University of Wyoming Extension

B-1245
February 2013

Toward a More Comprehensive Valuation of Western Rangelands

Benjamin S. Rashford ~ Alexandre V. Latchininsky ~ John P. Ritten

Toward a More Comprehensive Valuation of Western Rangelands

Authors:
Benjamin S. Rashford, Ph.D, *Associate Professor/Extension Specialist, Department of Agricultural and Applied Economics, University of Wyoming*
Alexandre V. Latchininsky, Ph.D, *Associate Professor/Extension Entomologist, Department of Ecosystem Science and Management, University of Wyoming, latchini@uwyo.edu*
John P. Ritten, Ph. D, *Assistant Professor/Extension Specialist, Department of Agricultural and Applied Economics, University of Wyoming*

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Glen Whipple, Director, Cooperative Extension Service, University of Wyoming, Laramie, Wyoming 82071.

Introduction

Rangelands occupy 53 percent of the land area in the 17 western states of the U.S. – approximately 661 million acres (Figure 1). Most western rangelands are either privately owned (399 million acres, 51 percent), or managed by Bureau of Land Management (167 million acres, 25 percent) or US Forest Service (95 million acres, 14 percent). They are essential to livestock production, which is the most common and widely distributed use of western rangelands. Cattle and calves alone generated over $45 billion in sales across the 17 western states in 2011 (NASS, 2011). The value of livestock forage, however, is not the only value derived from western rangelands. Economic values attributable to rangelands also include recreation and ecosystem service values (e.g., wildlife habitat). The comprehensive value of rangelands is important for informing rangeland protection and management policies. Most policies, especially those targeted toward federal lands, are explicitly or implicitly subjected to a cost-benefit type criterion. Such criteria generally depend upon assigning a value to the benefits rangelands produce. If forage is the only rangeland value considered, policymakers and managers will systematically underestimate rangelands value and therefore may choose policies poorly.

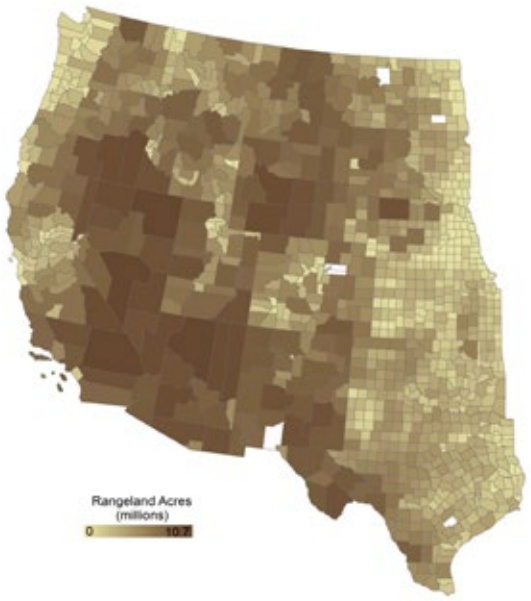


Figure 1. Rangeland acreage by county in the western U.S. (Data source: National Land Cover Database)

Pest management offers a concrete example of the values-management challenge. The USDA is mandated to manage public rangelands, a mandate that explicitly includes pest control. To make educated decisions on control interventions, federal land and pest managers apply an economic threshold approach in which control interventions are justified when the cost of damage to rangeland forage (i.e., the value of lost forage) becomes higher than the cost of treatments. However, there is increasing awareness that such an approach is disappointingly simplistic, and that rangeland benefits are not limited only to forage production. By ignoring the other values rangelands produce (many of which can be impacted by pests), the economic threshold approach as currently applied systematically underestimates the value of pest damages and will tend to recommend investing too little in pest control.

To help inform policy and contribute to a broader discussion of the comprehensive values of western rangelands, we estimate a suite of rangeland values not typically considered in policy discussions. Our objective is not to determine the "true" comprehensive value of rangelands – such an exercise is too difficult over a broad geographic area. Instead, we demonstrate, using readily available data, the potential contribution of non-livestock values to the comprehensive value of rangelands. Understanding the more comprehensive values of rangelands can help producers and policymakers better manage rangelands. Decisions to treat pests such as grasshoppers, for example, are typically not applied until a damage threshold is reached (i.e., until the value of potential damage exceeds the cost of treatment). If managers only consider livestock forage value, then these types of rangeland treatments may be applied too late.

Defining Rangeland Values

Economists define and classify values in a variety of ways. Two important distinctions for our

purpose are between market and non-market values, and between use and non-use values. Market values are associated with goods and services sold directly in a marketplace (e.g., crops and livestock); therefore, market prices are a good estimate of these values. Non-market values arise from goods and services that are not directly sold in a marketplace (e.g., ecosystem services). Similarly, use values arise from goods that are physically used (now or in the future), such as forage for livestock (market value) or outdoor recreation (usually a non-market value). Non-use values arise from goods that are never physically used. Non-use values include, for example, "existence value" (i.e., the value people place on simply knowing something, such as an unspoiled wilderness area, exists). Non-use values are often unrelated to any market good but are real economic values nonetheless. Non-market and non-use values are difficult to estimate; therefore, most policy discussions focus on market values.

In the case of rangelands, there are a large suite of relevant values, including both market and non-market, and use and non-use (Figure 2). Considering them all is beyond our scope, so we focus on a few values that can be measured with readily available data. Specifically, we estimate values associated with two market rangeland uses: livestock forage and carbon sequestration; and two non-market uses: recreation and ecosystem services. Though not exhaustive, this short list of values is sufficient to demonstrate the importance of considering a broader suite of rangeland values.

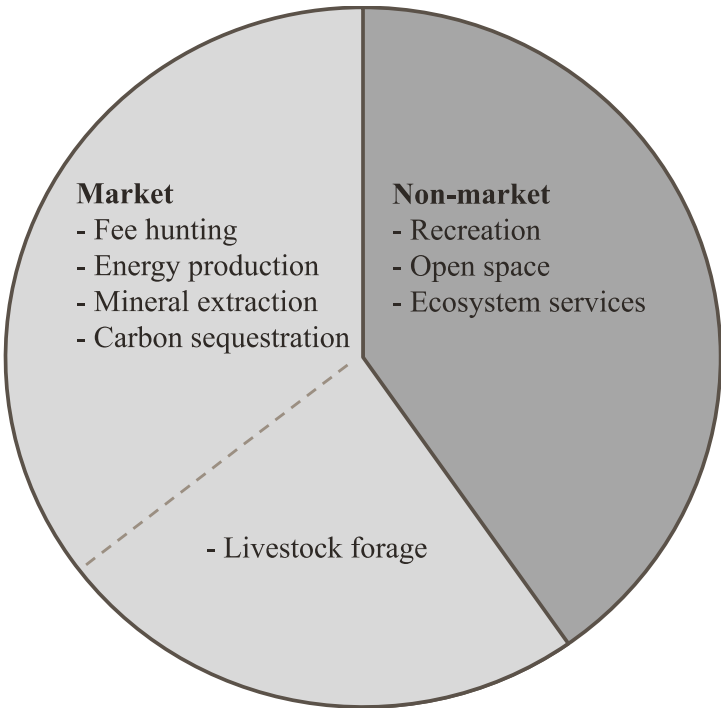


Figure 2. Economic values associated with western rangelands – more than just forage value.

Estimating Values

1 Forage for Livestock

The value of forage for livestock should, in theory, be the easiest rangeland value to estimate. In reality, however, there are many factors that make estimating rangeland forage values difficult. First, though forage is technically a market commodity, forage from rangeland is not typically directly sold in a market place. Rangeland forage is an input, or intermediate good, in the production of livestock, which are sold directly in the marketplace. Thus, the value of rangeland forage in livestock production depends upon the extent to which forage contributes to the final market value of livestock. Second, forage type and productivity are highly variable across space. Thus, regional averages can be misleading. Acknowledging these complicating factors, we use pastureland rental rates to proxy for forage values. Rental rates have the advantage of being readily available in secondary data sets, but are admittedly a coarse estimate.[1]

USDA National Agricultural Statistics Service (NASS) collects pastureland rental rates ($/acre/year) using annual surveys (NASS, 2011). Though NASS uses the term pastureland, the pastureland

[1]Pasture rental rates provide a coarse proxy for forage values because of shortcomings in rental rate data. First, rental rate data are collected by surveying individuals and therefore have all the limitations inherent to self-reported data (e.g., no validation). Second, rental agreements can differ on many dimensions (e.g., contract length and maintenance sharing), which implies that different rates are not necessarily comparable. Lastly, sustainable grazing provides a service to rangeland landowners; thus, rental rates may tend to be lower than the actual value of forage in livestock production.

State	Average	Maximum	Minimum	Standard Deviation
Arizona	N/A	N/A	N/A	N/A
California	15.05	28.00	4.70	5.22
Colorado	5.41	11.00	1.40	2.07
Idaho	14.19	48.00	1.90	10.81
Kansas	16.12	35.00	6.00	5.19
Montana	6.47	41.50	2.20	4.69
Nebraska	24.73	58.50	5.90	11.48
Nevada	13.90	25.50	7.20	7.66
New Mexico	2.38	7.90	0.80	1.32
North Dakota	14.18	29.50	7.60	4.26
Oklahoma	11.64	24.50	5.50	2.90
Oregon	29.27	50.00	13.00	9.09
South Dakota	26.12	55.50	4.80	13.28
Texas	8.61	21.00	0.30	3.62
Utah	6.04	18.00	2.10	3.33
Washington	26.33	114.00	3.10	22.06
Wyoming	4.99	14.00	2.60	1.94

Table 1. Characteristics of pastureland rental rates ($/acre/year) by state, 2008-2011

category primarily includes non-irrigated grazing land and is therefore representative of rangeland. To protect respondent anonymity, NASS does not report rental rates for counties/states that lack a sufficient number of respondents. As a result, no rental rate data are available for Arizona. Available rental rates depict the wide variability in rangeland productivity (Table 1). Rental rates range from a high of $114/acre in Washington to a low of $0.30/acre in Texas. The variability potentially captures differences in forage productivity and thus animal unit months (AUMs) that different regions can support.

We use pastureland rental rates to estimate the value of rangeland forage by first calculating the average rental rate by county (Figure 3). For counties with insufficient data, we use the state-level average to fill in missing county-level data. We omit all counties in Arizona because there is no county- or state-level rental rate data. We then multiply county-level rental rates by the number of rangeland acres in each county. This provides an estimate of the value of rangeland forage in each county.

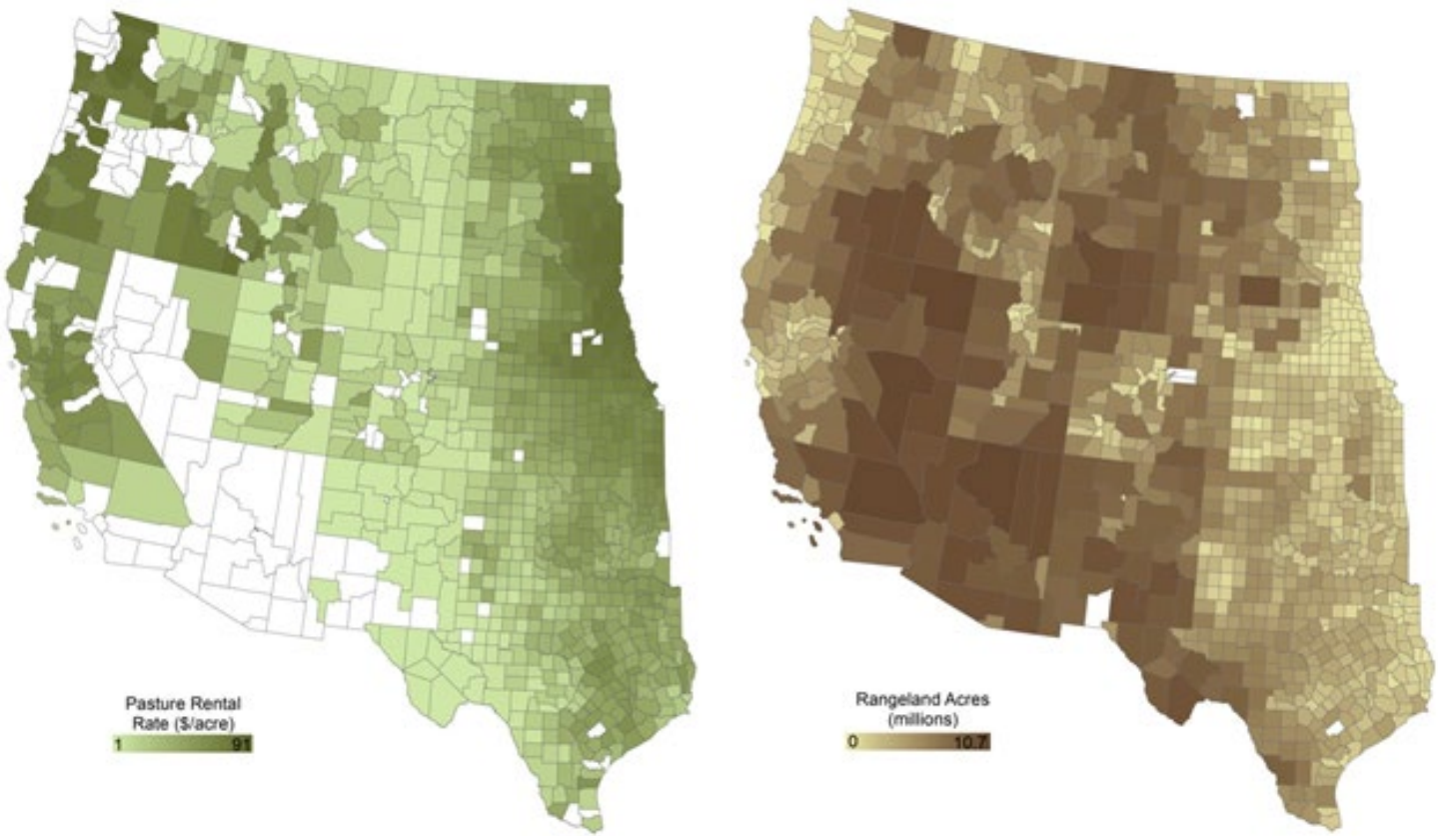


Figure 3. Pasture rental rates and total rangeland acres by county.

Using pasture rental rates to proxy for forage values suggests that rangeland forage is worth approximately $6.9 billion per year, or approximately $10 per acre on average. Aggregated to the state-level, there is wide variation in forage value (Table 2). States, such as Texas, have high total forage value, because of the spatial extent of rangelands, in spite of relatively low per-acre rental rates. Alternatively, states, such as Oregon, have high forage value as a result of high forage productivity (i.e., high rental rates).

State	Total Forage Value ($)	State	Total Forage Value ($)
Arizona	N/A	North Dakota	255,509,674
California	676,239,250	Oklahoma	255,585,742
Colorado	178,037,585	Oregon	816,470,891
Idaho	469,110,637	South Dakota	514,311,596
Kansas	377,647,552	Texas	739,988,798
Montana	321,770,352	Utah	170,129,989
Nebraska	466,243,123	Washington	317,925,947
Nevada	753,481,357	Wyoming	251,585,123
New Mexico	135,042,227		
Total:			***6,699,079,840***

Table 2. State-level total forage value estimates calculated using pasture rental rates

2 Carbon Sequestration

The value of carbon sequestration provides one estimate for a market-based ecosystem service on western rangelands. We estimate the value of carbon sequestration on rangelands using the approved Chicago Climate Exchange (CCX) sequestration rates and observed carbon market prices. Since carbon market prices vary, we use a range of prices to capture potential value. Specifically, following Ritten et al. (2012) we consider a low carbon price of $1.11/ton and a high carbon price of $4.24/ton. These prices are consistent with those observed on the CCX from 2005 to 2009.[2] There is potential for significantly higher carbon prices if the U.S. institutes mandatory offset regulations. We therefore also estimate carbon sequestration values using a price of $30/ton, which is consistent with prices observed in the European carbon market and with predictions based on proposed U.S. cap-and-trade legislation (see Ritten et al. 2012). We cannot estimate carbon values for all counties, or for any counties in Arizona and Nevada, because the CCX does not allow all regions to participate in the market (i.e., there are no approved carbon sequestration rates for rangelands in many western counties).

The state-level average estimated value of rangeland sequestered carbon ranges from $0.18/acre to $6.84/acre depending upon the price scenario and approved sequestration rate (Table 3). In the low-price scenario, the total annual value of rangeland carbon is over $74 million per year across the entire region, or approximately 1 percent of the estimated forage value (using rental rates). In the high and cap-and-trade price scenarios, however, the total annual value of carbon is $284 million and $2 billion, respectively. The value of carbon in these scenarios ranges from 2 percent of forage value to 150 percent of forage value across counties.

[2] Since 2009 there has been relatively little market activity for carbon sequestration on western rangelands, and recent observed prices have been as low as $0.05/ton.

State	Carbon Sequestration Value ($/acre/year)		
	Low	High	Cap & Trade
Arizona	N/A	N/A	N/A
California	0.18	0.68	4.80
Colorado	0.19	0.74	5.24
Idaho	0.13	0.51	3.60
Kansas	0.22	0.85	6.00
Montana	0.18	0.69	4.89
Nebraska	0.25	0.97	6.84
Nevada	NA	NA	NA
New Mexico	0.25	0.95	6.69
North Dakota	0.14	0.55	3.86
Oklahoma	0.22	0.85	6.00
Oregon	0.13	0.51	3.60
South Dakota	0.21	0.79	5.59
Texas	0.22	0.85	6.00
Utah	0.13	0.51	3.60
Washington	0.13	0.51	3.60
Wyoming	0.23	0.88	6.25

Table 3. Estimated average per acre value of carbon sequestered in rangelands with alternative carbon price scenario

Our estimates of carbon value using CCX data provide a measure of the value of carbon sequestered in rangelands; however, there are many caveats that should be noted. The fixed sequestration rates approved by the CCX, for example, oversimplify the complex process of carbon sequestration. Sequestration rates are likely to be much more variable across the landscape due to differences in soil characteristics and management practices (see Derner and Schuman 2007). Adverse events, such as prolonged drought or fire, can also alter the carbon cycle. Thus, the actual social value of carbon sequestered in rangelands at a specific location and point in time is difficult (if not impossible) to determine. Nonetheless, our estimates provide a range of potential values for the carbon sequestered in western rangelands.

3 *Recreation*

We generate a coarse proxy for the recreational values of western rangelands using the U.S. Fish and Wildlife Service 2006 survey of wildlife-related recreation (USFWS 2006). The survey provides state-level total expenditures for hunting, fishing, and other wildlife-related recreation. The challenge is to determine how much of the state-level expenditures are attributable to rangelands. Given data availability, we are not able to generate a rigorous estimate of the rangeland proportion of recreation expenditures. Instead, we generate a simple proxy for the wildlife-related expenditures attributable to rangelands. First, we use ArcGIS and land-cover data to calculate the county-level rangeland acres as a proportion of total state area. We then multiply this proportion by the state-level expenditures to determine the proportion of expenditures attributable to rangeland (aggregated to the state-level in Table 4). This simple approach suggests that the value of rangelands for wildlife-related recreation ranges from $0.53/acre in North Dakota to $39.90/acre in California.

State	Total Recreation Expenditures	Rangeland Proportion of Recreation Expenditures	Avg. Rangeland Related Expenditures ($/acre)
Arizona	838,307,000	640,102,036	11.49
California	4,179,583,000	2,280,553,710	39.
Colorado	1,387,737,000	733,128,527	20.8
Idaho	265,383,000	154,487,657	4.96
Kansas	156,185,000	72,244,593	2.9
Montana	376,451,000	222,859,328	4.00
Nebraska	141,910,000	80,573,029	2.8
Nevada	362,229,000	303,991,203	5.1
New	297,174,000	234,501,377	3.94
North	22,913,000	9,871,092	0.5
Oklahoma	328,660,000	171,580,618	7.3
Oregon	776,414,000	425,773,647	12.33
South	183,304,000	117,189,488	3.71
Texas	2,939,018,000	1,958,343,645	17.1
Utah	564,443,000	330,382,857	10.3
Washington	1,502,311,000	567,799,358	32.92
Wyoming	394,869,000	326,190,806	6.3
Total	***14,716,891,000***	***8,629,572,971***	

Table 4. State-level total wildlife-related recreation expenditures and estimated rangeland proportion of expenditures

Our simple approach relies on a number of tenuous assumptions, including 1) wildlife recreation is uniformly distributed across each state, and 2) wildlife recreation is uniformly distributed between rangeland and other land covers. We do not have any data to verify or rebut these assumptions; however, intuition suggests that many of the recreation activities included in the expenditure data occur primarily on forested lands (e.g., big game hunting). This suggests assuming recreation is uniformly distributed across the landscape would tend to overestimate the contribution of rangelands to recreation expenditures. On the other hand, many wildlife-related recreation activities, even if they do not physically occur on rangelands, may still indirectly depend on healthy rangeland habitats. Many big game species in the western states, for example, depend on rangeland for seasonal habitat (see Coupal et. al, 2004). This suggests that rangelands are responsible for at least some proportion of state-level expenditures on wildlife-related recreation.

Since it is difficult to determine what proportion of wildlife-related expenditures should be attributed to rangelands in each state, we also calculate a range of possible estimates. Beginning with the expenditures attributable to rangelands estimated above (i.e., assuming recreation is uniformly distributed on the landscape), we also calculate expenditures assuming that only 1 percent, 5 percent and 25 percent of those expenditures can be attributed to rangelands. Thus, the estimate above can be interpreted as a likely upper-bound on rangeland dependent recreation values, while the 1 percent estimate can be interpreted as a lower bound (Table 5).

Table 5. Estimated wildlife-related values associated with rangeland using alternative assumptions about rangelands contribution to wildlife-related recreation

	Expenditures ($/Acre)[1]				
State	**100%**	**1%**	**5%**	**10%**	**25%**
Arizona	11.49	0.11	0.57	1.15	2.87
California	39.90	0.40	1.99	3.99	9.97
Colorado	20.84	0.21	1.04	2.08	5.21
Idaho	4.96	0.05	0.25	0.50	1.24
Kansas	2.97	0.03	0.15	0.30	0.74
Montana	4.00	0.04	0.20	0.40	1.00
Nebraska	2.87	0.03	0.14	0.29	0.72
Nevada	5.12	0.05	0.26	0.51	1.28
New Mexico	3.94	0.04	0.20	0.39	0.99
North Dakota	0.53	0.01	0.03	0.05	0.13
Oklahoma	7.35	0.07	0.37	0.73	1.84
Oregon	12.33	0.12	0.62	1.23	3.08
South Dakota	3.71	0.04	0.19	0.37	0.93
Texas	17.16	0.17	0.86	1.72	4.29
Utah	10.39	0.10	0.52	1.04	2.60
Washington	32.92	0.33	1.65	3.29	8.23
Wyoming	6.31	0.06	0.32	0.63	1.58
Average	***10.99***	***0.11***	***0.55***	***1.10***	***2.75***

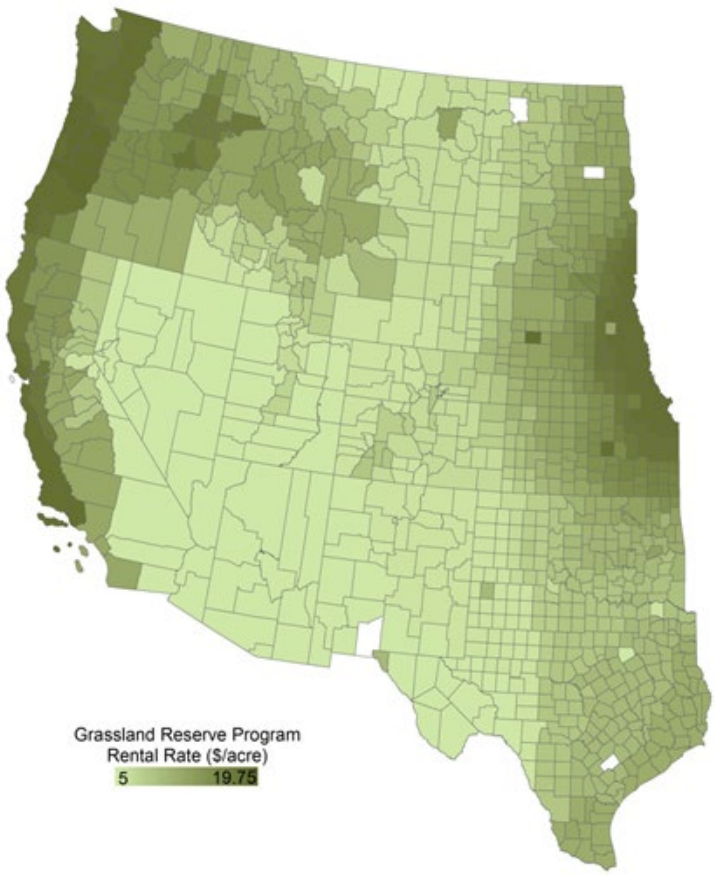
[1]The 100% column assumes that wildlife-related expenditures occur on rangelands in direct proportion to rangeland area in each state. The remaining columns assume that only 1%,…, 25% of the rangeland area in the state contributes to the state's total wildlife-related recreation.

The results of assuming that rangelands contribute smaller amounts to wildlife-related recreation are predictable. It is important to note, however, that even modest assumptions about the contribution of rangelands to wildlife-related recreation imply relatively large recreation values for rangelands. If we conservatively assume, for example, that only 10 percent of rangelands contribute to the USFWS's estimate of wildlife-related expenditures, wildlife recreation values still average $1.10 per acre across the western region. Though seemingly small, this estimated value is nearly 10 percent of the average forage value. Moreover, in some states (e.g., California, Colorado, Texas, and Utah), these wildlife values represent 20-40 percent of forage value. If we assume that 25 percent or more of rangelands contribute to wildlife-expenditures, then wildlife recreation values in many states are equal to or larger than our estimated values of forage for livestock.

4 Other Ecosystem Services

There is no readily available data set on the provision of general ecosystem services from rangelands. Some studies on specific ecosystem services in specific locations do exist (see Gomez-Baggethun 2010 for a review), but they are insufficient to confidently apply them across the entire Western region. We therefore use a simple approach to approximate some of the ecosystem service values provided by western rangelands. The Grassland Reserve Program (GRP) is a voluntary program that compensates landowners to restore and protect grassland, including rangeland and pasture (NRCS 2012). The intent of the program is to enhance plant and animal biodiversity and protect grassland under threat of conversion. Thus, GRP rental rates could serve as a proxy for many of the non-market ecosystem services provided by rangelands. Since GRP also targets grassland with high conversion risk, rental rates tend to be higher in locations facing development pressure. These higher rates do not necessarily reflect greater ecosystem services and may overestimate ecosystem service values. On the other hand, areas with high conversion risk may also have a lower supply of ecosystem services, which suggest ecosystem services in these areas should be assessed at a higher value. GRP rental rates in the western U.S. average approximately $9/acre but range from a low of $5/acre to a high of nearly $20/acre (Figure 4).

Figure 4. Grassland Reserve Program county-level rental rates ($/acre/yr) for 2012



If GRP rental rates are a reasonable proxy for rangeland ecosystem service values, they suggest ecosystem services contribute substantial value to western rangelands. Multiplying the per-acre GRP rental rates by the total number of rangeland acres in each state generates values on par with those for livestock forage (Table 6). Since GRP rental rates reflect the value for lands eligible for the program (i.e., above-average productivity and at risk of conversion), applying the rates to all rangeland acres likely overestimates ecosystem service values. Nonetheless, even if only a fraction of the rental rate was applied, the value of ecosystem services would remain an important component of the comprehensive value of rangelands.

Table 6. Estimated value of ecosystem services by state using 2012 Grassland Reserve Program rental rates

State	Total	Average Value per Acre
Arizona	278,524,177	5.00
California	479,712,091	10.16
Colorado	229,122,555	6.58
Idaho	249,240,871	8.45
Kansas	279,486,907	11.49
Montana	401,773,842	7.54
Nebraska	286,495,005	12.23
Nevada	296,941,755	5
New Mexico	330,325,187	5.42
North Dakota	145,380,675	8.23
Oklahoma	189,673,951	8.31
Oregon	388,881,367	15.07
South Dakota	284,236,063	10.90
Texas	772,519,991	7.29
Utah	164,809,758	5.59
Washington	196,493,570	13.21
Wyoming	351,347,939	6.82
Total	***5,324,965,704***	***8.96***

Toward a More Comprehensive Estimate of Rangeland Values

A comprehensive measure of rangeland values should include all of the market and non-market values provided by rangelands. Given limited data, we have estimated proxies for a few important rangeland values, including: 1) forage values using pasture rental rates as a proxy for value; 2) carbon sequestration values using carbon market prices to proxy for the value of sequestered carbon; 3) recreation values using US FWS estimates of expenditures on wildlife-related recreation to proxy for recreation values; and 4) general ecosystem service values using Grassland Reserve Program payment rates as a proxy for general ecosystem service values. These four rangeland values are neither comprehsive nor mutually exclusive. There is surely a long list of rangeland uses for which we did not estimate an explicit value (e.g., scenic views). Additionally, the values we did estimate probably have some overlap (e.g., forage and carbon sequestration values are related – locations with high forage value also have high potential to sequester carbon). Given these issues, any estimate of the comprehensive value of rangeland derived from our four values should be interpreted cautiously. Simply summing our four values, for example, can be interpreted as a proxy for a "more comprehensive" estimate of rangeland values (i.e., relative to forage values alone). However, this proxy would tend to underestimate true values since not all uses of of rangelands are included, and it would tend to overestimate values since the values included are not mutually exclusive (i.e., there may

be some double counting). Nonetheless, it is likely that the value of uses not measured outweigh any double counting across our estimates. Thus, summing our four uses (see below) probably errors, perhaps substantially, on the conservative side, and is therefore a useful addition to any conversation about rangeland policy.

Table 7 summarizes all of our estimates by state on a per-acre, per-year basis. The value of forage for livestock generally represents, as expected, the largest per acre value. The value of general ecosystem goods and services, estimated with Grassland Reserve Program payments rates, adds substantial values – in some cases more than the value of forage (e.g., Montana, Nevada and New Mexico). Carbon sequestration and wildlife-related recreation can add significant values to rangelands depending on the assumption used. If carbon prices reach those predicted under cap-and-trade legislation, rangeland sequestered carbon would be a valuable ecosystem service. Additionally, wildlife-related recreation can add significant value to rangelands depending upon how much of the state-level expenditures are attributed to rangelands. When we assume rangeland accounts for expenditures in direct proportion to their area in the state (i.e., 100 percent column), wildlife-related recreation is more valuable than forage in many states. Even with more conservative assumptions, wildlife-related recreation can represent an important rangeland value.

Table 7. State-level average values ($/acre) by use/service

			Carbon Sequestration[2]			Wildlife-Related Recreation[3]				
State	*Forage*	*General EG&S*	*Low*	*High*	*Cap & Trade*	*100%*	*1%*	*5%*	*10%*	*25%*
Arizona	-	5.00	-	-	-	11.49	0.11	0.57	1.15	2.87
California	10.28	10.16	0.10	0.40	2.81	39.90	0.40	1.99	3.99	9.97
Colorado	4.44	6.58	0.16	0.62	4.37	20.84	0.21	1.04	2.08	5.21
Idaho	12.00	8.45	0.12	0.46	3.27	4.96	0.05	0.25	0.50	1.24
Kansas	15.46	11.49	0.16	0.63	4.46	2.97	0.03	0.15	0.30	0.74
Montana	5.71	7.54	0.18	0.69	4.89	4.00	0.04	0.20	0.40	1.00
Nebraska	23.04	12.23	0.18	0.68	4.78	2.87	0.03	0.14	0.29	0.72
Nevada	1.16	5.00	-	-	-	5.12	0.05	0.26	0.51	1.28
New Mexico	1.65	5.44	0.13	0.50	3.55	3.94	0.04	0.20	0.39	0.99
North Dakota	13.87	8.23	0.14	0.55	3.86	0.53	0.01	0.03	0.05	0.13
Oklahoma	11.46	8.31	0.10	0.40	2.81	7.35	0.07	0.37	0.73	1.84
Oregon	13.22	15.07	0.05	0.18	1.30	12.33	0.12	0.62	1.23	3.08
South Dakota	25.82	10.90	0.13	0.51	3.64	3.71	0.04	0.19	0.37	0.93
Texas	7.92	7.29	0.07	0.27	1.92	17.16	0.17	0.86	1.72	4.29
Utah	4.96	5.59	0.04	0.16	1.12	10.39	0.10	0.52	1.04	2.60
Washington	19.12	13.21	0.07	0.26	1.85	32.92	0.33	1.65	3.29	8.23
Wyoming	5.07	6.82	0.17	0.65	4.62	6.31	0.06	0.32	0.63	1.58

[1] General ecosystem goods and services (EG&S) values estimated using Grassland Reserve Program payment rates.
[2] Carbon sequestration values estimated using "low" and "high" observed carbon prices on the Chicago Climate Exchange and predicted carbon prices given cap-and-trade legislation.
[3] Wildlife-related recreation values estimated using state-level expenditures estimates from the U.S. Fish and Wildlife Service. State-level expenditures are attributed to rangelands based on rangelands proportion of the state ("100%"), and fractions thereof (i.e., "1%",…, "25%").

Our estimates above suggest western rangelands provide important values beyond those captured by livestock forage alone. Summing together the four values across all rangeland acres generates total values from $10.7 billion to $21.2 billion. Compared to forage value alone ($6.7 billion), ecosystem goods and services, and recreation contribute significantly to rangeland values. On average across the region, for example, forage value accounts for approximately 30 percent to 60 percent of our estimated total values (Figure 5).

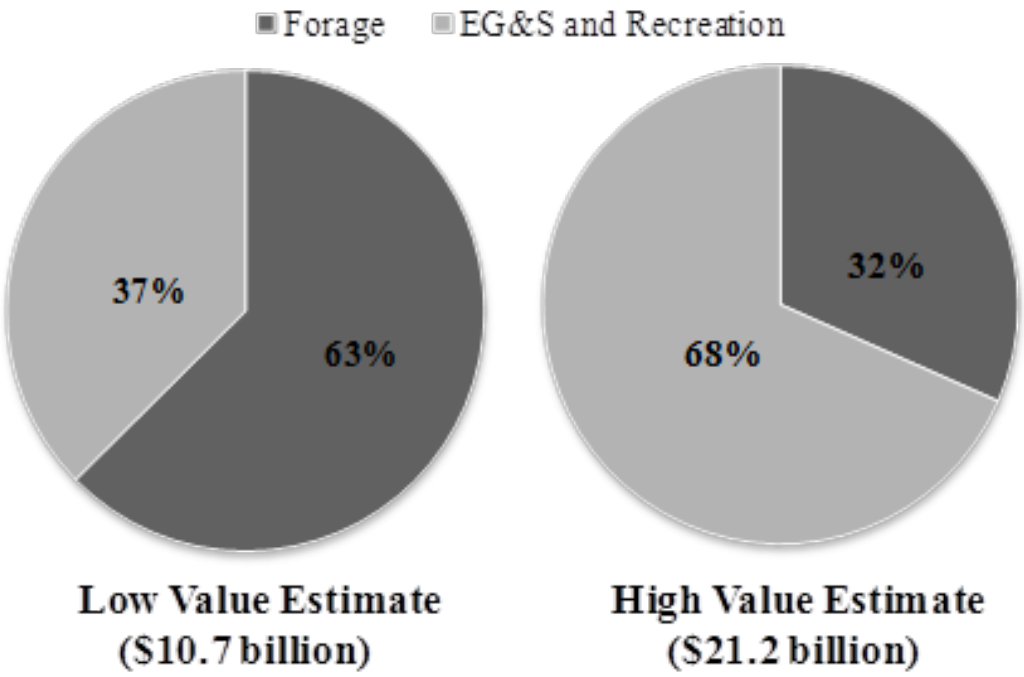


Figure 5. Relative contribution of forage, ecosystem goods and services (EG&S), and recreation to total estimated rangeland value in the western U.S. EG&S include carbon sequestration values and EG&S values derived from Grassland Reserve Program payment rates. Low-value estimates use low carbon prices and 1% rangeland contribution to wildlife recreation. High-value estimates use cap-and-trade carbon prices and 100% rangeland contribution to wildlife recreation.

The relative value of EG&S and recreation is also highly variable across the region. Recall that many western counties are excluded from the carbon sequestration market and many lack pasture rental rates (i.e., forage value estimates). Furthermore, GRP rental rates and wildlife-related recreation expenditures vary significantly across counties and states. Thus, there are many reasons why some states/counties have significantly higher proportions of rangeland value attributed to ecosystem services and recreation (Figure 6).

Some of the spatial variation is the spurious result of missing data; however, much of the variation can be explained by differences in rangeland quality and the intensity of rangeland uses. In regions where rangelands are highly productive (e.g., eastern Dakotas and Nebraska), forage value tends to account for a larger proportion of rangeland values. In regions where rangelands are relatively less productive but wildlife-related recreation is significant (e.g., Utah, Texas, and Wyoming), forage value tends to account for a smaller proportion of rangeland values.

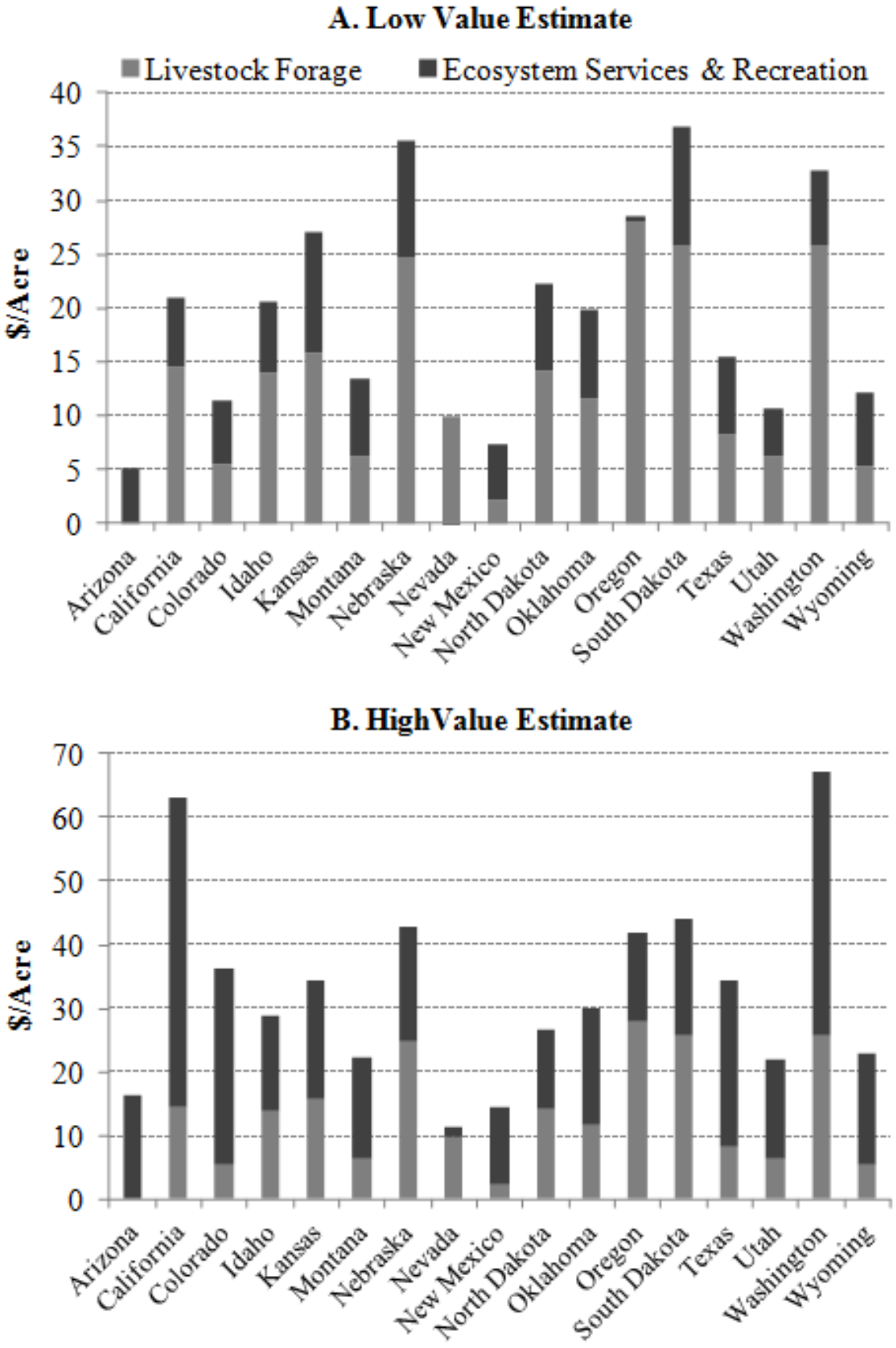


Figure 6. Composition of estimated rangeland values per acre by state. Panel A depicts low-value assumptions (i.e., low carbon price and 1% recreation value). Panel B depicts high-value assumptions (i.e., cap-and-trade carbon price and 100% recreation value)

Summary

There are many challenges to accurately estimating the comprehensive values of western rangelands. The estimates in this report represent one approach, using publicly available data, to further explore the diverse values of western rangelands. Given the many caveats and limitations discussed above, these estimates should be applied cautiously. Nonetheless, even our most conservative estimate suggests that the true value of western rangelands extends beyond the value associated with livestock forage. On average across the western states, forage for livestock represents 32-63 percent of our estimated comprehensive rangeland values. Considering forage values alone would therefore systematically underestimate the true value of rangelands. Policy decisions that depend upon estimates of rangeland value are likely to error significantly if they do not include a more comprehensive measure of rangeland values. Moreover, policies designed using limited value estimates (e.g., only forage values) may create unintended consequences by negatively affecting comprehensive rangeland values.

References

Coupal, Roger, Gary Beauvais, Dennis Feeney, and Scott Lieske. *The Role and Economic Importance of Private Lands in Providing Habitat for Wyoming's Big Game.* University of Wyoming, William D. Ruckelshaus Institute for Environment and natural Resources, Laramie, WY, pp. 8.

Derner, J.D. and G.E. Schuman. 2007. *"Carbon sequestration and rangelands: a synthesis of land management and precipitation effects."* Journal of Soil and Water Conservation 62(2): 77-85.

National Agricultural Statistics Service. 2011. *Rent, Cash, Pastureland.* Available from http://quickstats.nass.usda.gov.

NRCS (Natural Resources Conservation Service). 2012. *Grassland Reserve Program.* Available at: www.nrcs.usda.gov.

Ritten, J., C.T. Bastian, and B.S. Rashford. 2012. *"Profitability of stocking the range with carbon: Insights form recent market events."* Rangeland Ecology and Management (In Press).

USFWS (United States Fish and Wildlife Service). 2006. *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*, Washington DC, pp 168.