

DEVELOPMENT AND FEDERAL GRAZING POLICY IMPACTS ON TWO COLORADO COUNTIES: A COMPARATIVE STUDY

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ABSTRACT

Ranchers have concern over how federal policies such as the Endangered Species Act, the Clean Water Act, and other laws and regulations will affect the status of their ranching operations. The objectives of this study were to compare impacts of public forage losses on ranches in areas experiencing rapid growth (Routt County) and minimal growth (Moffat County) in Colorado. Thirty-five personal interviews obtained detailed cost-and-return information on public, leased, and private land. Enterprise budgets for seven distinct ranch averages were entered into a linear programming (LP) model to calculate impacts on ranches of public forage reductions of 25%, 50%, and 100%. Changes in net ranch returns and livestock production reflect the economic impact of policy changes. Grazing alternatives to hypothetical reductions in public grazing chosen by the ranchers were applied in the program to mimic rancher decisions. The study found, as would be expected, that larger ranches with more public forage dependency would be the most affected by public forage losses. Those with fewer sources of alternative forage, and ranches with low costs and high returns, experienced more difficulty in coping with the grazing reductions on public land. Routt County, with its higher dependence on public forage and minimal alternative forage sources, would be more affected by federal forage reductions than Moffat County.

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INTRODUCTION

As ranches are sold in some rapidly developing rural communities, the land becomes subdivided and converted to housing developments. In the face of this land-use conversion, many environmentalists and community members perceive ranching as protecting open space and wildlife habitat, and preserving cultural history and the integrity of their community. Yet, ranchers do not see urbanization as the sole threat to maintaining their ranches and way of life. Public policy also can threaten their livelihood. Federal policies such as the Endangered Species Act, the Clean Water Act, and changes in public land management priorities can affect public land ranchers by decreasing public grazing, requiring more stringent management and altered seasons of grazing, and increasing user costs through higher fees or costly management requirements.

Numerous studies have estimated the potential ranch-level impacts of changes in grazing policies (Bartlett et al. 1979, Cook et al. 1980, Gee 1981, Olson and Jackson 1975, Peryam and Olson 1975, Torell et al. 1980, Richardson et al. 1993), but none have focused on how reductions in public land ranching might be affected by existing pressures of rapid rural development. Public officials should know whether further federal policies will aggravate the exodus of ranchers, especially in rapidly growing areas where ranches are threatened. Policy makers lack critical information on potential economic impacts of their policies. Equally, concerned citizens need an educated and relevant basis for supporting or challenging new policies. Ranchers themselves lack knowledge of federal policy impacts and need to know the degree of their vulnerability to changes in grazing privileges. Ranchers require reliable information in order to make sound decisions for the future of their ranches.

OBJECTIVES

The objectives for this study were as follows: to investigate the impact on ranches of federal forage reductions of 25%, 50%, and 100%; to compare the different impacts of public forage reductions in a rapidly developing county versus a more traditional ranching community; and to assess the impact federal reductions would have on public ranch livestock production in the counties.

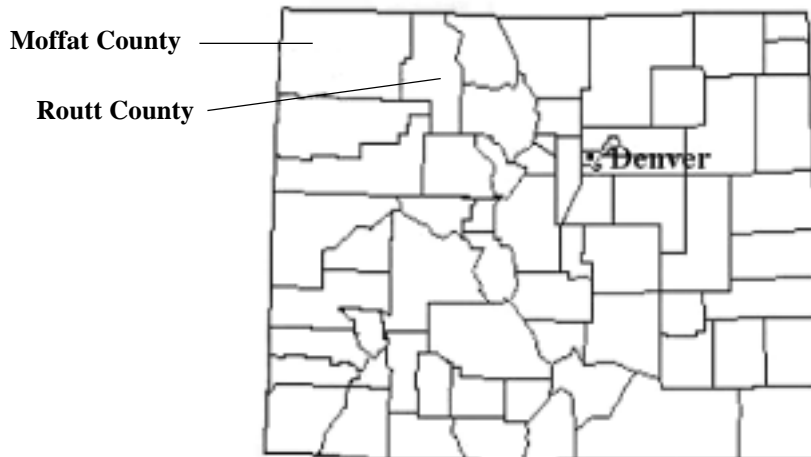
METHODS

Thirty-seven personal interviews with public land ranchers in the Colorado counties of Routt and Moffat were conducted. Ranchers were randomly selected from a compiled list of all federal land grazing permittees in the two counties.

Study Area

In order to compare the effects of urbanization, we chose two counties—one experiencing rapid development and the other a traditional agricultural county. Routt and Moffat counties, situated in the northwestern corner of Colorado, were selected for study based on their relative proximity, a shared cultural history, and because they both have significant ranching populations. Routt County comprises 1.5 million acres, and 49% of its land is either state or federally owned. Moffat has 3 million acres with 63% of that in public ownership (Frank 1997). In 1992, Routt County had 3.4% income dependence on agribusiness, and Moffat had 1.5% (CSU Department of Agriculture and Resource Economics 1995).

Map of Colorado



Recreationists flock to Routt County for outdoor pursuits, including skiing at the popular Steamboat Springs Ski Resort. The tourism industry in Routt County supports 147 related establishments for lodging, amusement/recreation, and eating/drinking. Moffat County has only 37 such businesses. Population growth in Routt has been double that in Moffat. Routt County had a growth rate of 18.3% between 1990 and 1997, while Moffat County increased by 8.9% (Yampa Valley Partners 1999). The overall cost of living also has risen disproportionately for the two counties according to a Colorado cost of living survey. This survey composed a numeric scale using one as the average for the state based on the costs for 59 goods. Routt County ranks highest in the “above average” category at 1.096, whereas Moffat falls into the “low” cost of living category at 0.870 (Garner and Eckert 1999). Property values in Routt County have leapt from \$291.2 million in 1993 to \$419.2 million in 1997. For the same years, Moffat County values increased from \$358.7 million to \$367 million (Yampa Valley Partners 1999). These county differences allow us to compare the effects of growth between rapidly developing Routt and traditional Moffat County.

Study Sample

A sampling frame of 242 federal permittees in the two counties was produced by compiling the Bureau of Land Management (BLM) and U.S. Forest Service (USFS) permittee lists and eliminating duplicate listings. The standard statistical equation for calculating sample size from a finite population derived a sample size of 26, using variation in non-fee grazing costs found in Redmond et al. (1992). Stratification by ranch size and location increased the desired sample size to 35. Every effort was made to interview each of the randomly selected ranchers, but replacements were used for those that refused, those who were not actively running

their ranches, or those who lived too far outside the counties. Thirty-seven personal interviews were completed, and, of those, 35 completed the information relevant to this study.

Stratifying the Sample

The sample was stratified to create sets of ranch budgets that, once compiled and averaged, could be used as representative budgets for different ranch sizes and livestock categories. To ensure that each stratum would statistically represent each ranch size, strata sample sizes were determined by multiplying stratum weight and sample size (Table 1). Each county initially also had a sheep-only stratum. Insufficient numbers of ranchers raise only sheep in these counties to collect data for a representative sample. Therefore, the sheep rancher surveys were combined with the cattle and sheep grouping, increasing the actual numbers of ranchers interviewed in these strata. A total of 13 ranchers in Routt County and 22 in Moffat County were surveyed. Critical data gaps in some surveys reduced useable surveys to 11 in Routt and 15 in Moffat (Table 1).

The Routt County sample included four ranchers that, although they hold permits in Routt County, live just across the border in Wyoming or Utah. Their responses may dilute the strength of comparison between impacts of forage reductions on rapidly developing versus traditional ranch economies. Each Routt County strata contains at least one out-of-state survey.

Survey and Analytical Instruments

Using contributions from Redmond et al. (1992) and SPA (McGrann et al. 1993), a detailed questionnaire was designed to elicit all costs associated with private, public, and leased land in livestock ranching. Budget categories included operating and ownership costs as well as gross receipts. These costs did not include hay enterprises and did not include

Table 1. Sample size for each ranch strata.

	Stratum							Totals
	Moffat I	Moffat II	Moffat III	Moffat IV	Routt I	Routt II	Routt III	
Livestock type	cattle	cattle	cattle	cattle/sheep	cattle	cattle	cattle/sheep	
Number of AUMs	>550	85–550	<85	all	>100	<100	all	
N_i^1	28	54	44	30	35	32	19	242 ²
W_i^3	0.1157	0.2231	0.1818	0.1240	0.1446	0.1322	0.0785	1
n_i^4	3	6	5	4	4	3	2	27
Ranches surveyed ⁵	4	6	5	7	4	4	5	35
Useable surveys ⁶	3	4	5	3	4	3	4	26

¹Population within each strata

²Population size is 156 in Moffat and 86 in Routt.

³ $N_i/N=W_i$ (weight of each strata) ($N=242$)

⁴ $n \times W_i = n_i$ ($n=26$)

⁵Number of ranch surveys completed

⁶Actual number of ranch surveys used in each strata

family living expenses such as the value of the family residence, personal electric and phone bills, etc.

Linear programming (LP) was used to create models for each representative ranch budget. The LP model calculated gross sales and net revenue based on cost and revenue inputs. Appendix A lists values entered into LP for each ranch model. The models calculated the impacts of 25%, 50%, and 100% reductions in federal forage use on each of the seven ranch budgets. The economic impact of the proposed policy change can be viewed in two ways: reduction in herd units and change in contribution margins. Herd units represent the livestock herd per cow; livestock numbers change proportionately to herd unit adjustments. Contribution margins equal gross returns less variable costs. This indicator does not account for fixed costs. Appendices B and C detail the amount of public, leased, and hay forage; the number of herd units, gross returns, and contribution margins for each reduction level; and adjustment strategies (reducing herd size or increasing alternative forages) for each stratum.

Interview responses indicated ranchers' preference to reduce their herd, lease more land, or increase hay production if faced with hypothetical public grazing reductions. These responses were used in the program to create two strategies to adjust to federal forage loss. With herd reductions, only public forage is reduced and all other forage sources remain the same. The LP models were used to estimate the new herd size that could be supported under such a scenario. In the models, livestock numbers are tied to the number of cows (herd units) by coefficients allowing a reduction in herd units to represent an overall reduction in the ranch herd. The second strategy, forage substitution, forces herd size to remain constant; the model substitutes for the diminished public forage with an increase in private leased land (up to a 25% increase) and purchased hay (Appendices B and C).

A forage budget for each model calculated the relative amounts of hay, grain, protein supplement, public, leased, and private forage required per cow from the survey data. These percentages were then used to set forage supplied equal to the livestock requirements. In reality, ranchers often do have extra forage available to buffer annual fluctuations and changes in available forage. This buffer would allow for more and cheaper flexibility than the hay reduction and forage substitution strategies permit, but our model and surveys could not estimate this surplus accurately.

LBUDGET, a computer budget program designed to calculate livestock cost-and-return estimates (Stodick et al. 1991), was used to calculate the variable costs for public, leased, and private land for the LP models. LBUDGET calculates repair and fuel costs for all machinery, equipment, and vehicles as well as depreciation costs and interest, and produces a complete ranch enterprise budget based on the defined cost assumptions.

RESULTS

This section explores how federal grazing reductions impact herd reduction and forage substitution. Expanding the ranch models to represent their strata and counties allowed a description of the overall impacts to the counties. Comparisons are made of how the two counties would be affected by decreased availability of federal forage.

Ranch Impacts from Federal Forage Reductions

Herd reduction

Two indicators can be used to show the impacts associated with federal grazing cuts: herd reductions and change in contribution margins. These indicators, however, give conflicting results. Ranch models with the greatest reductions in herd size (Moffat I and Routt III, Tables 2 and 3) do not necessarily have the greatest reductions in contribution margin. Thus, the indicators reflect different information about the ranch models. The percent decrease in herd size is directly proportional to the public forage decrease in each model. A combination of initial herd size and dependence on public lands affects the overall herd reductions (Fig. 1).

Contribution margins reflect public dependency and ranch size as affected by herd losses, but also account for the efficiency of the ranch. Less efficient ranches (higher variable costs and fewer sales) actually save money by reducing livestock numbers because costs currently exceed revenues. Efficiency plays a role in which ranchers are more impacted. A ranch that produces more sales at lower cost per AUM will effectively stand to lose more per AUM than a less efficient ranch.

Smaller ranches had greater variable costs per herd unit than the larger ranches (Fig. 2). However, the data suggests that overall losses in contribution margins are more correlated with efficiency than either ranch size or variable costs. The greater the contribution margins without any federal reductions, the greater the loss with 100% public forage reductions (Fig. 3). While these figures correlate, to some degree, with size of ranch, the two largest ranches have more moderate contribution margins and losses. Using herd size as an indicator of federal forage reduction impacts, larger ranches and ranches more dependent on public land will sustain higher reductions in livestock numbers. The contribution margin is more of an indicator of efficiency.

Forage substitution

Losses from federal grazing reductions with forage substitution can be assessed by contribution margin changes. Forage substitution left herd size intact, but made substitutions for public forage with leased forage and hay. Private leased land was increased by 25% and purchased hay was allowed to make up the balance of the animal requirements. Relative amounts of leased and public lands tended to make the most difference in how each ranch model was affected under this scenario. In three ranch models, the 25% increase

Table 2. Ranch losses from federal forage reductions.

Item reduced	Ranch model	Herd reductions ¹			Forage substitution ²		
		25%	50%	100%	25%	50%	100%
Change in contribution margin							
	Moffat I	-1,633	-3,257	-6,503	+2,925	-5,913	-23,590
	Moffat II	-340	-684	-1,368	-45	-1,326	-3,886
	Moffat III	+233	+466	+932	+799	+785	+756
	Moffat IV	-6,382	-12,763	-25,526	-7,784	-18,735	-40,637
	Ranch loss (weighted average)	-1,573	-3,145	-6,288	-763	-4,903	-13,183
	Routt I	-2,382	-4,765	-9,531	-3,892	-8,211	-16,849
	Routt II	+1,494	+2,988	+5,975	-932	-1,911	-3,868
	Routt III	-333	-651	-4,219	-20,187	-45,125	-106,999
	Ranch loss (weighted average)	-487	-971	-2,588	-6,391	-14,023	-31,937
Reduction in livestock numbers (in herd units)							
	Moffat I	19.24	38.51	77.05			
	Moffat II	2.76	5.51	11.03			
	Moffat III	0.51	1.02	2.03			
	Moffat IV	10.47	20.93	41.86			
	Ranch loss (weighted average)	6.58	13.16	26.26			
	Routt I	11.34	22.69	45.37			
	Routt II	1.78	4.16	8.33			
	Routt III	42.95	85.93	188.47			
	Ranch loss (weighted average)	14.78	29.78	63.19			

¹Reduce livestock numbers in response to federal forage reductions.

²Increase available leased private forage by 25% and allow infinite amount of hay purchase in response to federal forage reductions.

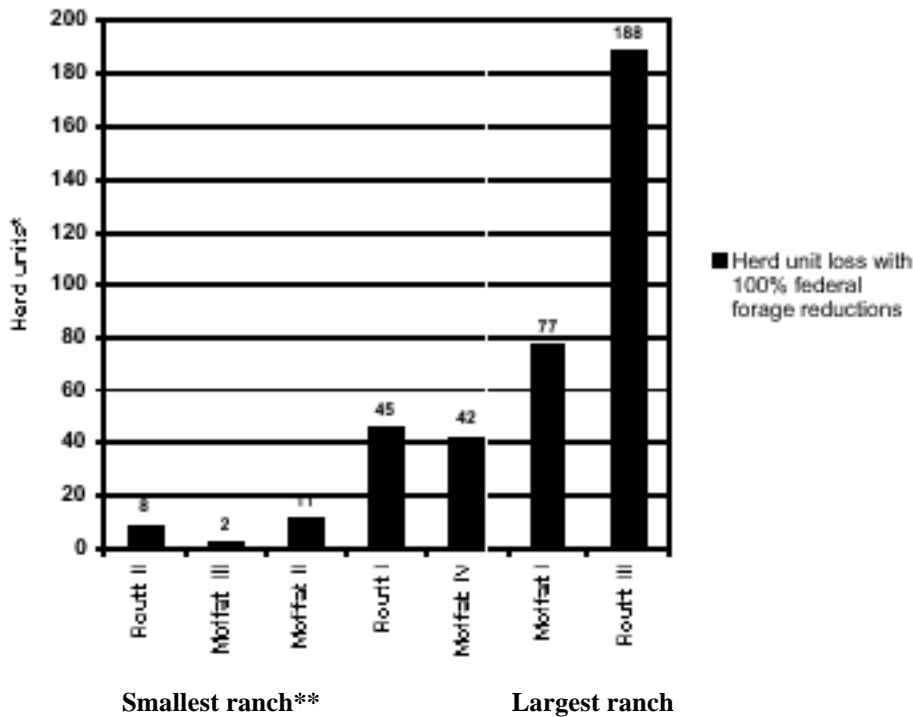
Table 3. Ranch losses from federal forage reductions per reduced AUM.

Item reduced	Ranch model	Herd reductions ¹			Forage substitution ²		
		25%	50%	100%	25%	50%	100%
Change in contribution margin per AUM							
	Moffat I	-4.42	-4.40	-4.40	+7.91	-8.00	-15.95
	Moffat II	-6.46	-6.50	-6.50	-0.85	-12.59	-18.45
	Moffat III	+27.49	+27.49	+27.49	+94.28	+46.31	+22.30
	Moffat IV	-39.69	-39.69	-39.69	-63.19	-58.26	-63.19
	Routt I	-13.67	-13.67	-13.67	-22.33	-23.56	-24.10
	Routt II	+36.35	+36.35	+36.35	-22.68	-23.25	-23.50
	Routt III	-0.28	-0.28	-0.88	-16.90	-18.89	-22.40
Reduction in livestock numbers (in herd units/AUM)							
	Moffat I	0.052	0.052	0.052			
	Moffat II	0.052	0.052	0.052			
	Moffat III	0.060	0.060	0.060			
	Moffat IV	0.065	0.065	0.065			
	Routt I	0.065	0.065	0.065			
	Routt II	0.043	0.051	0.051			
	Routt III	0.036	0.036	0.039			

¹Reduce livestock numbers in response to federal forage reductions.

²Increase available leased private forage by 25% and allow infinite amount of hay purchase in response to federal forage reductions.

Figure 1. Herd reductions for ranch models under a 100% reduction in federal forage.



*Herd units represent livestock herd per cow; livestock numbers change proportionately to herd unit adjustments.

**The total number of AUMs of the ranch defines size of ranch. Model ranches represent the following number of AUMs on public land: Routt II, <100; Moffat III, <85; Moffat II, 85-550; Routt I, >100; Moffat IV, cattle and sheep, sheep only; Moffat I, >550; Routt III, cattle and sheep, sheep only.

in leased land adequately compensated for a 25% loss in public forage because the forage from leased land was equal to or greater than the forage from public land (Moffat I, II, and III, Tables 2, 3, and 4). However, at a 50% federal forage reduction, the 25% increase in leased land could no longer cover the loss of forage. In the other models (Moffat IV and Routt I, II, and III), the amount of public land forage is greater than the amount of leased land forage (Table 3), resulting in greater reliance on purchased hay at higher costs. In situations in which leased land can compensate for federal forage loss, the impacts are less by increasing forage substitution than they are by reducing herd size, especially in Moffat I and III, where the lease overcompensates for the loss of public forage and reduces hay requirements, saving the ranch money (Tables 2 and 3). However, once hay is needed to compensate for public forage losses, reducing herd size clearly becomes the more cost-effective solution (Tables 2 and 3).

Regional Impacts from Federal Forage Reductions

County Impacts

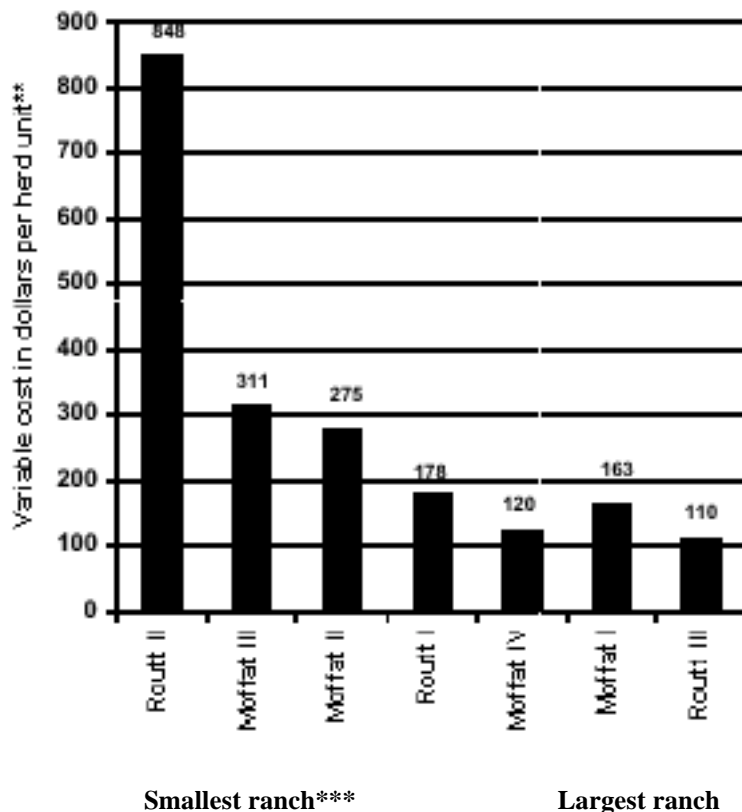
Each model was constructed to represent a number of ranches within the respective counties. In order to show the impacts to the counties, or to ranches of a certain size within

a given county, ranch models are multiplied by the number of ranches they represent (Table 5). In doing so, we find that public land ranchers in the two counties, taken together, would lose \$1,203,274 and reduce their herd sizes by 9,534 herd units with a total elimination in federal forage. If these ranchers chose to maintain herd sizes, increase leases by 25%, and feed hay to account for the elimination of public forage, the two counties' public ranchers would sustain a loss of \$4,802,682. These hypothetical losses can be compared with the market value of livestock, poultry, and their products sold in 1997 totaling \$19,348,000 in Routt County and \$16,024,000 in Moffat County (Colorado Department of Agriculture 1997).

Differences Between Routt and Moffat Counties

The authors predicted that Routt County development pressures would aggravate the effect of the federal forage cuts, causing the Routt County ranchers to incur more loss than the Moffat ranchers. Indeed, looking at the countywide impact of federal forage reductions on herd size, Routt County is more affected by each level of reduction (Table 5). As noted above, public land dependency and ranch size seem to determine the severity of forage reduction impacts. Both factors, as well as efficiency, may be related to development

Figure 2. Variable costs per herd unit for ranch models.



*Herd units represent livestock herd per cow; livestock numbers change proportionately to herd unit adjustments.

**Variable costs on private land per herd unit are calculated as follows from figures in Appendix A:

$$\frac{(\text{Total variable costs} - \text{costs specifically incurred on leased or public land})}{\text{number of cows} + \frac{(\text{number of sheep})}{5}}$$

***The total number of AUMs of the ranch defines size of ranch. Model ranches represent the following number of AUMs on public land: Routt II, <100; Moffat III, <85; Moffat II, 550-85; Routt I, >100; Moffat IV, cattle and sheep, sheep only; Moffat I, >550; Routt III, cattle and sheep, sheep only.

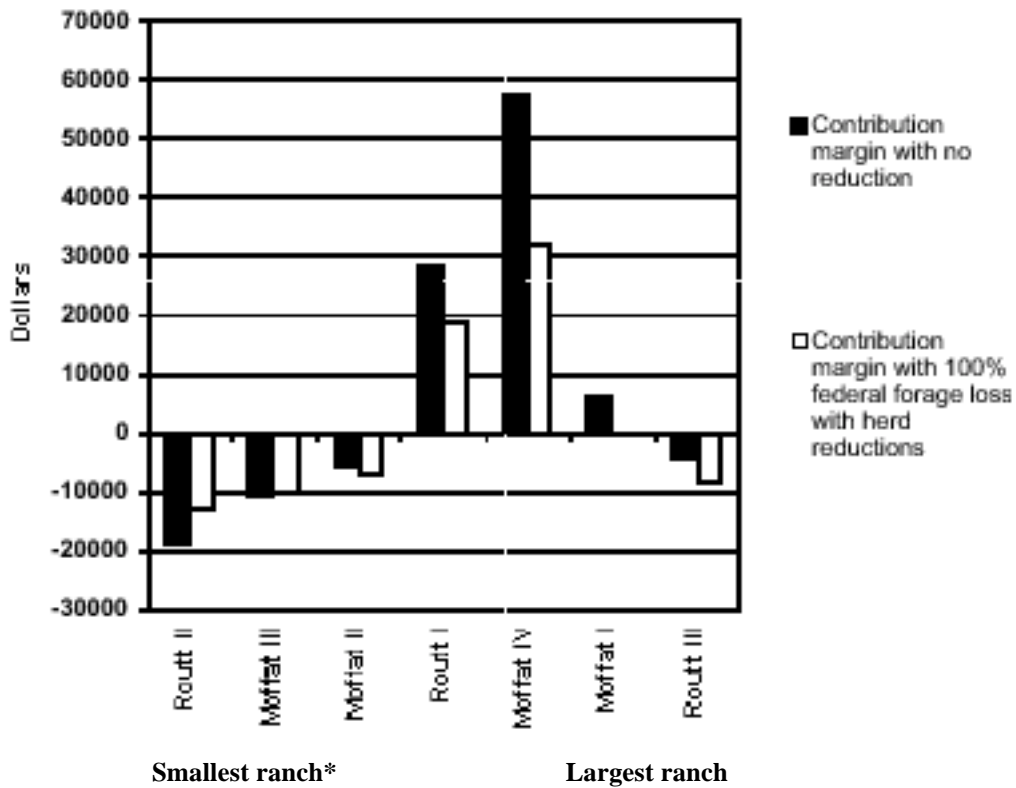
pressures decreasing land availability and increasing costs. Routt County public land ranchers use public land for 34% of their total forage requirements, compared with 19% in Moffat County. Routt County, though smaller in total forage requirements (426,158 AUMs for Moffat and 313,468 AUMs for Routt), has the largest ranch model in the study (Routt III). Routt III heavily contributes to overall herd reductions for the county (Fig. 1).

Moffat County ranchers sustain greater losses than Routt County ranchers under herd reductions using contribution margins as the indicator (Table 5). Differences in efficiency can explain the discrepancy. As mentioned earlier, ranches with higher costs and lower sales (lower efficiency) sustain either savings or less loss in contribution margin as federal forage and herd size are reduced. In Routt County, the weighted contribution margin, before any reductions, is \$309,913 compared with \$1,100,942 in Moffat County. Individual ranch models show correlation between efficiency and

reductions in contribution margin (Fig. 3). Routt County ranch models tend to be less efficient than Moffat County ranches. Smaller contribution margin losses for Routt County with federal forage and herd reductions reflect this inefficiency.

With the forage substitution strategy, contribution margins fell more in Routt County than in Moffat County because of their relative amount of leased land holdings (Table 5). Moffat County ranchers rely much more on leased land than Routt County ranchers (Table 4). Routt County ranch models only use leased land for 2% of forage needs. A 25% increase in leased land barely compensates for any reduction in public forage, which comprises 34% of the forage resource. Moffat County, by contrast, relies on public forage and leased forage for 19% and 19%, respectively, making the substitution of leased forage for public forage more effective at deterring impacts. Even after the 25% lease forage use increase, Moffat

Figure 3. Comparing efficiency through contribution margins with reductions in livestock numbers in response to an elimination of federal forage.



*The total number of AUMs of the ranch defines size of ranch. Model ranches represent the following number of AUMs on public land: Routt II, <100; Moffat III, <85; Moffat II, 550-85; Routt I, >100; Moffat IV, cattle and sheep, sheep only; Moffat I, >550; Routt III, cattle and sheep, sheep only.

Table 4. Distribution of forage resources for the ranch models.

Ranch model	----- Percent of AUMs of each forage type -----			
	public	leased	private	hay
Moffat I	27	37	18	18
Moffat II	14	14	23	49
Moffat III	3	18	50	29
Moffat IV	38	14	35	13
Weighted average for Moffat	19	19	32	31
Routt I	17	3	42	37
Routt II	38	2	22	38
Routt III	57	2	28	13
Weighted average for Routt	34	2	31	32

Table 5. County impacts in rangeland livestock production from federal forage reductions.

Item reduced	Ranch model	Herd reductions ¹			Forage substitution ²		
		25%	50%	100%	25%	50%	100%
Strata change in contribution margin							
	Moffat I (represents 28 ranches)	-45,724	-91,196	-182,084	+81,900	-165,564	-660,520
	Moffat II (represents 54 ranches)	-18,360	-36,936	-73,872	-2,430	-71,604	-209,844
	Moffat III (represents 44 ranches)	+10,252	+20,504	+41,008	+35,156	+34,540	+33,264
	Moffat IV (represents 30 ranches)	-191,460	-382,890	-765,780	-233,520	-562,050	-1,219,110
Moffat County							
	loss of contribution margin	-245,292	-490,518	-980,728	-118,894	-764,678	-2,056,210
	Routt I (represents 35 ranches)	-83,370	-166,775	-333,585	-136,220	-287,385	-589,715
	Routt II (represents 32 ranches)	+47,808	+95,616	+191,200	-29,824	-61,152	-123,776
	Routt III (represents 19 ranches)	-6,327	-12,369	-80,161	-383,553	-857,375	-2,032,981
Routt County							
	loss of contribution margin	-41,889	-83,528	-222,546	-549,597	-1,205,912	-2,746,472
	Two-county loss of contribution margin	-287,181	-574,046	-1,203,274	-668,491	-1,970,590	-4,802,682
Strata herd unit reductions³							
	Moffat I (represents 28 ranches)	539	1,078	2,157			
	Moffat II (represents 54 ranches)	149	298	596			
	Moffat III (represents 44 ranches)	22	45	89			
	Moffat IV (represents 30 ranches)	314	628	1,256			
	Moffat County herd unit reductions	1,024	2,049	4,098			
	Routt I (represents 35 ranches)	397	794	1,588			
	Routt II (represents 32 ranches)	57	133	267			
	Routt III (represents 19 ranches)	816	1,633	3,581			
	Routt County herd unit reductions	1,270	2,560	5,436			
	Two-county herd unit reductions	2,294	4,609	9,534			

¹Reduce livestock numbers in response to federal forage reductions.

²Increase available leased forage by 25% and allow infinite amount of hay purchase in response to federal forage reductions.

³Herd size changes proportionately to herd unit reductions

County continues to fare better than Routt County due to its lower dependence on public lands.

DISCUSSION

Public forage reductions, depending on the indicator used, disproportionately impact ranches with greater forage needs, higher public forage dependency, better efficiency, and no cost-effective forage substitutes. Ranches in the rapidly developing county experience more adverse changes than those in a more traditional rural county.

Where leased land is available, even at rates as high as \$15.50 per AUM, leasing can be the least-cost alternative. However, ranchers in the survey indicated that leased land is severely limited, perhaps rendering this an unrealistic alternative.

Buying hay to compensate for reductions is far more expensive than reducing livestock numbers. The ranch models developed in this study did not include hay production costs, but instead calculated costs of purchased hay based on

average market prices (Colorado Department of Agriculture 1999). In reality, the majority of ranchers produce much of their own hay and supplement by buying hay. But while the market prices from the Colorado Department of Agriculture may overestimate the actual cost of production, the reality remains that whether ranchers produce their own hay or buy from other ranchers, hay is an expensive replacement for rangeland forage.

Other options exist for supplementing income on or off the ranch that might help buffer public forage loss, but these alternatives did not garner either recognition or enthusiasm from the ranchers at the time of this study.

The small ranch models in both counties (Routt II and Moffat III) actually increased their contribution margins with decreases in grazing. These models are representative of the hobby ranchers described by Smith and Martin (1972) and Tanaka and Gentner (2001). Rather than working the ranch for profit, hobbyists enter into ranching for the way of life. Fully cognizant of their unprofitable venture, some of these

ranchers mentioned in interviews that they work outside jobs in order to support their ranching hobby.

Ranchers in Routt County depend heavily on public land, causing these ranchers increased herd losses with public land reductions. Further, with fewer leased resources, Routt County ranchers have less buffering capacity if faced with changes in forage resources. Minimal use of leased land and heavy dependence on public land forage may reflect declining availability of leases due to land development pressures in Routt County.

It appears that Routt County ranchers are less efficient than Moffat County ranchers. Higher costs may reflect the increased costs of living seen in Routt County (Garner and Eckert 1999). Their higher costs also may be associated with the "hobby rancher" attitude that ranching is a pastime and way of life rather than a primary income source. Hobby ranches are characterized by their smaller size and decreased efficiency. Routt County appears to have a higher prevalence of such ranches; 38% of ranches in Routt County have less than 100 AUMs of allotted public grazing as compared to only 30% in Moffat County. This difference may result from the changing pressures found in Routt County. In Routt County, lower efficiency buffers the impact of federal forage reductions.

If policy objectives seek to preserve large tracts of agricultural land, policy makers should take notice of the disproportionate impact federal forage reductions would place on large ranches over their smaller counterparts (Fig. 3). Smaller ranches have higher variable costs (Fig. 2) and tend to operate at a loss (Moffat II and III, and Routt II and III, Appendices B and C). Thus, public grazing reductions, and a resulting decline in size, may put large ranch owners at risk of losing their businesses and selling part or all of their land. Further, using the strata to estimate impacts to counties as a whole, it is obvious that the two-county region would be greatly impacted with losses of over a million dollars with cuts in livestock of 9,534 herd units given 100% public grazing and herd reductions (Table 5).

This economic study attempted to gauge how policy changes would impact ranches through linear programming models. Although this information helps explain how certain types of ranchers can be differentially impacted depending on efficiency, size, distribution of forage resources, and the development influences of the county, it falls short of predicting whether the ranchers can stay in business. Torell et al. (2001) argue that, since ranchers are motivated by quality of life and not profit, they will not be likely to leave ranching until they are forced to. In order to capture the point at which a rancher would be financially "forced" to leave, economic models should include non-ranch resources such as off-ranch income, wealth, and debt load (Torell et al. 2001). In addition, the model should distinguish between traditional ranchers and hobby ranchers. Federal policy changes may cause few, if any, changes for the hobby rancher. Future studies must

allow for this distinction, as the composition of the livestock industry is changing along with public land policies.

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Appendix A. Table 1. Number of cattle per ranch model.

Cattle type	Moffat I- large cattle ranches (>550 AUMs)	Moffat II- medium cattle ranches (85-550 AUMs)	Moffat III- small cattle ranches (<85 AUMs)	Moffat IV- cattle and sheep ranches	Rout I- large cattle ranches (>100 AUMs)	Rout II- small cattle ranches (<100 AUMs)	Rout III- cattle and sheep ranches
Cows (herd unit ¹)	291.34	76.75	64.8	109.34	263.5	21.67	346.5 ⁵
Cows with calves	275.6	74	64.2	94.33	218	19.67	182.5
Steer calves	138.6	38.75	33.4	53.33	111.25	9.67	90.5
Heifer calves	137	35.25	30.8	41	130.25	10	92
Retained heifer/steer calves	150.67	41	18	32	36	10.67	14.5
Cow/calf pairs sold	0	0	0	0	48.75 ³	0	0
Cull cows	26.67	4.25	5.2	10.67	14.25	2.67	4.5
Bred cows purchased	0	0	1	0	0	0	155
Calves purchased	0	0	0.2	0	0	0	0
Cow/calf pairs purchased	0	0	0	0	0	1.67	0
Bulls	24	3.5	4.6	6.33	17.75	4	11.25
Horses	8.33	4	3.2	13.33	9.75	5.33	10.5
Steer stockers purchased	181	0	0	0	116.75 ⁴	0	0
Heifer stockers purchased	0	0	0	0	6.25 ⁴	0	0
Steer stockers sold	181	0	0	0	115.75	0	0
Heifer stockers sold	0	0	0	0	6.25	0	0
Steer yearlings sold ²	76	44.33	8	0	1.5	0	0
Heifer yearlings sold ²	0	2.25	0	0	8.75	0	1.5
Steer yearlings unsold	0	2.5	2	15.33	2.5	0	0
Heifer yearlings unsold	1.33	1.75	1	0	12.5	0	8.5
Heifer calves sold	56.33	25.50	18.2	19	70.75	2	77.5
Steer calves sold	68.67	7.5	28	43.33	111.25	7	90.5
Cull bulls	1.33	0.25	0.4	1.33	5.25	3.33	0.5
Replacement bulls	3	0	1.2	1.67	3.25	0.33	5
Cull horses	0	0.25	0	1.33	1	1	0.25
Replacement horses	0	0.5	0.4	0.33	0	0.33	0.75

¹Herd unit refers to the number of cows, which is tied to herd size. As the herd unit is reduced, each livestock type is reduced proportionately.

²Does not include stockers.

³Sold mid-March.

⁴Purchased in June.

⁵Ratios of livestock to the number of cows are based on 187.5 head of cattle in the model, as that was the number for 1998, the year surveyed. However, the model uses 346.5 head to represent the productive capacity of the ranch.

Appendix A. Table 2. Forage resources and costs per ranch model.

Cattle type	Moffat I- large cattle ranches (>550 AUMs)	Moffat II- medium cattle ranches (85-550 AUMs)	Moffat III- small cattle ranches (<85 AUMs)	Moffat IV- cattle and sheep ranches	Routt I- large cattle ranches (>100 AUMs)	Routt II- small cattle ranches (<100 AUMs)	Routt III- cattle and sheep ranches
Variable private land cost per cow ¹ per ewe ²	162.62	275.08	327.47	314.29	177.68	847.57	168.9 2.21
Private lease rate ³	7.44	3.81	14.88	7.09	8.47 ²⁵	7.63	6.11
Variable lease costs/AUM ⁴	1.72	3.97	0.63	5.19	11.16	3.40	7.52
Total lease rate ⁵	9.16	7.78	15.51	12.28	19.63	11.03	13.63
Public lease rate ⁶	1.35	1.35	1.35	1.35	1.35	1.35	1.35
Variable public costs/AUM ⁷	6.73	6.31	28.93	4.92	5.85	6.82	4.73
Total public rate ⁸	8.08	7.66	30.28	6.27	7.20	8.17	6.08
Forage (AUMs):							
US Park Service Season 2 ⁹	83.18	0	0	0	0	0	0
Public total	1,479.08	210.58	33.9	1,703.65	697.09	164.38	4,777.51
BLM total	1,479.08	210.58	33.9	1,307.67	137.91	164.38	4,240.41
Season 1 ¹⁰	63.54	13.77	0.92	735.98	0	51.36	2,178.5
Season 2 ⁹	291.58	75.56	6.28	382.61	39.41	24.88	404.32
Season 3 ¹¹	631.95	114.40	24.86	49.26	98.5	74.78	411.26
Season 4 ¹²	492.01	6.85	1.84	139.82	0	13.36	1,246.33
USFS							
Season 2 ⁹	0	0	0	0	74.88	0	0
Season 3 ¹¹	0	0	0	395.98	484.3	0	537.10
Private lease total	2,064.92	204.2	197.48	643.13	137.91	8.75	171.23
Season 1 ¹⁰	29,821 ¹⁸	0 ²⁰	19,052 ²²	0	0	0	0 ²⁸
Season 2 ⁹	562.39	91.68	48.29	87.48	39.41	0	56.77
Season 3 ¹¹	1,252.42	111.72	117.85	555.65	98.5	8.75	114.46
Season 4 ¹²	220.29	0.8	12.29	0	0	0	0
Private land total	990.33	338.43	541.5	1,539.16	1,716.05	92.37	2,357.09
Season 1 ¹⁰	55,521 ¹⁹	0 ²¹	89,852 ²³	305,272 ²⁴	83,652 ²⁶	0 ²⁷	0 ²⁹
Season 2 ⁹	171.27	31.21	126.05	271.32	578	35.2	430.08
Season 3 ¹¹	398.43	201.24	255.63	802.47	765.31	43.44	1,668.32
Season 4 ¹²	365.11	105.98	69.97	160.10	289.09	13.73	258.69
Other forage:							
hay (tons)	419.61	301.06	138.71	247.35	665.62	65.62	471
protein (tons) ¹³	11.01	2.4	0.2	1.44	4.81	0	0
grain (bushel) ¹⁴	26.68	682.6	4.47	189.42	44.12	318.38	272.24
hay (AUMs) ¹⁵	931.53	668.35	307.94	549.12	1,477.68	145.68	1,045.62

Appendix A. Table 2. Forage resources and costs per ranch model (con't).

protein (AUMs) ¹⁶	40.49	8.83	0.736	5.3	17.69	0	0
grain (AUMs) ¹⁷	1.39	35.5	0.232	9.85	2.29	16.56	14.16
Total AUMs	973.41	712.68	308.91	564.27	1,497.66	162.24	1,059.78

¹Calculated through LBUDGET, subtracting out public and leased variable costs and dividing by the number of cows per strata.

²Shear cost.

³Average cost of strata leases divided by total leased land AUMs.

⁴Total variable costs associated with leased land from surveys divided by total leased land AUMs.

⁵Sum of lease rate and cost per AUM, as entered in the model.

⁶Current public grazing fees per AUM.

⁷Total variable costs associated with public land from surveys divided by total public land AUMs.

⁸Sum of public lease rate and cost per AUM, as entered in the model.

⁹May, June.

¹⁰February, March, April for Moffat I; December, January, February, March, April for all other ranch models.

¹¹July, August, September, October.

¹²November, December, January for Moffat I; November for all other ranch models.

¹³Soybean meal.

¹⁴Oats and rye.

¹⁵AUMs/ton are calculated by multiplying tons of hay by 2.22.

¹⁶AUMs/ton are calculated by multiplying tons of protein by 3.678.

¹⁷AUMs/bu. are calculated by multiplying bushels of grain by 0.052.

¹⁸Cut from 392.65 AUMs to adjust for feeding hay, grain, and protein at this time.

¹⁹Cut from 729.35 AUMs to adjust for feeding hay, grain, and protein at this time.

²⁰Cut from 509 AUMs to partially adjust for feeding hay, grain, and protein at this time.

²¹Cut from 25.19 AUMs to partially adjust for feeding hay, grain, and protein at this time.

²²Cut from 71.47 AUMs to adjust for feeding hay, grain, and protein at this time.

²³Cut from 336.97 AUMs to adjust for feeding hay, grain, and protein at this time.

²⁴Cut from 933.96 AUMs to adjust for feeding hay, grain, and protein at this time.

²⁵Calculated by average of leased cost per AUM in order to reduce impact of outlier figure.

²⁶Cut from 1674.85 AUMs to adjust for feeding hay, grain, and protein at this time.

²⁷Cut from 98.78 AUMs to partially adjust for feeding hay, grain, and protein at this time.

²⁸Cut from 30.40 AUMs to partially adjust for feeding hay, grain, and protein at this time.

²⁹Cut from 706.81 AUMs to partially adjust for feeding hay, grain, and protein at this time.

Appendix A. Table 3. Number of sheep per ranch model.

Sheep type	Moffat III- small cattle ranches (<85 AUMs)	Moffat IV-cattle and sheep ranches	Routt III-cattle and sheep ranches
Ewes	11.4	896	934.25
Rams	1.1	28.33	25.75
Lambs	14.4	927.67	900
Stockers purchased	0	408.67	0
Stockers sold	0	402.33	0
Rams sold	0	0	2.75
Rams purchased	0	3.33	0.25
Lambs sold	12	797.67	786.25
Lambs retained	2.4	130	113.75
Wool/ewe (lbs.)	5.56	10	12.8

Appendix B. Effects of federal forage reductions on Moffat County ranch models.

Ranch model	Item reduced Herd reductions ² Forage substitution ³		
		0% ¹	25%	50%	100%	25%	50%	100%
Moffat I (>550 AUMs):								
	Herd unit	291.34	272.1	252.83	214.29	291.34	291.34	291.34
	Public forage (AUMs)	1,479	1,109	740	0	1,109	740	0
	Private lease (AUMs)	2,065	2,065	2,065	2,065	2,581	2,581	2,581
	Other forage: hay (AUMs)	420	420	420	420	356	528	853
	Gross returns	204,283	190,790	177,279	150,257	204,283	204,283	204,283
	Contribution margin ⁴	6,111	4,478	2,854	-392	9,036	198	-17,479
	% change in contribution margin⁵	—	-27	-53	-106	+48	-97	-386
Moffat II (550-85 AUMs):								
	Herd unit	76.75	73.99	71.24	65.72	76.75	76.75	76.75
	Public forage (AUMs)	211	158	106	0	158	106	0
	Private lease (AUMs)	204	204	204	204	255	255	255
	Other forage: hay (AUMs)	301	301	301	301	302	325	373
	Gross returns	42,927	41,384	39,844	36,761	42,927	42,927	42,927
	Contribution margin	-5,914	-6,254	-6,598	-7,282	-5,959	-7,240	-9,800
	% change in contribution margin	—	-6	-12	-23	-0.8	-22	-66
Moffat III (<85 AUMs):								
	Herd unit	64.8	64.29	63.78	62.77	64.8	64.8	64.8
	Public forage (AUMs)	34	26	17	0	26	17	0
	Private lease (AUMs)	197	197	197	197	246	246	246
	Other forage: hay (AUMs)	139	139	139	139	120	124	132
	Gross returns	27,280	27,066	26,852	26,425	27,280	27,280	27,280
	Contribution margin	-10,955	-10,722	-10,489	-10,023	-10,156	-10,170	-10,199
	% change in contribution margin	—	+2.1	+4.3	+8.5	+7.3	+7.2	+6.9
Moffat IV (all):								
	Herd unit	109.34	98.87	88.41	67.48	109.34	109.34	109.34
	Public forage (AUMs)	1,704	1,278	852	0	1,278	852	0
	Private lease (AUMs)	643	643	643	643	804	804	804
	Other forage: hay (AUMs)	247	247	247	247	367	559	942
	Gross returns	169,795	153,544	167,294	104,790	169,795	169,795	169,795
	Contribution margin	57,707	51,325	44,944	32,181	49,923	38,972	17,070
	% change in contribution margin	—	-11	-22	-44	-13	-32	-70

¹Percentages refer to levels of federal forage reductions.

²Reduce livestock numbers in response to federal forage reductions.

³Increase available leased forage by 25% and allow infinite amount of hay in response to federal forage reductions.

⁴Returns less variable costs.

⁵(Contribution margin at reduction – Contribution margin w/ no reduction) /contribution margin w/ no reduction.

Appendix C. Effects of federal forage reductions on Routt County ranch models.

Ranch model	Item reduced	Herd reductions ²				Forage substitution ³		
		0% ¹	25%	50%	100%	25%	50%	100%
Routt I (>100 AUMs):								
	Herd unit	263.5	252.16	240.81	218.13	263.5	263.5	263.5
	Public forage (AUMs)	697	523	349	0	523	349	0
	Private lease (AUMs)	138	138	138	138	173	173	173
	Other forage: hay (AUMs)	666	666	666	666	728	807	964.09
	Gross returns	191,851	183,593	175,334	158,819	191,851	191,851	191,851
	Contribution margin ⁴	28,459	26,077	23,694	18,928	24,567	20,248	11,610
	% change in contribution margin⁵	—	-8	-17	-33	-14	-29	-59
Routt II (<100 AUMs):								
	Herd unit	21.67	19.89	17.51	13.34	21.67	21.67	21.67
	Public forage (AUMs)	164	123	82	0	123	123	123
	Private lease (AUMs)	9	9	9	9	11	11	11
	Other forage: hay (AUMs)	66	66	66	66	83.14	101.65	138.68
	Gross returns	8,437	7,627	6,816	5,195	8,437	8,437	8,437
	Contribution margin	-18,901	-17,407	-15,913	-12,926	-19,833	-20,812	-22,769
	% change in contribution margin	—	+8	+16	+32	-5	-10	-20
Routt III (all):								
	Herd unit	346.5	303.55	260.57	158.03	346.5	346.5	346.5
	Public forage (AUMs)	4,778	3,583	2,389	0	3,583	2,389	0
	Private lease (AUMs)	171	171	171	171	214	214	214
	Other forage: hay (AUMs)	471	471	471	471	848	1,303	2,412
	Gross returns	293,218	256,872	220,502	133,729	293,218	293,218	293,218
	Contribution margin	-4,280	-4,613	-4,931	-8,499	-24,467	-49,405	-111,279
	% change in contribution margin	—	-8	-15	-99	-472	-1,054	-2,500

¹Percentages refer to levels of federal forage reductions.

²Reduce livestock numbers in response to federal forage reductions.

³Increase available leased forage by 25% and allow infinite amount of hay in response to federal forage reductions.

⁴Returns less variable costs.

⁵(Contribution margin at reduction – Contribution margin w/ no reduction) /contribution margin w/ no reduction.