Alternative Public Land Management Policy Impacts: Ranch and County Level

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Abstract

A dynamic Monte Carlo linear programming model of a cattle ranch in Elko County, Nevada, provided a range of assets under management (AUM) valuations under alternative reductions in public land grazing permits. Employing these ranch level results into a county level input-output model, we derived a range of county economic, employment, and household income impacts for alternative public land policies. Estimation as to possible ranges in AUM valuations and county level economic impacts provides information to policy makers not only during periods of average economic condition but also under unfavorable economic conditions. Here Manski's credible interval scoring was employed for policy analysis.

INTRODUCTION

Almost one-third of total U.S. acreage is administered by the federal government. Of total federal land acreage, approximately 92.4% in 2015 was located in the 13 western states. Not only are most public lands located in the West, the federal government is also the dominant landowner of these lands (Table 1). Because of this vast public land management of the western lands, the federal government plays an important role in economic activity of rural western states' economies.

For the state of Nevada, approximately 83% of the total land area was federal land in 2018 (Table 2). A much smaller percentage, only 0.37%, was state lands. Over 85% of total county land acreage is under federal ownership in the Nevada counties of Nye, Esmeralda, Lander, Lincoln, and White Pine. Figure 1 shows the public lands within the state of Nevada. These seven Nevada counties have 54.87% of all federally owned land and make up 49.64% of the state's total land acreage (U.S. Census Bureau, 2022). Within the seven-county area in 2021, the metropolitan city of Las Vegas is located within Clark County. Clark County's population has 72.86% of the state's total population. Adding the six other rural counties, this seven-county area has 74.20% of the state's total population (U.S. Census Bureau, 2022). Elko County, Nevada, is in northeastern Nevada and has 74% of its land under federal administration.

Over the past few decades, rural residents have often come into conflict with urban residents, resource managers, and public lands stakeholders over perceived acceptable land uses. Many diverse users actively utilize these lands for both recreational and commercial activities such as fishing, camping, hiking, hunting, boating, grazing, logging, and mining. Many times, the multi-use nature of these activities includes overlap, and sometimes conflict, between them. Importantly, the landscapes also provide

critical ecosystem services related to water quality, air quality, and wildlife habitat along with a host of other functions.

One of the most sensitive resource management topics in these landscapes has been the reduction of animal units in public lands grazing (Pearce et al., 1999). Federal resource managers are faced with multiple objectives with multiple use lands. On one hand, they are required to keep multiple use federal lands within environmentally acceptable limits. Some interest groups also advocate for removal of livestock from public lands because they define grazing of public lands as an adverse and unnecessary use of western landscapes. On the other hand, there are families and communities in the West whose livelihoods depend on livestock grazing in public lands, with livestock production remaining as a core sector of commerce.

Many rural counties have strong ties to the livestock industry, which help to provide economic stability and a rural lifestyle to their families (Pearce et al., 1999; Boyd, Beck, and Tanaka, 2014; Davies, Bates, and Boyd, 2016). Although numerous western rural county economies continue to diversify, the livestock industry provides not only economic stability for many communities (Boyd, Beck, and Tanaka, 2014) but also ecological and landscape functions to manage increased wildfire risk (Davies et al., 2016).

The Bureau of Land Management (BLM), U.S. Forest Service (USFS), and National Park Service (NPS) policy decisions in recent decades have resulted in a consistent downward trend in the amount of alteration of the planned grazing in the West (Pearce et al., 1999). These previous and ongoing grazing reductions have impacted livestock operations, associated rural economies, and rural communities' social cohesion.

Public land management policies are often completed by using average values of key decision variables. This type of policy evaluation under certainty assumptions has been criticized by many, such as Manski (2013). Manski would argue that constructing and analyzing public policies such as public land management policies under a deterministic framework often ignores economic, social, and climate variabilities. He would classify deterministic modeling as "incredible certitude" analysis providing only a point estimate of key output variable such as net present value (NPV) or value of an animal unit month (AUM). However, "credible interval scoring" provides a probability distribution of key output variables, which is necessary for effective and efficient public land management policy analysis (Pouliquen, 1970; Reutlinger, 1970; Hardaker et al., 2004). Pouliquen states that the benefits of Monte Carlo modeling are that it provides decision-makers the extreme values of key operating variables and their relative probabilities along with a weighted estimate of the relationships between unfavorable and favorable outcomes. In addition to risk analysis and how variabilities in output and input prices could affect business operations, Pouliquen would suggest that Monte Carlo analysis could be used to analyze alternative public land management policies. In addition, results of a ranch level Monte Carlo model can be coupled with a county input-output model to derive countywide impacts from changes in public land management policies.

In this paper, the economic impacts of reducing grazing permits on a livestock-dependent county that relies heavily on public lands for seasonal grazing will be estimated. A multi-period Monte Carlo linear programming model will be employed to derive ranch level impacts from alternative grazing permit scenarios. From results of the multi-period Monte Carlo linear programming model and the county input-output model, countywide impacts such as economic activity, employment, and labor income from alternative public land management policies will be derived. Specific objectives include:

- To complete an overview of the study area of Elko County, Nevada
- To discuss the ranch level multi-period Monte Carlo linear programming model
- To discuss the validation and verification of the Elko County IMPLAN input-output model
- To present results of the analysis of alternative public land management policies over a range of possibilities or Manski's interval scoring

STUDY AREA

The study area for this paper is Elko County, Nevada. Elko County is in northeastern Nevada. The economy of Elko County is based on natural resource industries and specializes in economic sectors related to natural resource industries. To show this specialization, an analytical statistic called location quotient is used. A location quotient for this study is computed as an economic sector's share of Elko County's total employment divided by the economic sector's share of the national employment. Table 3 shows the gold and silver mining sector with a location quotient of 452.85, which means Elko County's proportional share of total

county employment in the gold and silver mining sector is 541.36 times the national share and that Elko County's animal production sector location quotient of 2.55 is 4.67 times the national proportionate share. These two sectors are the export sectors for this county. Most of the federal land is rangeland and is used for livestock grazing by private landowners holding grazing permits and leases.

Dating back to the 1990s, a substantive number of BLM acres and permits have been under review and challenged by additional constraints. The overall management pattern occurring in recent decades yields a reduction in AUMs by the BLM on many of Elko County's public land allotments. Most ranches in northeastern Nevada rely on a matrix of public and private lands that include the ability to rotate cattle through lower and higher elevation areas to follow forage availability with the seasons.

Reduction in grazing permits puts ranchers' economic activities and counties' economies at risk. Stemming primarily from the overall permit loss, the reduction of AUMs of public forage available reduces the profitability of the livestock industry and puts at risk the economic activities across all sectors that are generated by the livestock industry. In addition, AUM reduction increases litigations, uncertainty, and risk faced by ranchers. To estimate the economic impacts of potential losses of AUMs, a multi-period Monte Carlo linear programming model will be developed to estimate AUM values from grazing allotment reductions at the ranch level. Afterwards applying the IMPLAN microcomputer input-output model algorithm, total economic impacts from reductions in public land grazing on the Elko County economy can be estimated.

Federal grazing plays a large role in Elko County agricultural production. According to the 1997 Census of Agriculture, 177 ranches held grazing permits or approximately 41% of total agricultural operations in Elko County (436) in 1997 and 68% of operations with a beef cow inventory (262) in 1997. Of these ranches, 144 held grazing permits with the BLM, 61 held grazing permits with the USFS, and 16 held permits with other types of landowners. Note that some owners had grazing permits with more than one type of agency.

Current data on the number of available AUMs was collected from Elko County regional offices of the BLM, USFS, and U.S. Fish and Wildlife Service. Table 4 displays the data. Total permitted AUMs in Elko County in 2017 were estimated to be 847,058, with 85% of the total permitted AUMs on BLM lands and the remaining 15% on USFS land. A small amount of grazing was permitted on the Ruby Lake National Wildlife Refuge. Actual AUMs used were less than the permitted amount and vary from year to year. Another study of Elko County grazing estimated that as much as 49% of total AUMs used by the cattle industry were provided by federal grazing land (Torell, Garrett, and Ching, 1981). In addition to being a large portion of total AUMs, often the timing of forage availability on federal lands increases their importance to the ranch operation. Because of the seasonal factors, several studies have found that the value of an AUM from federal lands is greater than the value of AUMs from other sources (Torell, Garrett, and Ching, 1981; Torell et al., 2002a).

ELKO COUNTY RANCH MODEL

The Elko multi-period ranch model was developed to exemplify range cattle operation in the Elko-Eureka area of Nevada. The ranch runs a 700 cow-calf operation utilizing a mixture of private and public rangelands during the grazing season and private hay meadows to produce winter feed and aftermath grazing in the fall. Cattle are turned out in early April and return to private lands in early October.

A multi-period linear programming model is employed and has been used to derive impacts of federal land policies (Torell et al., 2002b; Rimbey et al., 2003; Taylor et al., 2004; 2005), evaluations of drought management strategies (Torell, Murugan, and Ramirez, 2010; Bastian et al., 2009; Ritten et al., 2010), grazing management assessments (Stillings et al., 2003; Tanaka et al., 2007), juniper control (Aldrich et al., 2005), and wildfire impacts (Maher, Tanaka, and Rimbey, 2013). The NPV of discounted annual returns is maximized over a 40-year time span subject to linear constraints that define resource limitations and resource transfers between years. Figure 2 shows the general structure of the multi-period linear programming model (Torell et al., 2014).

The model maximizes the present value of net returns. Results also account for off-ranch income and fixed costs (e.g., mortgage payment) that do not change over time. Variable production costs include animal production expenses plus feed costs and costs that vary with level of production, such as labor, veterinary costs, etc.

Livestock prices generally influence annual ranch income and optimal production. A Monte Carlo analysis was employed to consider the effects of beef price variations on ranch returns and optimal production strategies. Different beef cattle prices

were generated for each of 100 model iterations over a 40-year planning horizon using beef cattle cycle and trends. The Monte Carlo multi-period linear programming model is superior to the deterministic multi-period linear programming model.

Manski (2013) would argue that constructing and analyzing public land management policies under a deterministic framework often ignores price and cost variabilities. Manski would classify deterministic modeling as "incredible certitude" analysis providing only a point estimate of key output variable such as NPV or value of an AUM. However, "credible interval scoring" provides a probability distribution of key output variables, which is necessary for effective and efficient public land management policy analysis (Pouliquen, 1970; Reutlinger, 1970; Hardaker et al., 2004). Pouliquen indicates that the benefits of the Monte Carlo multi-period linear programming model are that it provides public land decision-makers the extreme values of key operating variables and their relative probabilities along with a weighted estimate of the relationships between unfavorable and favorable outcomes. In addition to risk analysis and how variabilities in livestock prices affect livestock operations, Pouliquen would suggest that complete multi-period Monte Carlo linear programming analysis could be used to analyze alternative public land management policies. In addition, results of the ranch level multi-period Monte Carlo linear programming model can be coupled with a county input-output model to derive countywide impacts from changes in public land management policies. Often county impacts from changes in grazing permits are estimated using average value of AUMs. For understanding the potential impacts of grazing reductions on a county economy, ranges of AUM values should be used to estimate the range of county-wide impacts that could occur from public land management policies.

Verified and Validated Elko County Input-Output Model

Estimation of the economic, employment, and household income impacts of changes in the Elko County economy from changes in public land management policies will be derived from employing an input-output or interindustry model. Interindustry analysis was developed by Wassily Leontief in the late 1930s to represent the interdependencies between different economic sectors in a study area (1936). Interindustry analysis shows how economic sectors are linked together by sales and purchases between other economic sectors. Since its inception, the framework of interindustry models has continued to be improved and is one of today's most applied analytical techniques in economics (Baumol, 2000). The advantage of interindustry analysis is its ability to provide an easy to understand, transparent, and detailed picture of economic structure of a study area's economy at a point in time. Another advantage is that interindustry models do not incorporate any behavioral equations of individuals or businesses, so it is politically and ideologically neutral (Foran, Lenzen, and Dey, 2005).

One of the most used secondary input-output models is IMPLAN. Originally developed by the USFS, IMPLAN is now a private modeling company (IMPLAN, 2021). The two major components of IMPLAN are its data files and software. The desktop database includes information on 528 different economic sectors, along with a national input-output model to derive regional or county level input-output models. The IMPLAN model is reasonably flexible, allowing users to verify and validate data used in county model development.

However, there must be the verification and validation of dataset used for developing IMPLAN models as outlined by Willis and Holland (1997). The first step is to download the IMPLAN model data from the industry detail file, which has sectoral employment. The second step is to download quarterly census of employment and wage data for the study area from the Nevada Department of Employment, Training, and Rehabilitation's (DETR's) employment data by the North American Industry Classification System (NAICS). Using IMPLAN user supplied crosswalk tables, the NAICS sectors and employment levels are redefined into IMPLAN economic sectors.

After creating the IMPLAN economic sectors, employment data for the same year as the IMPLAN data and model is downloaded from Bureau of Economic Analysis Regional Economic Information System (BEA REIS). The BEA REIS employment data will have employee and proprietor data. The data will show employment by two-digit NAICS code that can be cross-referenced with and redefined into the IMPLAN economic sectors defined above. Therefore, using data from the state employment offices, proportional values of each sector to each two-digit IMPLAN sector can be estimated. Willis and Holland (1997) suggest reclassifying certain sectors in a way that intuitively makes more sense to the public. By using procedures outlined by Willis and Holland (1997) and DETR and BEA REIS data, county level input-output models for this analysis are verified and validated.

RESULTS

As noted by Gardner (1997, 11), "the Animal Unit per Month permit's value represents the capitalized value expected future differences between fee (and non-fee grazing costs) and value of forage." To derive the value of grazing permits as grazing permits are reduced or eliminated, the multi-period Monte Carlo linear programming model was used to derive 40 years of discounted returns to estimate an income-based grazing permit value.

Rimbey, Torell, and Tanaka (2007) and Torell, Dixon, and McCollum (2012) found that highly federal land–dependent ranches had estimated permit values ranging from approximately $100 to $350 per AUM. These values were similar to capitalized return reductions estimated by Torell et al. (2014).

Using the Monte Carlo multi-time period model, a distribution of value of AUM permits for a 25% reduction, 50% reduction, and 75% reduction is shown as a "credible interval scoring"—not from a deterministic livestock price, which is "incredible certitude" result. Figure 3 shows that the value of an AUM permit from a 25% reduction in Elko County varies from $202.22 per AUM to $245.49 per AUM, with average value of $226.25 per AUM. Figure 4 shows that the value of an AUM permit from a 50% reduction in Elko County varies from $213.47 per AUM to $258.67 per AUM, with average value of $240.40 per AUM. Figure 5 shows that the value of an AUM permit from a 75% reduction in Elko County varies from $226.27 per AUM to $268.02 per AUM, with average value of $251.29 per AUM.

The results from the Elko County ranch model show that, in terms of ranch production, one AUM of federal grazing can potentially generate on average from a 25% reduction in AUM permits of $226.25 per AUM, with a low value of $202.22 per AUM and a high value of $245.49 per AUM. A 50% reduction in AUM permits yields an average of $240.40 per AUM, a low value of $213.47 per AUM, and a high value of $258.67 per AUM. In contrast, a 75% reduction in AUM permits yields an average value of $251.29 per AUM, a low value of $226.27 per AUM, and a high value of $268.02 per AUM. This assumes that since federal AUMs are part of an overall grazing system, a change in federal grazing affects the optimal use of the rest of the forage resources.

From Table 4, the regional impacts from a change in public AUMs can be seen. If using only the average AUM value for 25% reduction, the results would show decline in economic activity of $47,911,718, loss of 463 jobs, and reduction of labor income of $9,566,237. However, deriving a range of AUM values for a 25% reduction in AUM permits shows economic activity decrease ranging between $42,823,017 and $51,986,067, with loss of employment ranging between 414 jobs and 502 jobs and loss of labor income ranging between $8,550,208 and $10,379,737. This shows that using only average impacts does not give a true picture of AUM reduction impacts. Table 4 shows that analysis of impacts of reductions in AUMs on public lands should be analyzed by credible interval scoring.

CONCLUSION

This paper provided an initial experiment in investigating impacts of changes in public land management policies by employing a dynamic Monte Carlo linear programming model. Deriving a range of values for AUMs for alternative reductions in grazing permits provides information as to the range of impacts that could result. Also, using these ranges with interindustry analysis provides information as to the potential range of county economic, employment, and labor income impacts. As Hardaker et al. (2004) suggested in investigating ranges of potential policy results, deriving impacts at average does not yield suitable information. Estimation of potential ranges provides information as to possible policy impacts during not only average times but also times when the economy is low. Again, Manski's credible interval scoring could be employed in any regional policy analysis.

REFERENCES

Aldrich, G.A., J.A. Tanaka, R.M. Adams, and J.C. Buckhouse. 2005. "Economics of Western Juniper Control in Central Oregon." *Rangeland Ecology & Management* 58 (5): 542–552.

Bastian, C.T., P. Ponnamaneni, S. Mooney, J.P. Ritten, W.M. Frasier, S.I. Paisley, M.A. Smith, and W.J. Umberger. 2009. "Range Livestock Strategies Given Extended Drought and Different Price Cycles." *Journal of the American Society of Farm Mangers and Rural Appraisers* 72 (1): 153–163.

Baumol, W. 2000. "Leontief's Great Leap Forward: Beyond Quesnay, Marx, and von Bortkiewicz." *Economic Systems Research* 12 (2): 141–152.

Boyd, C.S., J.L. Beck, and J.A. Tanaka. 2014. "Livestock Grazing and Sage-Grouse Habitat: Impacts and Opportunities." *Journal of Rangeland Applications* 1: 58–77.

Davies, K.W., J.D. Bates, and C.S. Boyd. 2016. "Effects of Intermediate-Term Grazing Rest on Sagebrush Communities with Depleted Understories: Evidence of a Threshold." *Rangeland Ecology & Management* 69 (3): 173–178.

Davies, K.W., J.D. Bates, C.S. Boyd, and T.J. Svejcar. 2016. "Prefire grazing by cattle increases postfire resistance to exotic annual grass (*Bromus tectorum*) invasion and dominance for decades." *Ecology and Evolution* 6 (10): 3356–3366.

Foran, B., M. Lenzen, and C. Dey. 2005. *Balancing Act: A Triple Bottom Line Analysis of the Australian Economy.* Canberra, ACT: CSIRO Sustainable Ecosystems and University of Sydney.

Gardner, B.D. 1997. "Some Implications of Federal Grazing, Timber, Irrigation, and Recreation Subsidies." *Choices* 12 (3): 9–14.

Hardaker, J.B., R.B.M. Huirne, J.R. Anderson, and G. Lien. 2004. *Coping with Risk in Agriculture,* 2nd ed. Wallingford, Oxfordshire, UK: CABI Publishing.

Headwaters Economics. 2022. Economic Profile System, Land Use. https://headwaterseconomics.org/apps/economic-profile-system.

IMPLAN. 2021. IMPLAN Basics. https://support.implan.com/hc/en-us/categories/360002245673-IMPLAN-Basics.

Leontief, W.W. 1936. "Quantitative Input and Output Relations in the Economic Systems of the United States." *The Review of Economic Statistics* 18 (3): 105–125.

Maher, A.T., J.A. Tanaka, and N.R. Rimbey. 2013. "Economic Risks of Cheatgrass Invasion on a Simulated Eastern Oregon Ranch." *Rangeland Ecology & Management* 66 (3): 356–363.

Manski, C.F. 2013. *Public Policy in an Uncertain World: Analysis and Decisions.* Cambridge, MA: Harvard University Press.

Nevada Legislative Counsel Bureau. 2013. Nevada Federal Owned Lands by County. https://www.nvnaco.org/advocacy/public-lands.php.

Pearce, R., D. Henderson, T. Harris, and T. Tetz. 1999. "Impacts of Federal Land Livestock Reductions on Nevada's Economy." *Rangelands* 21 (4): 22–24.

Pouliquen, L.Y. 1970. *Risk Analysis in Project Appraisal.* Baltimore, MD: The Johns Hopkins University Press.

Reutlinger, S. 1970. *Techniques for Project Appraisal under Uncertainty.* Baltimore, MD: The Johns Hopkins University Press.

Rimbey, N.R, T. Darden, L.A. Torell, J.A. Tanaka, L.W. Van Tassell, and J.D. Wulfhorst. 2003. "Ranch Level Economic Impacts of Public Land Grazing Policy Alternatives in the Bureau Resource Area of Owyhee County, Idaho." Moscow, ID: University of Idaho, Department of Agricultural Economics and Rural Sociology, Agricultural Economic Extension Series No. 03-05.

Rimbey, N.R., L.A. Torell, and J.A. Tanaka. 2007. "Why Grazing Permits Have Economic Value." *Journal of Agricultural and Resource Economics* 32 (1): 20–40.

Ritten, J.P., W.M. Frasier, C.T. Bastian, S.I. Paisley, M.A. Smith, S. Mooney. 2010. A Multi-Period Analysis of Two Common Livestock Management Strategies Given Fluctuating Precipitation and Variable Prices. *Journal of Agricultural and Applied Economics* 42 (2): 177–191.

Stillings, A.M., J.A. Tanaka, N.R. Rimbey, T. DelCurto, P.A. Momont, and M.L. Porath. 2003. "Economic Implications of Off-Stream Water Developments to Improve Riparian Grazing." *Journal of Range Management* 56 (5): 418–424.

Tanaka, J.A., N.R. Rimbey, L.A. Torell, D.T. Taylor, D. Bailey, T. DelCurto, K. Walburger, and B. Welling. 2007. "Grazing Distribution: The Quest for the Silver Bullet." *Rangelands* 29: 38–46.

Taylor, D.T., R.H. Coupal, T. Foulke, and J.G. Thompson. 2004. "The Economic Importance of Livestock Grazing on BLM Land in Fremont County Wyoming." University of Wyoming, Department of Agricultural and Applied Economics.

Taylor, D.T., R.H. Coupal, T. Foulke, and J.G. Thompson. 2005. "The Economic Importance of Federal Grazing on the Economy of Park County, Wyoming." University of Wyoming, Department of Agricultural and Applied Economics.

Torell, L.A., B. Dixon, and D. McCollum. 2012. "The Market Value of Ranches and Grazing Permits in New Mexico, 1996 to 2010." New Mexico State University, College of Agricultural, Consumer, and Environmental Sciences.

Torell, L.A., J.R. Garrett, and C.T.K. Ching. 1981. "The Economic Effects of Three Changes in Public Lands Grazing Policies." *Journal of Range Management* 34 (5): 373–376.

Torell, L.A., S. Murugan, and O.A. Ramirez. 2010. "Economics of Flexible Versus Conservative Stocking Strategies to Manage Climate Variability Risk." *Rangeland Ecology & Management* 63 (4): 415–425.

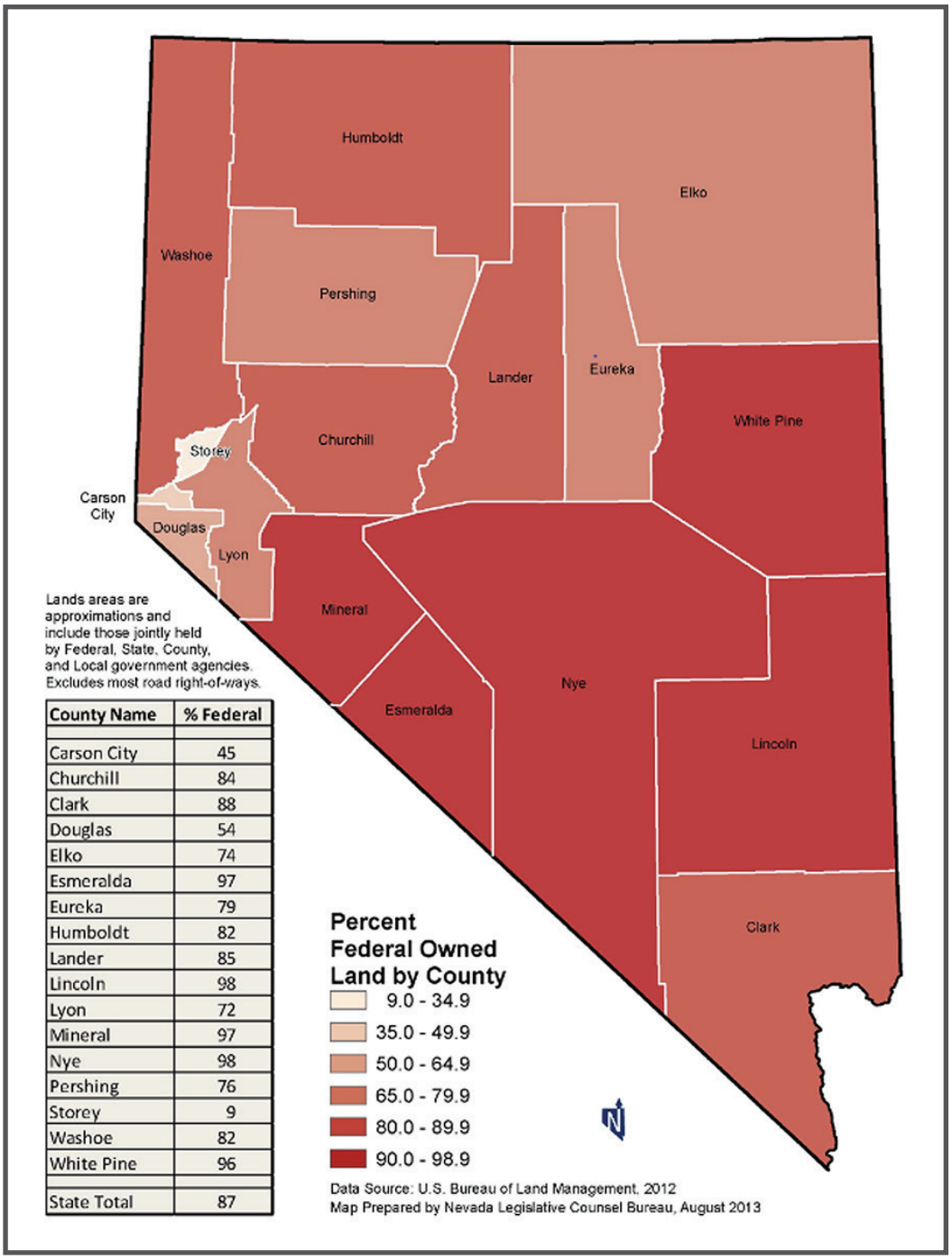
Torell, L.A., J.A. Tanaka, N.R. Rimbey, and T.D. Darden. 2002a. "A User Manual for a Ranch Planning and Policy Analysis LP Model." Caldwell, ID: Policy Analysis Center for Western Public Lands (PACWPL).

Torell, L.A., J.A. Tanaka, N. Rimbey, T. Darden, L. Van Tassell, and A. Harp. 2002b. "Ranch-Level Impacts of Changing Grazing Policies on BLM Land to Protect the Greater Sage-Grouse: Evidence from Idaho, Nevada, and Oregon." Caldwell, ID: Policy Analysis Center for Western Public Lands.

Torell, L.A., J.A. Tanaka, J.P. Ritten, N.R. Rimbey, D.T. Taylor, and T.K. Foulke. 2014. "Ranch-Level Economic Impacts of Altering Grazing Policies on Federal Land to Protect the Greater Sage-Grouse." University of Wyoming Extension. https://www.wyoextension.org/publications/Search_Details.php?pubid=1858&pub=B-1258A.

U.S. Census Bureau. 2022. Quick Facts. https://www.census.gov/quickfacts.

Willis, D., and D. Holland. 1997. "Translating Farm Enterprise Budgets into Input-Output Accounts: Another Example from Washington State." Washington State University, Department of Agricultural Economics.



County Name	% Federal
Carson City	45
Churchill	84
Clark	88
Douglas	54
Elko	74
Esmeralda	97
Eureka	79
Humboldt	82
Lander	85
Lincoln	98
Lyon	72
Mineral	97
Nye	98
Pershing	76
Storey	9
Washoe	82
White Pine	96
State Total	87

Figure 1. Percent of total land under federal ownership by county in the state of Nevada. (Source: Nevada Legislative Counsel Bureau, 2013.)

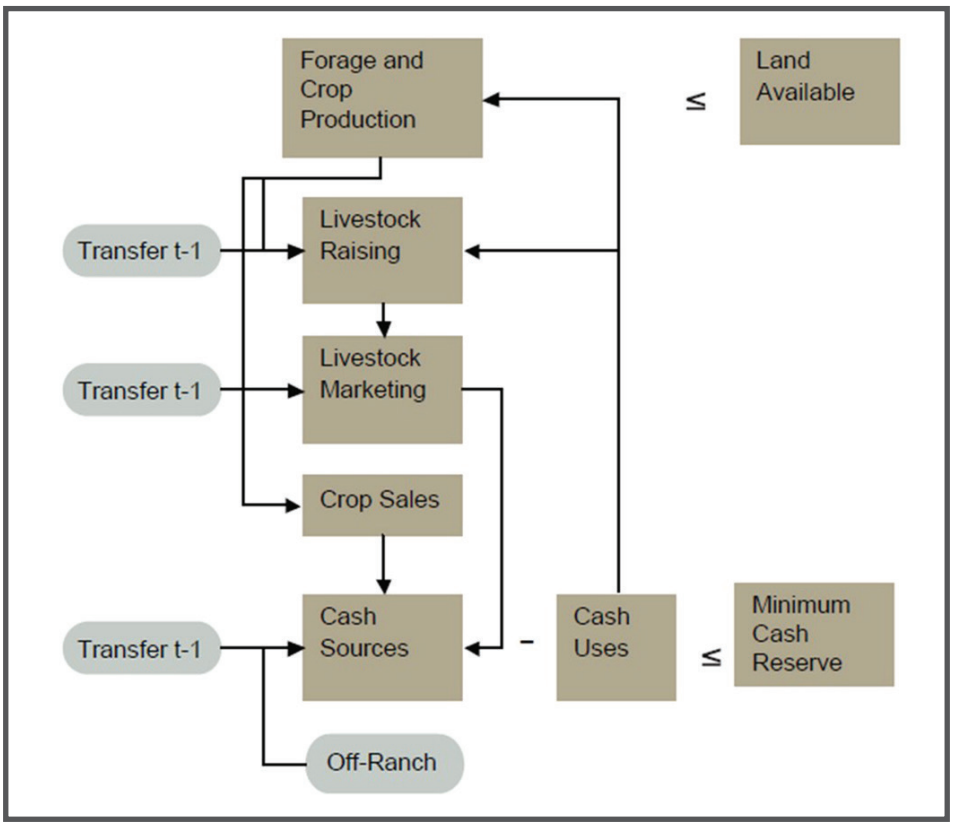


Figure 2. Schematic of multi-period linear programming model. (Figure adapted from Torell et al., 2014.)

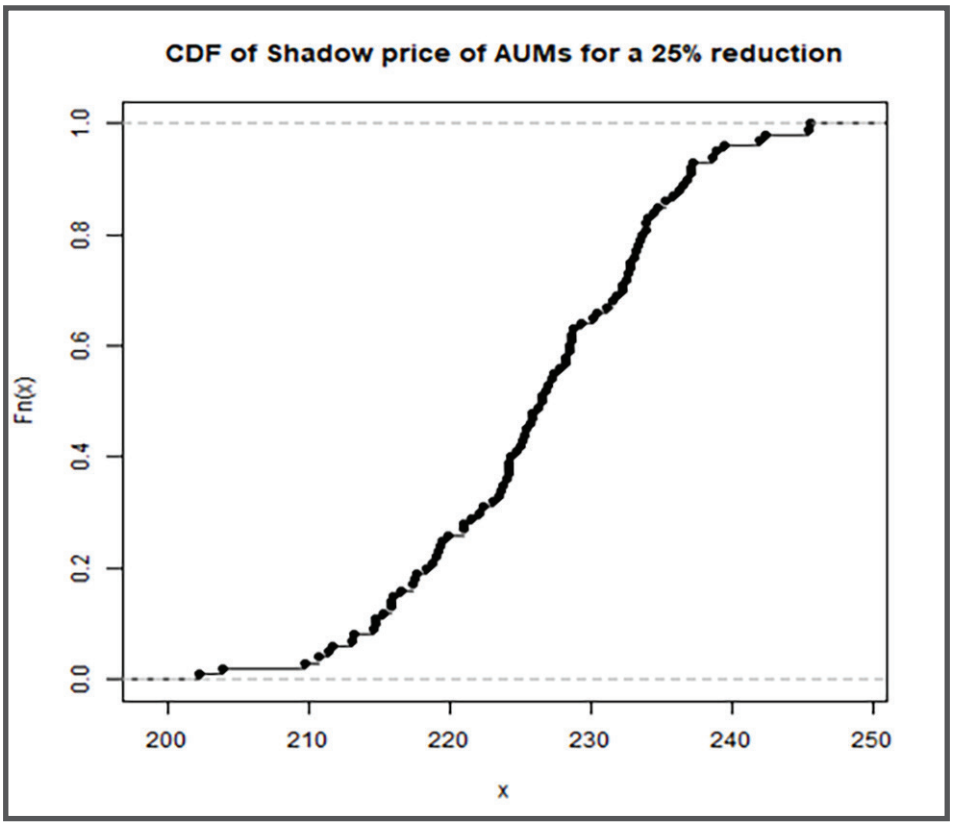


Figure 3. CDF of valuation of AUMs in Elko County from a 25% reduction in public land grazing permits

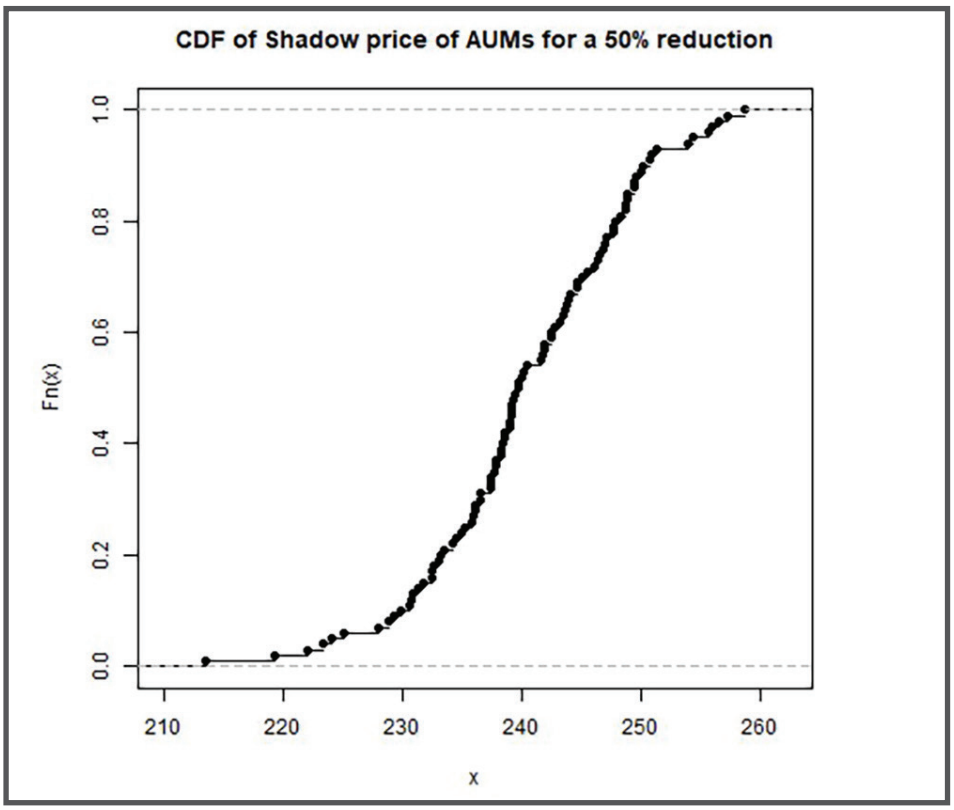


Figure 4. CDF of valuation of AUMs in Elko County from a 50% reduction in public land grazing permits

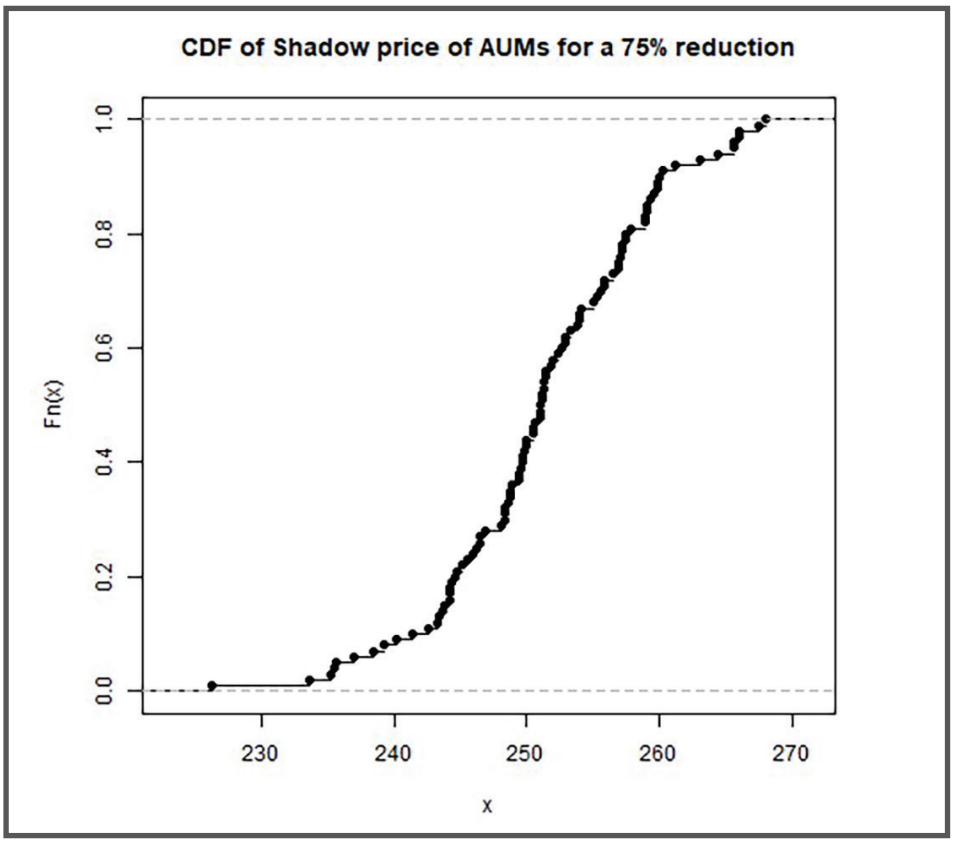


Figure 5. CDF of valuation of AUMs in Elko County from a 75% reduction in public land grazing permits

Table 1. Federal Lands in Western U.S. States			
State	**Total Acreage (acres)**	**Federal Lands (acres)**	**Percentage of Total Acreage That Is Federal**
Alaska	372,792,373	222,412,794	59.66%
Arizona	72,951,915	30,346,513	41.60%
California	101,159,181	47,915,621	47.37%
Colorado	66,620,719	37,017,343	55.56%
Hawaii	4,116,516	2,132,873	51.81%
Idaho	53,494,867	33,547,324	62.71%
Montana	94,147,914	27,767,169	29.49%
Nevada	70,664,589	59,661,758	84.43%
New Mexico	77,819,693	26,283,866	33.78%
Oregon	62,053,174	32,273,753	52.01%
Utah	56,952,598	34,990,802	61.44%
Washington	43,212,988	12,565,361	29.08%
Wyoming	62,598,290	29,891,689	47.75%
TOTAL	**1,138,584,817**	**596,806,866**	**52.42%**
11 Contiguous Western States	761,675,928	372,261,199	48.87%
United States	2,303,091,014	632,461,561	27.46%

Source: Headwaters Economics, 2022.

Table 2. Federal and State Lands in Nevada

County	Private Lands		BLM		Forest Service		Other Federal	
	(acres)	(%)	(acres)	(%)	(acres)	(%)	(acres)	(%)
Carson City	38,310	38.07%	35,805	35.58%	15,326	15.23%	115	0.11%
Churchill	791,160	24.60%	1,997,934	62.14%	0	0.00%	366,147	11.39%
Clark	582,648	11.29%	2,631,068	51.00%	279,752	5.42%	1,534,950	29.75%
Douglas	142,009	30.08%	161,894	34.29%	83,041	17.59%	25	0.01%
Elko	2,844,111	25.83%	6,888,104	62.57%	1,067,810	9.70%	26,817	0.24%
Esmeralda	64,869	2.82%	2,160,499	94.06%	67,085	2.92%	3,704	0.16%
Eureka	565,004	21.12%	1,966,064	73.49%	144,104	5.39%	0	0.00%
Humboldt	1,096,813	17.74%	4,379,103	70.85%	289,555	4.68%	386,104	6.25%
Lander	537,034	15.20%	2,664,636	75.43%	296,542	8.39%	30,162	0.85%
Lincoln	142,447	2.09%	5,581,253	81.98%	29,467	0.43%	1,047,444	15.39%
Lyon	376,696	29.08%	562,602	43.43%	276,406	21.34%	59	0.00%
Mineral	99,825	4.09%	1,581,872	64.82%	375,347	15.38%	144,596	5.93%
Nye	305,785	2.63%	6,559,135	56.32%	1,963,183	16.86%	2,800,257	24.04%
Pershing	946,467	24.37%	2,907,584	74.88%	0	0.00%	15,668	0.40%
Storey	153,180	90.78%	15,146	8.98%	0	0.00%	0	0.00%
Washoe	683,420	16.32%	2,706,642	64.64%	108,710	2.60%	191,492	4.57%
White Pine	245,145	4.31%	4,515,194	79.31%	764,409	13.43%	90,189	1.58%
TOTAL	**9,614,923**	**13.59%**	**47,314,535**	**66.86%**	**5,760,737**	**8.14%**	**6,637,729**	**9.38%**

Table 2. Federal and State Lands in Nevada (Continued)

County	Tribal Lands		State Lands		City, County, Other		Total	
	(acres)	(%)	(acres)	(%)	(acres)	(%)	(acres)	(%)
Carson City	3,918	3.89%	4,062	4.04%	3,101	3.08%	**100,637**	**100.00%**
Churchill	52,401	1.63%	7,823	0.24%	0	0.00%	**3,215,465**	**100.00%**
Clark	79,143	1.53%	48,269	0.94%	3,126	0.06%	**5,158,956**	**100.00%**
Douglas	83,627	17.71%	1,496	0.32%	0	0.00%	**472,092**	**100.00%**
Elko	160,231	1.46%	22,413	0.20%	0	0.00%	**11,009,486**	**100.00%**
Esmeralda	0	0.00%	835	0.04%	0	0.00%	**2,296,992**	**100.00%**
Eureka	0	0.00%	0	0.00%	0	0.00%	**2,675,172**	**100.00%**
Humboldt	29,453	0.48%	0	0.00%	0	0.00%	**6,181,028**	**100.00%**
Lander	630	0.02%	3,476	0.10%	0	0.00%	**3,532,480**	**100.00%**
Lincoln	0	0.00%	6,669	0.10%	509	0.01%	**6,807,789**	**100.00%**
Lyon	50,911	3.93%	28,846	2.23%	0	0.00%	**1,295,520**	**100.00%**
Mineral	238,366	9.77%	298	0.01%	0	0.00%	**2,440,304**	**100.00%**
Nye	8,479	0.07%	10,263	0.09%	0	0.00%	**11,647,102**	**100.00%**
Pershing	6,018	0.15%	7,431	0.19%	0	0.00%	**3,883,168**	**100.00%**
Storey	320	0.19%	85	0.05%	0	0.00%	**168,731**	**100.00%**
Washoe	463,891	11.08%	20,586	0.49%	12,274	0.29%	**4,187,015**	**100.00%**
White Pine	70,488	1.24%	7,831	0.14%	0	0.00%	**5,693,256**	**100.00%**
TOTAL	**1,247,876**	**1.76%**	**170383**	**0.24%**	**19,010**	**0.03%**	**70,765,193**	**100.00%**

Source: Headwaters Economics, 2022.

Table 3. Location Quotient Values for Economic Sectors in Elko County, 2010 and 2019		
Sector	**2010**	**2019**
Crop Production	1.58	1.15
Animal Production	5.37	2.55
Other Agriculture	1.48	1.04
Gold and Silver Mining	492.5	452.85
Other Mining	2.52	1.59
Supportive Activities for Mining	17.89	107.84
Utilities	1.13	1.02
Construction	1.48	1.18
Manufacturing	0.13	0.14
Wholesale Trade	0.9	1.28
Retail Trade	0.99	1.02
Transportation and Warehousing	0.9	0.55
Information	0.37	0.8
Finance and Insurance	0.36	0.37
Real Estate and Rental and Leasing	0.56	0.77
Professional, Scientific, and Technical Services	0.39	0.43
Management of Companies and Enterprises	0.92	0.85
Administration and Support and Waste Management and Remediation Services	0.45	0.45
Educational Services	0.15	0.24
Health Care and Social Assistance	0.53	0.52
Arts, Entertainment, and Recreation	1.48	1.85
Accommodations and Food Services	3.94	1.63
Other Services (except Administration)	0.99	0.93
Government	1.03	1.04

Table 4. Range of Economic, Employment, and Labor Income Impacts from 25%, 50%, and 75% Reductions in AUM Permits in the Elko County Economy									
Result Types	**25% Reduction in AUMS**			**50% Reduction in AUMs**			**75% Reduction in AUMs**		
	Economic	**Employment**	**Labor Income**	**Economic**	**Employment**	**Labor Income**	**Economic**	**Employment**	**Labor Income**
Low	$42,823,017	414	$8,550,208	$90,410,736	873	$18,051,754	$143,747,860	1,388	$28,701,248
Average	$47,911,718	463	$9,566,237	$101,646,960	982	$20,295,221	$159,642,904	1,542	$31,874,913
High	$51,986,067	502	$10,379,737	$109,554,246	1,058	$21,874,020	$170,271,364	1,655	$33,997,032