 difference ($4.54-3.28) was the imputed value for cattle grazing on federal lands. The value for sheep was $1.13/AUM. These values were weighted at 80 percent cattle and 20 percent sheep to arrive at the $1.23/AUM base currently used in the PRIA fee formula.

Obermiller and Lambert (1984) conducted non-fee grazing costs studies in Oregon, Idaho, Nevada, Wyoming, North Dakota, and South Dakota. The authors reported similar total costs of grazing on private and federal lands, but in their study the private-land lease rate comprised a larger percentage of the total than the fee did on federal lands. A statistical comparison between this study and the values reported in the 1966 Western Livestock Grazing Survey was not possible because no random survey of lessees was made. To date, there has been no effort to duplicate the methodology of the 1966 Western Livestock Grazing Survey. Bartlett et al. (1984) reported a $17.68/AUM cost of grazing on federal lands in Colorado. A comparison between the later study and the 1966 Western Livestock Grazing Survey was not possible because the authors did not survey private land lessees.

Nielsen (1991) updated non-fee costs using indices developed by USDA. Nielsen reported a $12.26/AUM non-fee cost of grazing on federal lands in 1990. His study assumed that the relative cost structure was the same in 1990 as it was in 1966. This assumption may not hold now because maintenance requirements for range improvements on federal allotments have changed as have methods of grazing management.

The purposes of this study were:

1) To provide a comparison between the 1991 non-fee cost of grazing on federal and the non-lease cost of grazing on private lands in Colorado.

2) To compare the non-fee costs of grazing in 1991 on both private and federal lands to those reported in the 1966 Western Livestock Grazing Survey.

PROCEDURES

Lists of range livestock producers who hold federal grazing permits and private leases were compiled. A procedure for estimating sample size was developed. Questionnaires to survey producers using grazing on federal lands and on private lands in Colorado were developed.

Rancher Lists

The compilation of a complete frame (list of members of the population) and the correct selection of a sample from that frame were considered essential to the accuracy and efficiency of the survey. Two frames were required for this study, one for those producers using grazing on federal lands and the other for those producers leasing grazing on private lands. The procedure for the compilation of the frame will be discussed first followed by the procedure used for sample selection.

Federal Permittees: The frame was composed of individuals and firms that used grazing on federal lands. Individuals and firms were included in the frame to obtain information on non-fee costs of permittees on each allotment. The frame of permittees that used grazing in federal lands in Colorado was compiled from the Bureau of Land Management (BLM) and Forest Service (FS) rolls of federal permittees. The BLM "Range Manage-

ment Grazing Record Master" for each BLM Resource Area and the FS "Grazing Permittee Action and Actual Use Record" for each National Forest were combined. Sorts by name, address, and ZIP code were done to eliminate duplication of allotments on both FS and BLM lands. Those firms or individuals having permits on the Comanche and Pawnee National Grasslands were excluded from the frame.

The original list of 2,716 federal allotments was reduced to 1,977 ranchers whom utilized federal grazing in 1991. This number is down when compared to the 2,100 ranchers whom utilized federal grazing in 1983 (Bartlett et al. 1984).

Private Lessees: No frame existed listing individuals who leased private rangeland for grazing in Colorado. County commissioners were asked to develop a list of names, addresses, and phone numbers of those individuals who lease private rangeland for grazing in their counties. Two hundred eighty-nine names were received from counties, local livestock organizations, and Cooperative Extension. Duplications were eliminated from the frame.

Sample Design

A random sample was obtained from each frame. For federal grazing, sample size was estimated by using the variance in non-fee costs from the 1983 study (Bartlett et al. 1984). A stratified random sample was utilized to increase accuracy of the survey. Three strata became apparent when the frequency distribution of animal unit months of each ranch was analyzed. To estimate sample size, 1983 average costs and standard errors (Bartlett et al., 1984) were assigned to each strata. Strata 1 was the "large" federal permits with greater than 2050 AUM's, a $12.54/AUM average cost, and a standard deviation of ± $2.03. Strata 2 was the "medium" federal permits with 501-2050 AUM's, a $17.95/AUM average cost, and a ± $5.70 standard deviation. Strata 3 was the "small" federal permits with less than 500 AUM's, a $22.10/AUM average cost, and a ± $8.43 standard deviation. A sample size of 64 was estimated. The sample size was doubled to 128 based on an assumed response rate of 50 percent. Using the Neyman allocation (Schaefer et al. 1979), sample proportions were 27 percent, 51 percent, and 22 percent for the large, medium, and small strata, respectively. The sample sizes for each strata were 34 for large, 66 for medium, and 28 for small. Statistical procedures are shown in Appendix A.

The sample selection procedure used for private rangeland lessees was similar to the one described above for federal allotments. The variance in costs was assumed to be the same on private leases as for federal lands as no prior estimates for private leases existed. Of the 289 private leases, 130 were randomly selected for the sample.

Questionnaire Design

The questionnaire (Appendix D) for federal land was designed to estimate total 1991 non-fee costs and to identify allotment characteristics influencing the magnitude of those costs. The questionnaire was slightly modified for private leases to include the lease rate. The questions were formulated based on the 1983 grazing cost study (Bartlett et al. 1984).

The questionnaire consisted of three parts. Part I provided a general ranch description, identification of the permittee (or lessee for private leases), the region of the ranch, and ranch size. Part II asked for a list of allotments (or leases) that were active in 1991 and the federal agencies responsible for those allotments. Part III pertained to specific allotment (or lease) characteristics and associated management activities. Costs were itemized in eight management activities. Management activities are the type of expenses that livestock producers incurred while using the forage (Bartlett et al. 1984). They included depreciation, lost animals, transportation, gathering, herding maintenance, routine, and other costs (association fees, meetings, paperwork, etc.). A description of these activities is given in Appendix C.

Interview Method

A combination of mail and telephone surveys were conducted. Questionnaires were mailed to the randomly-selected permittees and lessees. Letters from the Colorado Cattlemen's Association and Colorado State University explaining the scope and importance of the project, questionnaires (one for each allotment), and a postage-paid envelope were mailed to each interviewee. Follow-up telephone interviews were conducted to assist and lessees in filling the questionnaires. Not all interviewees could be contacted by telephone. A follow-up letter was sent to all non-respondents to encourage response. The questionnaires were returned to the Rangeland Ecosystem Science Department at Colorado State University for analysis.

Data Analysis

Of the 128 questionnaires sent to federal permittees, 45 (35 percent) were returned. Of those returned, only 39 (30 percent) were in usable form. Of the 128 questionnaires sent to private lessees, 40 (31 percent) were returned. Of those returned, only 18 (14 percent) were in usable form. Twenty-two (17 percent) were returned blank. Several reasons may account for the low rate of response. First, the questionnaire was long and took a significant block of time to complete. Second, the mailing was delayed well into the spring when livestock producers were

busy. Finally, many of those included on the private lease list did not lease private land for livestock grazing.

Information from the completed surveys were entered into a spread sheet for data analysis. Cash and non-cash values were assigned to all activities using current livestock industry information and past grazing studies (Appendix B). Activity costs were summed across allotments (or leases) and divided by the total AUM's to obtain AUM-weighted non-fee costs averages and AUM-weighted private lease rates.

RESULTS

The 1991 AUM-weighted non-fee costs average of grazing on federal lands in Colorado was $19.87/AUM with a standard error of ± $1.30/AUM. The 1991 AUM-weighted average non-lease cost of grazing on private lands was $13.26/AUM with a standard error of ±1.20 (Table 1). The confidence interval of the mean was calculated at the 95 percent level, such that we can state that 95 percent of the time the estimate of non-fee costs will fall between $18.57/AUM and $21.17/AUM on federal allotments and between $12.06/AUM and $14.46/AUM on private leases (Appendix A).

The composition of the non-fee costs were examined by management activities (Table 1) and by component costs (Table 2). Lost animals ($4.14/AUM) and gathering ($3.75/AUM) were the two leading source of expenses incurred by permittees grazing on federal allotments (Table 1). Herding ($3.18/AUM) and gathering ($2.83/AUM) were the two leading source of expenses incurred by the lessees using grazing on private lands (Table 1).

Table 1. Non-fee costs of grazing on federal allotments and private leases in Colorado in 1991 by use activities ($/AUM).

Management activity	Federal	Private
Depreciation [a]	$ 1.42	$ 0.22
Lost animals [b]	4.14	2.10
Transportation [c]	1.20	0.60
Gathering	3.75	2.83
Herding	3.29	3.18
Maintenance	1.95	2.31
Routine	2.13	1.08
Other	1.99	0.94
Total	**$19.87**	**$13.26**
Standard Error	1.30	1.20

[a] Depreciation of developments based on total cost of improvements on each allotment or lease paid by permittee or lessee.
[b] Based on the value of animals unaccounted for, includes death loss and missing animals.
[c] Included are those resources used for moving animals to a lease or an allotment (hired trucking, vehicle use, and horse expenses).

Figure 1 shows the percentages that each management activity contributed to the total non-fee cost in federal lands. Lost animals accounted for 20.8 percent, gathering for 18.9 percent, herding for 16.6 percent, followed by routine activities (10.7 percent), maintenance (9.8 percent), depreciation (7.1 percent), and transportation (6.0 percent). Figure 2 shows the percentages that each management activity contributed to the total non-lease costs in private lands. Herding accounted for 24.0 percent, gathering for 21.3 percent, maintenance for 17.4 percent, death loss for 15.8 percent, routine for 8.1 percent, transportation for 4.5 percent, and depreciation for 1.7 percent.

Component costs (Table 2) categorized the type of costs that made up the management activities, e.g. labor, vehicle costs, horse costs. Component cost sources are important in allowing indexing of costs in subsequent years. Labor was the highest component costs in both federal ($9.47/AUM) and private lands ($7.11/AUM). Figure 3 shows the percentage that each component contributed to the total non-fee cost in federal lands. Labor accounted for 47.7 percent, followed by lost animals (20.8 percent), maintenance (9.8 percent), development depreciation (7.1 percent), vehicle use (4.5 percent), horse use (2.7 percent), animal health (2.3 percent), trucking (2.3 percent), miscellaneous (1.5 percent) and

Table 2. Weighted average 1991 non-fee costs in Colorado for federal allotments and private leases, and value of federal forage.

Component cost [a]	Federal	Private Lease
	$/AUM	$/AUM
Death loss	4.14	2.10
Hired trucking to and from allotment	0.46	0.02
Labor for all management activities	9.47	7.11
Vehicle use for all management actitivites	0.89	0.51
Horse cost for all management actitivites	0.53	0.39
Animal health	0.45	0.38
Maintenance	1.95	2.31
Association fees	0.26	0.20
Development depreciation[b]	1.42	0.22
Miscellaneous (vandalism, meetings, paperwork, predator control, theft, contracted feed, etc.)	0.30	0.02
Total nonfee costs	$19.87	$13.26
Private lease rate[c]	—	7.64
Total costs for private lease		$19.90
Value of federal forage[d]	$0.03	

[a] Categories of costs that made up management activity costs.
[b] Depreciation of developments based on total cost of improvements on each allotment or lease paid by permittee or lessee.
[c] Average lease rate reported, may include payment for services in addition to grazing.
[d] Total costs for private lease minus total nonfee costs on federal.

Figure 1. Non-fee costs by activity (federal).

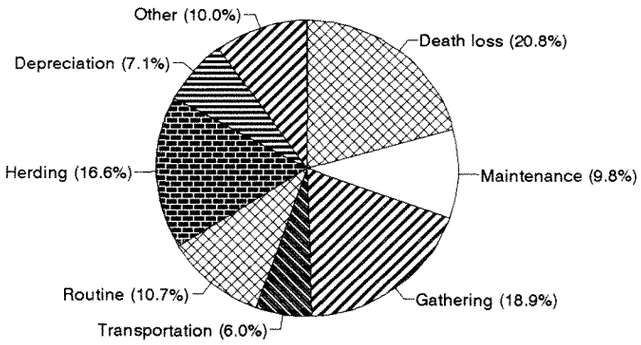
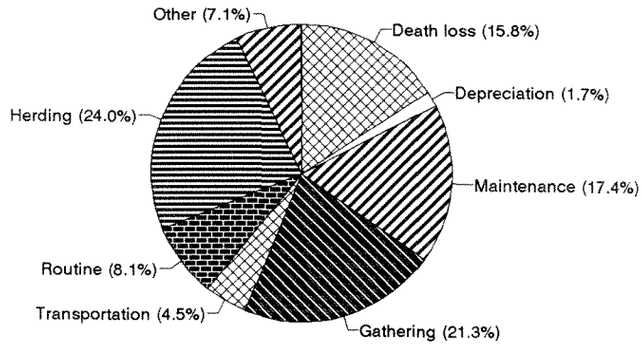


Figure 2. Non-fee costs by activity (private).



finally, association fees (1.3 percent). Figure 4 shows the percentages that each component contributed to the total non-lease cost in private lands. Labor accounted for 53.6 percent of the total non-lease cost followed by maintenance (17.4 percent), lost animals (15.8 percent), vehicle use (3.8 percent), horse use (2.9 percent), animal health (2.9 percent), association fees (1.5 percent), development depreciation (1.7 percent), hired trucking (0.2 percent), and miscellaneous (0.2 percent).

Non-fee costs of grazing on federal lands stratified by allotment size are listed on Table 3. Non-fee costs of grazing on federal lands were $29.42/AUM for allotments less than 500 AUM's, $22.87/AUM for allotments with 501 to 2050 AUM's, and $16.81/AUM for allotments greater than 2051 AUM's. Although the non-fee cost of grazing federal allotments decreases with an increase in allotment size, no inferences about increases in forage values as allotment size increases can be made because of possible corresponding economies of scale on private leases. This comparison was not possible because the response rate was insufficient to stratify non-fee costs by lease size on private lands.

Table 3. Non-fee costs of grazing on federal allotments by allotment size in Colorado in 1991 by use activities ($/AUM).

	Component Cost		
	Strata 1 (1-500 AUMs)	Strata 2 (501-2052 AUMs)	Strata 3 (2053+ AUMs)
Deprecation	$ 3.09	$ 2.39	$ 1.04
Lost animals	$ 5.45	$ 4.82	$ 3.64
Transportation	$ 0.97	$ 1.68	$ 1.01
Gathering	$ 6.46	$ 4.01	$ 3.27
Herding	$ 2.48	$ 4.09	$ 2.92
Maintenance	$ 3.18	$ 1.92	$ 1.79
Routine	$ 4.91	$ 1.68	$ 1.50
Other	$ 2.70	$ 2.28	$ 1.64
Total	**$29.24**	**$22.87**	**$16.81**
Average AUMs	237.3	1,003.5	4,448
n	19	13	6

Comparison to the 1966 Study

Table 4 provides a comparison between the results of this 1991 study and the values from the 1966 study indexed to 1990 (USDA/USDI 1992). The comparison between 1990-indexed values and the values from this study suggests that non-fee and non-lease costs have increased at a greater rate than that reflected in the indices. The 1991 non-fee cost of grazing federal lands ($19.87/AUM) was significantly higher than the 1990-indexed value estimated in the USDA/USDI 1992 study ($10.19/AUM). The $19.87/AUM non-fee cost of grazing federal

Table 4. Comparison between 1966 non-fee costs indexed to 1990 and 1991 non-fee costs ($/AUM) and estimates of federal forage value.

Cost	1966 Indexed to 1990[a]		1991	
	Federal	Private	Federal	Private
Lost animals	1.78	1.24	4.14	2.10
Association fee	0.20	0.00	0.26	0.20
Veterinary	0.32	0.37	1.93	0.87
Moving to and from allotment	0.79	0.79	4.30	3.10
Herding	1.83	1.11	3.29	3.18
Salt and feed	1.62	2.18	0.20	0.21
Travel to and from	1.03	0.81	0.65	0.33
Water	0.27	0.23	0.10	0.02
Horse	0.46	0.27	0.53	0.39
Fence maintenance	0.60	0.67	1.05	1.44
Water maintenance	0.51	0.39	0.90	0.87
Development depreciation[b]	0.31	0.08	1.42	0.22
Other	0.47	0.45	1.10	0.33
Total nonfee costs	10.19	8.59	19.87	13.26
Private lease rate[c]	—	4.55	—	7.64
Total cost	10.19	13.14	19.87	19.90
Value of federal forage[d]	2.95	—	0.03	—

[a] 1966 values indexed to 1990 as given in USDA/USDI (1992).
[b] Depreciation of developments based on total cost of improvements on each allotment or lease paid by permittee or lessee.
[c] Average lease rate reported, may include payment for services in addition to grazing.
[d] Total costs for private lease minus total nonfee costs on federal.

Figure 3. Non-fee costs by component (federal).

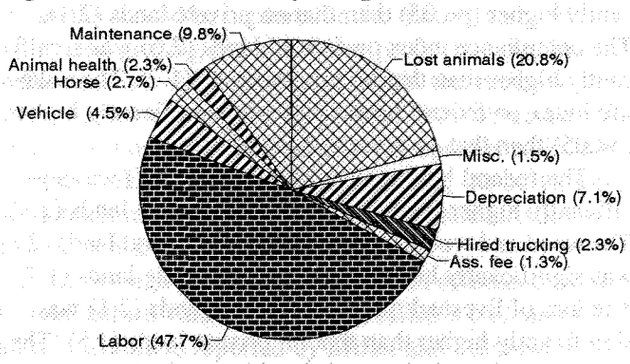
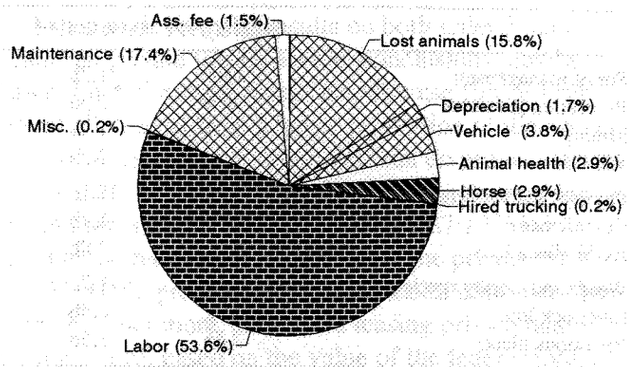


Figure 4. Non-fee costs by component (private).



lands from this study was 95 percent higher than the indexed non-fee costs of grazing on federal lands from the USDA/USDI 1992 study.

The non-fee cost of grazing on private lands estimated in 1991 ($13.26/AUM) was also significantly higher than the 1990-indexed value estimated in the USDA/USDI 1992 study ($8.59/AUM). Non-lease costs of grazing on private lands in 1991 were 54 percent higher than the non-lease costs indexed from 1966. In comparing cost components, lost animals and areas where labor requirements are high (veterinary, moving, herding, and maintenance) showed the greatest differences.

Forage Value

The value of the federal forage was estimated in the last part of Table 4. The private lease rate was added to the non-lease cost to obtain the total costs of grazing private forage. The non-fee cost on federal lands was subtracted from the total costs of grazing private forage to compute the value of the federal forage. This value was estimated at $0.03/AUM.

Table 5. Summary of allotment and lease characteristics.

	Federal	Private
Agency	32% BLM; 68% USFS	private
Average length of use	104 days	163 days
Livestock	27% sheep; 73% beef	12% sheep; 88% beef
Average AUM's	1,196	780
Acres available	14,411	2,472
Time of use		
Spring	10%	20%
Summer	53%	36%
Fall	32%	31%
Winter	05%	13%
Total ranch size	385 AU's	264 AU's
Management intensity	74% High	50% High

The 1990-indexed lease rate from the 1966 study was $4.55/AUM while the reported lease rate in this 1991 study was $7.64/AUM. The estimate of federal forage value from indexing 1966 results was $2.95/AUM, $2.92/AUM higher than the estimated value from this 1991 study.

Allotment and Lease Characteristics

Table 5 summarizes the allotment and lease characteristics found in this study. Sixty-eight percent of the public land grazing in Colorado was Forest Service while 32 percent was BLM. The season of use on private lands was longer than that on public lands. Producers leasing private lands had a higher percentage of cattle and a lower percentage of sheep than those producers using public lands. Although average AUM's and ranch size were higher in federal lands, differences were not significant ($p<.05$).

Acres available for grazing were significantly higher ($p<.05$) on federal lands (14,411 acres) than on private lands (2,472 acres). Time of use was significantly different ($p<.05$) in private and federal lands. Although the largest percentage of use was summer and fall for both private and federal lands, private lands were used more in the spring and winter than federal lands.

Management intensity was determined based on the type of grazing management. Continuous grazing, non-scheduled deferment or other similar plans were considered low management intensity. Rest rotation, deferred rotation or open rotation were considered high management intensity. Management on federal lands was significantly ($p<.05$) higher (74 percent) than on private lands (50 percent).

Conflict Indices

When obtaining forage, conflicts from multiple use, interference, and harassment is of varying concern. Indices used in the 1983 survey (Bartlett et al. 1984) assessing the importance of each area of concern was utilized in this survey (Table 6). Survey respondents rated vari-

Table 6. Use conflict indices (4=high, 1=low).

	Federal 1991	Private 1991
Forest management	1.9a[1]	1.2b
Recreation pressures	2.7a	2.5a
Mining	1.2a	1.2a
Wildlife	2.8a	2.3b
Physical and topographic features	2.7a	2.1b
Compliance	2.6a	1.7b
AUM allocations	2.7a	1.8b
Weeds and woody species	2.8a	1.7b
Livestock loss	2.1a	1.5b
Poisonous plants	2.4a	1.6b

[1] Numbers in the same row follwed by the different letters are significantly different (p<.05).

ous factors as highly critical (4), moderately critical (3), low critical (2), and non-critical (1), as they pertained to their operation on a particular allotment or private lease.

The forest management index measured how timber and logging intensity affected forage productivity, costs or animal performance. The recreation pressure index measured the degree of disturbance four-wheeling, hunting, camping or other recreational activities caused in relation to livestock, and forage. The mining index measured the impact that mining and mineral exploration caused on labor, costs, or animal performance. The physical and topographic features index measured how physical and topographic features affected access to forage, quality of forage, and yield. The compliance index measured the degree of conflict produced by compliance with the lease, such as adjustments made by the producer to adhere to on/off dates due to range readiness and condition or change in AUM's. The wildlife index measured the competition of available forage from wildlife at critical times in the season.

The herd management index measured how the AUM allocations on the lease affected herd management. The weed and woody species index measured the degree at which management is affected by the presence of weed and woody species in the allotment. The livestock loss index measured the degree of livestock loss due to predation. The poisonous plants index measured how the control of poisonous plants on key grazing areas affected costs, labor or livestock performance.

The conflict indices showed that most areas of conflict are greater for the producers using federal allotments than those using private leases. The forest management index on federal lands (1.9) was significantly higher (p<.05) than on private lands (1.2). The recreation pressure index for federal lands (2.7) was not significantly different than for private lands (2.47). The mining index on federal lands (1.2) was not significantly different than on private lands. The physical and topographic features index on federal lands (2.7) was significantly higher (p<.05) than that on private lands (2.1). The compliance index on federal lands (2.6) was significantly higher than that on private lands (1.7). The wildlife index on federal lands (2.8) was significantly higher (p<.05) than that on private lands (2.3).

The federal herd management index (2.7) was significantly higher (p<.05) than that on private lands (1.8). The weed and woody species index on federal lands (2.8) was significantly higher than that on private lands (1.7). The loss of livestock index on federal lands (2.1) was significantly higher than that on private lands (1.5). The poisonous plants index on federal lands (2.4) was significantly higher (p<.05) than that on private lands (1.6).

Livestock Performance

Livestock performance is very important to livestock producers in evaluating the value of forage sources. Livestock statistics and performance from both federal and private surveys were summarized in Table 7. When results were compared, animals on private leases showed larger average daily gains than the same class of animals on federal forage. Also, death losses on federal allotments were generally greater than losses on private leases. There appears to be an economic advantage of grazing private leases compared to federal allotments although further investigation is necessary to fully predict the factors that are responsible for the differences in livestock gains and death losses between the two sources of forage.

Permit Value

Because a competitive market exists for grazing permits, a direct estimate of the annual value of public land grazing can be obtained by computing a rate of return on the grazing permit investment and adding this to the current grazing fee (Nielsen and Wennergren 1970). Differ-

Table 7. Livestock performance in Colorado in 1991.

	Federal	Private	Difference[a]
Average daily gain			
Calves (lbs/day)	2.07	2.15	-0.08
Yearling beef (lbs/day)	1.38	1.86	-0.48
Lambs (lbs/day)	0.41	0.45	-0.04
Death loss			
Cows	1.6%	0.6%	1.0%
Yearlings	1.3%	0.2%	1.1%
Calves	3.2%	2.1%	1.1%
Bulls	1.9%	2.3%	-0.4%
Rams	2.6%	0.0%	2.6%
Ewes	1.7%	2.5%	-0.8%
Lambs	2.7%	3.4%	-0.7%

[a] Federal value minus private value.

ences in production, costs and returns between grazing allotments should be captured in the market value of public land grazing permits. More productive ranches and/or ranches with lower costs should theoretically have a higher valued grazing permit. Thus, observed grazing permit values should give site specific estimates of forage value while directly considering the costs, forage quality, range improvements, and characteristics of specific public land ranches.

The average permit value per AUM estimated from the total permit value and the total AUM's on federal lands in Colorado reported by Miller and Bainbridge (1993) was $54.64/AUM. Using a capitalization rate of 3.35% (Torell and Doll 1991), the annual value of the permit is $1.83/AUM. This amount added to the fee paid in 1991 ($1.97/AUM) is $3.80 per AUM and represents another estimate of the value of federal forage. This estimate exceeds the estimate reported in Table 2 of this study by $3.77 per AUM.

If permit values arise only because of a capitalized cost advantage for public land grazing, then this method should provide a direct estimate of forage value. However, if permit values are influenced by factors other than expected livestock returns, valid estimates of forage value will not necessarily be obtained using this method. Jensen and Thomas (1967) found that factors associated with grazing cattle on public ranges explained only 55 percent of the variation in permit sales value. Similarly, Torell and Doll (1991) found that permit values have not provided a consistent estimate of the value of public land forage.

DISCUSSION

When reviewing the results on both federal allotments and private leases, several conclusions may be drawn. First, livestock producers who use forage from federal allotments have a larger proportion of their total costs represented in non-fee costs than do producers who use privately leased forage. Second, when the non-fee cost of grazing federal allotments ($19.87/AUM) is added to the fee ($1.97/AUM) and to the permit value ($1.83/AUM), producers who use federal allotments pay as much, if not more, than those leasing private land for grazing. Third, based on the value of the federal forage estimated in this study ($0.03/AUM), the total cost method is not an appropriate procedure to elicit the grazing value on public land. In 1991, federal permittees paid the grazing fee ($1.97/AUM) and the permit value ($1.83/AUM) for an implied forage value of $3.80/AUM. Fourth, operators graze federal allotments for a shorter time with lower animal performance than operators grazing on private leases. Fifth, operators on federal allotments are subjected to more conflicts from outside pressures than livestock operators on private leases.

Because non-fee grazing costs in federal allotments seem to decrease as allotment size increases, a comparative by-strata size analysis for private leases is recommended for future studies. Also future studies should measure the increase in non-fee costs produced by conflicts associated with multiple use, terms, and compliance with agency regulations.

The study was undertaken to provide a comparison between the 1991 non-fee cost of grazing federal land and the non-lease cost of grazing on private lands in Colorado. Non-fee costs on federal lands ($19.87/AUM) were significantly higher than non-lease costs on private lands ($13.26/AUM). In addition, indexing costs from the 1966 Western Livestock Grazing Survey resulted in estimates that were significantly lower than actual costs in 1991.

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APPENDICES

Appendix A Statistical Procedures for Estimating Sample Size

Presurvey estimates, using 1984 costs and 1991 allotment size to determine the number of allotments to sample, were calculated using the following set of equations.

Eq. 1.

The following equation was used to estimate the average cost per animal unit month (Sheaffer et al. 1979):

$$\bar{y}_{st} = \frac{1}{N} \sum_{i=1}^{L} N_i \bar{y}_i$$

where
- N = total number of allotments in population.
- N_i = number of allotments in size stratum i.
- L = number of strata.
- $\bar{y}_i$ = average cost per AUM for stratum i.
- $\bar{y}_{st}$ = average cost per AUM.

Eq. 2.

The following formula was used to assign a bound on the error of estimation (Scheaffer et al. 1979):

$$2\sqrt{\hat{V}(\bar{y}_{st})} = 2\sqrt{\frac{1}{N^2} \sum_{i=1}^{L} N^2 \left(\frac{N_i - n_i}{N_i}\right) \left(\frac{s^2{}_i}{n_i}\right)}$$

where
- n_i = number of allotments to sample in size stratum i.
- s_i^2 = stratum variance on cost per AUM (taken from 1983 study).
- $\hat{V}(\bar{y}\ st)$ = Estimated variance of $\bar{y}$ st (estimator of mean).

Eq. 3.

The following equation was used to estimate the number of ranches to be surveyed (Scheaffer et al. 1979):

$$n = \frac{\sum_{i=1}^{3} \frac{N^2{}_i \sigma^2}{w_i}}{N^2 D + \sum_{i=1}^{3} N_i \sigma^2}$$

where
- n = total sample in all strata
- w_i = fraction of observations allocated to stratum i. (number of allotments in stratum i / total allotments) = N_i/N
- D = bound on error of estimation

$$D=\frac{B^2}{4}$$

when estimating μ

$$2\sqrt{\hat{V}(\overline{y}_{st})}=B$$

$$V(\overline{y}_{st})=\frac{B^2}{4}$$

This yielded 64 ranches to be surveyed.

Eq. 4.

The Neyman allocation method was utilized to assign the proportion of sample size n to each stratum (Scheaffer et al. 1979):

$$n=\left[\frac{N_i\sigma_i}{\sum_{i=1}^{3} N_i\sigma_i}\right]$$

The following are the proportions and sample sizes:

Large strata = 27% or .27*64 = 17 allotments.
Medium strata = 33% or .33*64 = 33 allotments.
Small strata = 22% or .22*64 = 14 allotments.

Eq. 5.

The following formula was used to calculate the confidence interval of the non-fee costs.

$$\overline{y}\pm\left(\frac{t\alpha}{2}\right)\left(\frac{se}{\sqrt{n}}\right)$$

df=n-1

Appendix B Cash and Noncash Costs

1. Estimated Vehicle Cost

Item	Pickup	Pickup trailer	Stock truck
New Price	$15,000.00	$20,000.00	$25,000.00
Salvage	$5,000.00	$7,000.00	$5,000.00
Years of use	8	8	12
Ownership cost/year	$1,250.00	$1,625.00	$1,666.67
Miles/year	10000	10000	5000
Fuel consumption (mpg)	12	8	8
Fuel cost/gallon	$1.20	$1.20	$1.20
Fuel cost/year	$1,000.00	$1,500.00	$750.00
Annual interest	0.1	0.1	0.1
Annual tax/license	$100.00	$150.00	$200.00
Annual insurance	$400.00	$450.00	$450.00
Annual maintenance	$300.00	$350.00	$400.00
Annual oil/lub cost	$100.00	$100.00	$100.00
Misc. cost/year	$900.00	$1,050.00	$1,150.00
Tire cost	500	800	1500
Miles/set of tires	25000	20000	25500
Tire cost/year	$200.00	$400.00	$294.12
Total Cost/mile	$0.37	$0.50	$0.85

Car cost: $0.28/mile (Sales and Marketing Management 1990, p. 105).
Semi/Trailer cost: $2.00/loaded mile (Edens and Carver 1991).

2. Death Loss

Death loss values were considered for animals lost through death and disappearance on federal allotments or private leases. Costs were determined by the 1987 Index of Prices Received by Farmers, and the 1991 Colorado Agricultural Statistics. Weights used to calculate the value of calves, lambs, and ewes were from Bartlett et al. 1984.

(a) Calves (at weaning) steers and heifers:

412 lbs @ $99.80/cwt = $411.18

(b) Yearling steer and heifers:
800 lbs @ $80.00/cwt = $640.00

(c) Cows:
1000 lbs @ $53.10/cwt = $531.00

(d) Bulls: Bulls were valued at the depreciated rate after 2 years of service (assuming 4-year useful life).

Purchase	$2000.00	
Less salvage value	$1000.00	
Carrying value	$1000.00	4 yrs life = $250/yr

Assuming loss after 2 yrs: $250/yr * 2yrs = $500+loss of foregone sales ($1000) = $1500
Using a discount rate of 10% interest value for loss of bull ($1500 * .9)= $1350

(e) Lambs (ewes and weithers):
70 lbs @ $54.40/cwt = $ 38.08

(f) Ewes: 120 lbs @ $24.10/cwt = $ 28.92

(d) Rams: Rams were valued at the depreciated rate after 2 years of service (assuming 4-year useful life).

Purchase	$ 250.00	
Less salvage value	$ 55.00	
Carrying value	$ 195.00	4 yrs life = $48.75/yr

Assuming loss after 2 yrs: $48.75/yr * 2yrs = $97.50+loss of foregone sales ($55) = $152.50
Using a discount rate of 10% interest value for loss of ram ($1500 * .9)= $137.25

3. Horse Costs

Horse costs were estimated on a depreciation basis of $1200 purchase price, $600 salvage value, and 10 years of useful life.

Purchase price:	$1200
Salvage value	-$ 600
Carrying value	$ 600/10 years = $60/year

Expenses to maintain a horse were calculated by:

Hay (3 ton/yr @ $100/ton)	$ 300
Pasture (7 mos @ $20/mo)	$ 140
Supplement	$ 200
Ferrier	$ 150
Veterinary	$ 100
Miscellaneous	$ 50
Total variable costs	$ 940

Total costs= $60 + $940 = $1000
On a per day basis: $1000/365 = $2.74/day

4. Labor costs:

Labor costs were calculated from returned surveys and included social security, workmans comp., and room and board where applicable.

Labor Costs			
Manager/operator	Family	Regular hired	Day labor
$10.76/hr	$ 5.11/hr	$ 7.55/hr	$ 6.52/hr

Appendix C Description of Allotment Management

Activity Costs: All costs are reported on a dollar per animal unit basis.

1. Death Loss: Death losses were reported by the total number of unaccounted for animals per animal unit month.

2. Maintenance: Maintenance costs included labor, vehicle, horse, fence, structural and watering materials, contracted labor and equipment and owned equipment expenses.

3. Gathering: Gathering costs included those resources used for taking livestock off a lease or allotment.

4. Transportation: Transportation costs included those resources used for moving livestock to a lease or allotment (hired trucking, vehicle, labor and horse expenses). If livestock were moved to another lease or allotment following grazing on current lease or allotment, then transportation costs were considered for the next allotment.

5. Routine and Miscellaneous: This section included those resources used in herd checking, doctoring, salting, feeding, water, etc. Cash costs included the actual cash outlay for salt, supplement, feed and veterinary care. Other costs included vehicle, labor and horse costs.

6. Herding and distribution: Cost expenses in this section included the cost for livestock herding, distribution of animals according to grazing management schemes, etc. Cash expenses included vehicle, labor and horse costs.

7. Development depreciation: Total labor, equipment and materials costs for range improvements on each allotment were determined and depreciation expenses per year were calculated.

8. Other costs: Included in these sections were such cash costs as grazing association fees, contracted feed and water hauling, predator control, and water costs. Paper work, stockmen's meetings, vandalism, chasing stock, etc., were reported as noncash cost items indicated by hours spent, vehicle milage and horse use.

9. Estimated range improvement costs

	New cost	Ave cost	Life	Deprec	Intrest	Annual Cost
Ponds[1]	$1880.00	$ 940.00	20	$ 94.00	$ 79.90	$ 173.90
Springs[1]	$2270.00	$1135.00	20	$ 113.50	$ 96.48	$ 209.98
Wells[1]	$4700.00	$2350.00	25	$ 188.00	$ 199.75	$ 387.75
Water Tanks[1]	$ 900.00	$ 450.00	20	$ 45.00	$ 38.25	$ 83.25

Spraying[1]	$ 12.00	$ 6.00	7	$ 1.71	$ 0.43	$ 2.14
Fence[1]	$ .75	$ 0.38	25	$ 0.03	$ 0.03	$ 0.06
Corrals[3]	$1264.80	$ 632.40	25	$ 50.59	$ 53.76	$ 104.35
Cow camp[2]	$2500.00	$1200.00	10	$ 250.00	$ 102.00	$ 352.00
Bentonite ponds[2]	$ 500.00	$ 500.00	5	$ 50.00	$ 4.25	$ 54.25
Seeding[1]	$ 42.50	$ 21.25	25	$ 1.70	$ 1.80	$ 3.52

1. Figures arrived at using 1992 USDA SCS cost doc.

   a. Ponds 2000 yd^3 earth moved at $0.94/$yd^3$.

   b. Well $6.00/foot drilling, $3.00/foot to case, $1000/pump,m $1000/power source.

   c. Fence per foot.

   d. Springs, water tanks, are a unit of one.

2. Cow camps and bentonite are assumptions.

3. Corrals were estimated from Feds Cattle Budget, Beef Cow Enterprise, Central Mountain Region adjusted from 1984 at 3%.

Appendix D Questionnaire

The following questionnaire was sent to those livestock producers using federal allotments in Colorado. A similar questionnaire was sent to those using private leases for grazing. The wording of some of the questions was changed to reflect private leases instead of federal allotments.

1991 Grazing Cost Survey
Colorado State University

I. GENERAL RANCH DESCRIPTION

The following information is for the 1991 operating year. Please include accurate information for your deeded land as well as your federal allotments.

A. Who can we contact if we need any further help with this survey?

Name: _____

Phone: _____

B. In what county is your ranch headquarters located?

County: _____

C. What was your average livestock inventory in 1991?

1. Mother cows _____ No. Heifers _____ No.

   Bulls _____ No.

2. Ewes _____ No. Rams _____ No.

   Rams _____ No.

3. Yearling market livestock

   Raised _____ No.

   Purchased _____ No.

4. Horses _____ No.

5. Other livestock (specify) _____

   _____ No.

6. What percentage of the total ranch forage requirements did you obtain from Forest Service, B.L.M., grazing on private leased lands and your owned deeded land?

Percent Feed Requirement				
	Spring*	Summer*	Fall*	Winter*
USFS				
BLM				
Private				
Deeded Land				

***Spring: March, Apr., May** ***Fall: Sept., Oct., Nov.**
***Summer: June, July, Aug.** ***Winter: Dec., Jan., Feb.**

II. LIST OF ALLOTMENTS

In this section, please provide a list of all allotments leased in 1991. (**Note:** This information can be obtained from your Allotment Management Plan)

A. Allotment 1

Name of allotment_____

Is this allotment a BLM or USFS allotment? (check one)

BLM_____ USFS_____

Name of resource area or national forest and district in which allotment is located:

_____

B. Allotment 2

Name of allotment_____

Is this allotment a BLM or USFS allotment? (check one)

BLM_____ USFS_____

Name of resource area or national forest and district in which allotment is located:

_____

C. Allotment 3

Name of allotment_____

Is this allotment a BLM or USFS allotment? (check one)

BLM_____ USFS_____

Name of resource area or national forest and district in which allotment is located:

_____

D. Allotment 4

Name of allotment_____

Is this allotment a BLM or USFS allotment? (check one)

BLM_____ USFS_____

Name of resource area or national forest and district in which allotment is located:

_____

E. For any additional allotment please list on back of page.

III. ALLOTMENT CHARACTERISTICS AND MANAGEMENT

This part of the survey will be filled out for each allotment that you have identified in Part II as being used in 1991.

A. ALLOTMENT NAME_____

1. What were the turn-on and gathering dates for this allotment in 1991?

   Date on_____ Date off_____

2. What were the number of livestock run on this allotment in 1991?

Number of Livestock on Allotment in 1991	
Breeding Cows	
Replacement Heifers	
Bulls	
Yearling Marketstock	
Ewes	
Rams	

2. How many acres are in this allotment?

   Acres_____

3. Of the total acres for this allotment, how many acres are accessible for grazing?

   Accessible acres_____

4. What other land ownership occurs within this allotment?

   a. Name of ownership_____

      Total acreage of other ownership_____

      Percent of total forage in this allotment_____

   b. Name of ownership_____

      Total acreage of other ownership_____

      Percent of total forage in this allotment_____

5. What are the predominant vegetation types in this allotment? (Please check all that apply):

   ☐ Alpine
   ☐ Subalpine
   ☐ Spruce-Fir
   ☐ Mountain Park
   ☐ Pinon-Juniper
   ☐ Woodlands
   ☐ Saltdesert Shrub
   ☐ Midgrass plains
   ☐ Shortgrass plains
   ☐ Sandsage plains
   ☐ Sandhills
   ☐ Sagebrush foothills

6. What topographic features best describe this allotment? (give proportions)

Steep, rocky_____%

Hilly, steep_____%

Rolling hills_____%

Gentle, flat_____%

Other*_____%

(*Specify_____)

7. How many pasture (units) are there in this allotment? (please check one)
☐ 1, ☐ 2, ☐ 3, ☐ 4, ☐ 5, ☐ 6 or more

8. How would you best describe your current grazing management plan on this allotment? (Please check one)

☐ Scheduled rest rotation among a number of pastures (one or more pastures used each year)
How many pastures are used?_____

☐ Scheduled deferred rotation among a number of pastures
How many pastures are used?_____

☐ Open rotation with scheduled moves.
1. How many pastures were used?_____
2. How many moves while in this lease?_____

☐ Continuous grazing, with all livestock distributed freely

☐ Decision deferment (i.e., non-scheduled moves)

☐ Other (specify) _____

_____

9. How critical are the following situations (as they reflect on your costs, labor, or livestock performances) for grazing on this allotment in 1991? (Please check whether it was Highly Critical (H), Moderate (M), Low (L), or Non Critical (N).

	H	M	L	N	
a.	☐	☐	☐	☐	Forest management intensity (e.g., timber, logging, etc.) as it relates to forage productivity
b.	☐	☐	☐	☐	Recreation pressures (e.g., 4 x 4, hunting, camping) as it relates to range, livestock, and forage mineral exploration
c.	☐	☐	☐	☐	The impact of mining and mineral exploration
d.	☐	☐	☐	☐	The physical and topographic features can affect access of forage, quality of forage, and yield.
e.	☐	☐	☐	☐	Compliance with permit causes adjustments in grazing operation (e.g., on-off dates) relative to range readiness.

f. ☐ ☐ ☐ ☐ Competition of available forage from wildlife at critical times in the season

g. ☐ ☐ ☐ ☐ AUM allocations on this allotment can affect base herd management (e.g., AUM allotment increases or decreases).

h. ☐ ☐ ☐ ☐ Weed and/or woody species composition on this allotment

i. ☐ ☐ ☐ ☐ Loss of livestock due to predation

j. ☐ ☐ ☐ ☐ Control of poisonous plants on key grazing areas

k. ☐ ☐ ☐ ☐ Other disturbances (specify)_____

10. For a similar allotment, what is the sale value of the permit in your area?

$/AUM:_____

a. Was this allotment permit purchased?

☐ No ☐ Yes

1. What was purchase date? _____

2. What was purchase value of permit?

$/AUM:_____

3. Was this permit purchased (check one)

☐ with ranch and livestock
☐ with livestock only
☐ with ranch only
☐ separately

b. What would be the annual lease rate that you would pay for this allotment if it were administered by a private landlord?

$/AUM_____

c. What would be the annual lease rate that you would pay for a private lease to replace this public allotment?

$/AUM_____

11. Inventory of Allotment Improvements

As part of the description of this allotment, we would like to obtain an inventory of improvements in the allotment. Please make a complete listing of all improvements listed in the codes and any other improvements on the allotment.

Type of Improvement	
Improvement	Code
Wells	01
Springs	02
Ponds	03
Fences:	
Let down	04
4-strand barb	05
Hot wire	06
Buck and pole	07
Roads	08
Corrals	09
Tanks and troughs	10
Pipelines	11
Dipping vats	12
Seeding	13
Spraying	14
Windmills	15
Other (Specify_____)	16

Improvements made on this pasture since 1971 (last 20 years)

Type of improvement	Measure of improvement (specify mi, acres, ft, # of units)	Year improvement was constructed	In the initial construction, what was the percentage of labor, material, and construction equipment provided by you?		
Code		Year	% labor	% materials	% equipment
Code		Year	% labor	% materials	% equipment
Code		Year	% labor	% materials	% equipment
Code		Year	% labor	% materials	% equipment
Code		Year	% labor	% materials	% equipment
Code		Year	% labor	% materials	% equipment
Code		Year	% labor	% materials	% equipment
Code		Year	% labor	% materials	% equipment
Code		Year	% labor	% materials	% equipment
Code		Year	% labor	% materials	% equipment

B. CASH COSTS

This section of the questionnaire will be used to list the cash costs expended in grazing livestock on this allotment.

1. What were the cash expenditures for the following items in 1991?

_____ $ Salt
_____ $ Veterinary and medicines
_____ $ Protein supplements
_____ $ Grain
_____ $ Hay
_____ $ Contracted feed/water hauling
_____ $ Predator control (poisons, trappers, gunning
_____ $ Water costs (gas, electric, diesel, service)
_____ $ Association fees

Do these association fees pay for: (check all that apply)

☐ Herding
☐ Salt and supplements
☐ Fence and improvement maintenance
☐ Other (specify_____)

2. Miscellaneous Costs

a. What were the cash and non-cash cost expenditures for the following items pertaining to this allotment during 1991? (Paperwork, stockmen's grazing meetings, vandalism, rounding up stray stock after gates are left open, meetings with federal personal etc.)

	Transportation		Labor			
	Vehicle Type (Code	Mileage	Manager Operated (hrs)	Family (hrs)	Regular Hired (hrs)	Day (hrs)
Paper work						
Stock meetings						
Vandalism						
Stray roundup						
Fed. meetings						

3. Labor costs
This question will be used to estimate the cost for labor. The amount (time) of labor used to run livestock in this allotment will be dealt with in later sections.

	Pay Unit* (code)	Wage rate per unit time	Approx. monthly cost for social security, unempl. insurance, room and board and benefits.
Manager			
Family members			
Hired labor			
Day labor			

*Paid by: hr=1 day=2 wk=3 mo=4 unpd=5

C. **LIVESTOCK PERFORMANCE**

This section of the questionnaire will ask you about the condition or performance of your livestock on this allotment.

1. What were the livestock gains on this allotment in 1991?

	Beginning weight	Ending weight
Calves	lbs	lbs
Yearlings	lbs	lbs
Lambs	lbs	lbs

2. How many livestock died or disappeared on this allotment in 1991?

Cows_____ Yearlings_____

Calves_____ Bulls_____

Rams_____ Ewes_____

Lambs_____

3. If this allotment was used for the breeding of livestock, what was the reproductive rate of cows or ewes on <u>only</u> this allotment?

_____ % Percentage of calves born to cows bred on this allotment (i.e., number of calves dropped to number of cows bred)?

_____ % Percentage of lambs born to ewes bred on this allotment (i.e., number of lambs dropped to number of ewes bred)?

4. Does geography of allotment necessitate more than normal number of bulls or rams for desired conception rate?
If so how many males/ female:

Bulls_____/Cows_____
Rams_____/Ewes_____

If so what is the typical ratio in your area?

Bulls_____/Cows_____
Rams_____/Ewes_____

D. This section of the questionnaire asks about the labor requirements (number of people and the hours required) to move livestock to allotment, to herd and distribute livestock on allotment, to gather and move livestock from allotment, to maintain the physical requirements of the allotment (fences, water tanks, dams, etc.) and the labor requirements for animal health and maintain (herd checking, doctoring, salting, feeding, watering, etc.).

	Livestock to allotment (A)		Herding, distribution, grazing mgt. (B)		Gathering & moving livestock (C)		Maintain allotment (D)		Animal health and maintenance (E)	
	no.	hrs.	no.	hrs.	no.	hrs.	no.	hrs.	no.	hrs.
Yourself/manager										
Family members										
Regular hired labor										
Day labor										

1. What percent* of total labor in in column B was spent in the following activities:

_____%Required-scheduled grazing management program

_____%Protection from predators or poisonous plants

_____%To move livestock from recreation or wildlife areas

_____%To distribute livestock to better forage or proper use.

_____%Other(specify:_____)

*Sum of the above should equal 100 percent

2. Percentage* of the total labor in column D was spent on the following maintenance activities on this allotment

_____%Structural repairs

_____%Normal upkeep

_____%Vandalism destruction

_____%Wildlife destruction

_____%Snow down repairs

*Sum should equal 100%

3. What percent* of total labor in column E was spent in the following activities:

_____%Salting

_____%Supplemental feeding

_____%Doctoring

_____%Watering

_____%Other(specify_____)

*Sum should equal 100%

F. Horse

This section of the questionnaire will ask you about the horse requirements to operate and maintain this allotment

1. Horse requirements to operate and maintain this allotment

Horse Requirements		
	Average number horses used	Average days horses used
Livestock to allotment		
Livestock distribution/herding/ grazing management		
Livestock gathering		
Livestock off allotment		
Maintenance of allotment		
Animal health and maintenance		

2. What percent* of the total horse requirements were provided by the following:

_____%Owned horses

_____%Rented horses

_____%Horses provided by hired rangeriders

_____%Other:(specify:_____)

* Sum should equal 100%

_____**END**

E. This section of the questionnaire asks about the vehicle requirements to move livestock to allotment, vehicle requirements to herd and distribute livestock on allotment, gather and move livestock from allotment, maintain the physical requirement of the allotment (fences, water tanks, dams, etc.) and the vehicles requirements for animal health and maintance (herd checking, doctoring, salting, feeding, watering, etc.). (**Please:** use hours on farm and industrial equipment instead of miles)

	Livestock to allotment		Herding & distribution in allotment		Gathering & moving livestock		Allotment maintenance		Animal health & maintenance	
Vehicle type used*	No. used	Miles (hrs)	No. used	Miles (hrs)	No. used	Miles (hrs)	No. used	Miles (hrs)	No. (hrs)	Miles (hrs)

*Some vehicles that might be used: Pickup, Pickup-stocktrailer, stock truck, Semi-tractor trailer, All-terrain vehicle (ATV), Water-tank truck, Tractors, Implements

Of the total costs for equipment (to maintain this allotment) what percentage was done by:

_____%Rented/Contracted

_____%Owned equipment