# A Model for Federal Public Land Surface Rights Management

Authors

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Abstract

The U.S. Forest Service and the U.S. Bureau of Land Management (BLM) control large tracts of federal public lands. Management goals for these tracts are described as ''multiple-use.'' Some of the lands are forested, mountainous, contain wildlife or possess other scenic and recreational attributes and warrant the multiple-use designation; however, a significant portion, especially that under BLM control, contains little scenic, recreation or wildlife value, thus offering little multiple-use potential and non-pecuniary value. Inherent in the management of all federal lands is a defacto fiduciary responsibility to prudently and efficiently manage these assets. We develop a framework that measures present values of both quantitative and qualitative economic benefits and costs of federal public lands to assist managers and policy makers in determining future management policy. By applying this framework, federal public land policymakers may be aided in fulfilling their fiduciary responsibilities.

The largest inventory of federal public lands in the United States is under the control of the U.S. Department of Agriculture, via the U.S. Forest Service (USFS), and the U.S. Department of Interior via the Bureau of Land Management (BLM).[1] The largest proportion of these lands is found in the western United States, although public lands exist in almost every state. The primary objective for both USFS and BLM lands is multiple-use, where the definition of multiple-use is managing a land area to simultaneously provide more than one of the following resource objectives: fish and wildlife, wood products, recreation, aesthetics, grazing, watershed protection, and historic or scientific values.[2] Given these multiple-use objectives, a de facto fiduciary responsibility to the public requires that these lands be prudently, efficiently, and effectively managed.[3] The purpose of this paper is to develop a framework that measures the present values of both quantitative/pecuniary and qualitative/non-pecuniary economic benefits and costs of federal public lands to assist managers and policy makers in determining future management policy, and to assess the effectiveness and efficiency of surface rights management for both types of federal public land.[4]

The paper addresses two issues. First, we develop a management model that considers the present value of future multiple use attributes (both pecuniary and

non-pecuniary) and future management costs of individual public land parcels in the decision to either continue to own and manage each parcel or sell the parcel to private ownership. Inherent in the non-pecuniary attributes are multiple-use attributes including scenic, recreational and hunting, as well as pecuniary attributes including grazing and foresting. Much of the public land that we are specifically targeting for inventorying is BLM land that is completely surrounded by private land and contains little scenic or recreational value. We recognize that there may be other alternatives that would improve management efficiency and effectiveness. Specifically, the model may also assess the benefit/costs of other modifications of land use that may include changing management policy or selling the land to private ownership. For example, this may include turning control of some parcels over to the states in which the parcel is located.

We further use a hedonic model developed from private land sales in Wyoming to estimate the value of public lands controlled by both the USFS and the BLM. Because of the scope of this study and data availability, we limit our estimation of the value of federal lands to USFS and BLM lands in the State of Wyoming; however, we observe the entire operating budgets for both types of federal lands. Even though we limit our estimation of federal land values to those lands located in Wyoming, we are confident that much of our analysis also pertains to the value of public lands in other western states, and to a somewhat lesser extent nationally, since federal lands located in the western U.S. are very similar to public lands located in Wyoming. Because of lower population density and lower potential demand for lands in Wyoming, our valuation is a very conservative estimate of the value of federal lands nationally. Higher values for public lands will enforce our policy recommendations.

Although management goals for all lands controlled by these agencies are described as multiple-use, some of the lands possess very few of the attributes to provide significant multiple-use contributions. Some of the lands are forested, mountainous, contain wildlife or possess other scenic and recreational attributes and warrant the federal multiple-use designation (significant non-pecuniary attributes); however, a significant portion of the land, especially that under BLM control, contains little scenic, recreation or wildlife value, thus offering very little multiple-use potential. Much of the land not warranting multiple-use potential has never been titled to anyone except the federal government (never sold nor homesteaded). Since it is our finding that management inefficiencies, operating deficits, and bureaucratic overstaffing for USFS and BLM lands have created a situation where government's fiduciary responsibility may have been abrogated, we suggest that all federal lands be inventoried with regard to multiple-use attributes and be assessed on a benefit-cost basis. Large operating deficits resulting from the management of USFS and BLM surface rights makes these lands an expensive liability rather than an asset. Thus we posit that these agencies be required to justify their continued defacto ownership of these lands.[5]

## History of USFS and BLM Lands

In 1812, Congress established the General Land Office in the Department of the Treasury to oversee the disposition of federal lands. As the nineteenth century progressed and the nation's land base expanded westward, Congress encouraged the settlement of these lands by enacting a wide variety of laws.

The late nineteenth century marked a shift in federal land management policies, where instead of using public lands to promote settlement exclusively, Congress decided these lands should be held in public ownership because of their resource values. The Taylor Grazing Act of 1934, specifically addressing surface rights, established the U.S. Grazing Service to manage the public rangelands. In 1946, the Grazing Service was merged with the General Land Office to form the Bureau of Land Management within the Department of the Interior. The BLM had no unified legislative mandate until Congress enacted the Federal Land Policy and Management Act of 1976. The act declared that these lands would remain in public ownership, and created the term ''multiple-use'' management, defined as ''management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people.''[6]

Since 1996, federal grazing fees on USFS, BLM, and National Grasslands (administered by the USFS) are set by presidential executive orders based on formulas established by the Public Range Improvements Act (PRIA) passed by Congress in 1978. The federal grazing fee for western public lands managed by the BLM and the USFS was $1.79 per animal unit month (AUM) in 2005.[7] These rates are considerably lower than for private grazing rates provided by the USDA Agricultural Marketing Service, which averaged $18.30 for western states.[8] Thus, current USFS and BLM grazing (lease) fees, a primary source of surface revenues, appear to be low relative to reported market private rates.

The Multiple-Use Sustained-Yield Act of 1960 as amended through December 31, 1996, P.L. 104–333 states: ''AN ACT To authorize and direct that the national forests be managed under principles of multiple use and to produce a sustained yield of products and services, and for other purposes.'' Furthermore, it states:

> That 16 U.S.C. 528À it is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. The purposes of this Act are declared to be supplemental to, but not in derogation of, the purposes for which the national forests were established as set forth in the Act of June 4, 1897 (16 U.S.C. 475). Nothing herein shall be construed as affecting the jurisdiction or responsibilities of the several States with respect to wildlife and fish on the national forests. Nothing herein shall be construed so as to affect the use of administration of the mineral resources of national forest lands or to

> affect the use or administration of Federal lands not within national forests.

The act continues:

> SEC. 4. 16 U.S.C. 531À As used in this Act, the following terms shall have the following meanings: (a) ‘‘Multiple use’’ means: The management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output. (b) ‘‘Sustained yield of the several products and services’’ means the achievement and maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land.

The USFS planning regulations (Federal Register, Volume 47 (190): 43026-43052) require maximization of net public benefit, which includes net present value of all multiple-use outputs (market and non-market values), along with multiple use values that are quantitative but not expressed in dollars, and qualitative beneficial effects as well. The BLM Federal Land Policy and Management Act directives for multiple use management have a parallel definition of multiple use from Congress (see Swanson and Loomis, 1996).

The USFS Program for Forest and Rangeland Resources (1990) includes the monetary value of outdoor recreation and wildlife (calculated using federally accepted methods). It suggests that recreation is one-third the value of the National Forests and wildlife habitat is approximately 25% of the value of the National Forests. Grazing, in the USFS Program, represents less than 2% of the value of the National Forests.[9] The monetary valuation model developed below, however, may be applied to all federal public lands when considering pecuniary land attributes. If pecuniary attributes do not justify retaining ownership of a tract of public land, ownership may be justified by non-pecuniary values, such as esthetic multiple-use values to the public.

The public often implicitly assumes that all public lands are the pristine ‘‘National Forests’’ that we all wish to conserve. However, much of the land controlled by he BLM and some of the land controlled by the USFS contains no forests, has very little recreational potential, and provides very little wildlife habitat. These

lands that are currently leased for 'grazing rights' possess little value other than as grazing land. These are the lands that should be inventoried with regard to a benefit-cost assessment to determine their value with regard to future federal ownership or potential sale.

### *Current Controversy*

In most western states, the surface rights for farms and ranches are likely to consist of deeded property with accompanying federal and/or state leases/permits. It is common practice that when ranches and farms are sold, public land leases are transferred along with the sale of the deeded real property. Private lease rates have been used historically as indicators of the value of public leases, thus since private lease rates for comparable lands are generally higher than public lease rates, public leases and permits may have value. Thus it is commonly believed that public leases are priced below fair market value, where the difference in the intrinsic value and grazing fee rate is capitalized in the sale price of farms and ranches.[10]

Numerous arguments have been made for and against current federal management policies focusing on surface leasing, where surface leasing has generally been for grazing leases. The issue of grazing leases and other revenues from surface rights on public lands is a politically contentious topic; however, we wish to skirt this issue and concentrate on the financial effectiveness and efficiency of current management policy and suggest possible alternatives.[11]

### *Previous Work*

Previous related work by Sunderman, Spahr, and Bunyan (2004) and Sunderman and Spahr (2006) assess whether current management policy fulfills fiduciary obligations with respect to maximizing investment returns generated on Wyoming school trust lands through grazing leases. To estimate returns on school trust lands, they estimated both the realized annual revenues and the market value of the trust lands. Both papers used hedonic models to estimate market values of school trust lands and then estimated returns from realized surface lease revenues. The estimated rate of return on market value was compared with the most likely alternative scenario that assumes the land were sold and the proceeds were reinvested in long-term U.S. Treasury securities.[12] We apply a similar methodology for BLM and USFS surface rights.

## Model for Trust Land Policy

Inherent in the management of federal public lands is a defacto fiduciary responsibility to prudently, efficiently, and effectively manage these lands. Given that objectives and desired utilization of federal public lands is ''multiple-use,'' we develop a model that considers both the benefits from multiple-use and the BLM and USFS fiduciary responsibilities to prudently manage these lands. We assume that public land managers have two alternative choices for each land

parcel. One alternative is to continue public ownership of surface rights and current stewardship. This would result in generating future public non-pecuniary (scenic, recreation, wildlife, etc.) and pecuniary benefits (fee or lease revenues), as well as incurring management expenses. Alternatively, the second choice is to sell the land and use the proceeds for alternative public benefit.[13] Since preservation of the public multiple-use value is the goal for federal lands, it is logical that the economic opportunity cost of holding federal lands is the long-term U.S. Treasury rate that could be earned on their market value.

A once and for all sale and public reinvestment decision is similar to Vitaliano and Hill's (1994) conversion of farm land from agricultural production to non-farm uses and Wicksell's classic problem of the timing of the cutting of a forest (see Bentick and Pogue, 1988). Assuming that sales and reinvestment costs are negligible, the decision for policymakers is between continuing to receive a possibly growing stream of revenue payments and possibly a growing steam of operating expenses or alternatively, to receive a fixed public benefit or stream of revenues from the reinvestment of sales proceeds. Given the model's determination of the tradeoff between continuing to own each specific land parcel and the public benefits of sale of the parcel, any shortfall may then be compared with the future steam of public non-pecuniary benefits accrued from multiple-use.[14]

## Model for USFS and BLM Federal Lands

A model for USFS and BLM lands is developed, where the discounted present value of benefits received from a land parcel is $V_t$. Also, let $L_1$ denote the current annual revenue from fees or leasing a particular parcel of public land, and $g_L$ is the expected annual growth rate in these fee or lease revenues. Also, let $E_1$ denote current operating expenses for the parcel under consideration, where $g_E$ is the expected annual growth rate in these operating expenses. Proceeds from the sale of the parcel at time $t$ are denoted as $S_t$ (current sales price is $S_1$), where the sales price is expected to grow at $g_S$ until the date of the sale. Once the sale has occurred, it is assumed that the proceeds will be invested in long-term U.S. Treasury securities for perpetuity with a yield of $r$. Payments in lieu of taxes (PILT) to local governments is another expense for federal lands, thus $p$ denotes the rate at which PILT are paid on lease revenues, $L_1$, and $g_p$ represents the annual growth rate in PILT.[15] Thus, the present discounted value of benefits to the federal government received from a parcel of public federal land, $V_t$, is given by:

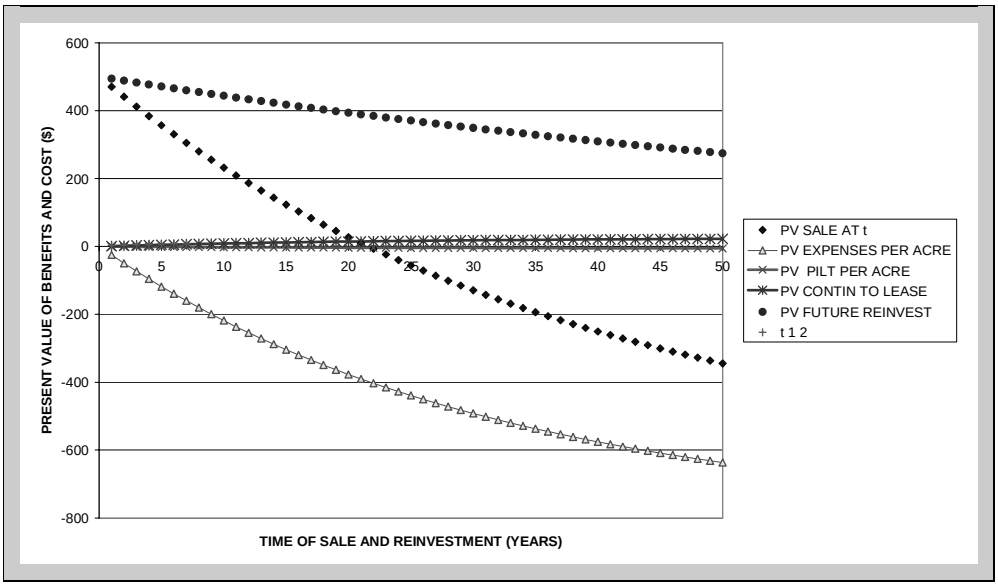
$$V_t = L_1\left[\frac{1 - e^{(g_L - r)t}}{r - g_L}\right] - E_1\left[\frac{1 - e^{(g_E - r)t}}{r - g_E}\right] + \frac{rS_1e^{(g_S - r)t}}{r} - pL_1\left[\frac{1 - e^{(g_L - r)t}}{r - g_p}\right], \quad (1)$$

where, $t = 1,2,....$

The first term in (1) represents the present value of annual fee/lease payments (revenue), growing at $g_L$, until the land is sold at time *t*. The second term represents the present value of operating expenses associated with the parcel in question until the parcel is sold at time *t*. The third term represents the present value of annual interest on reinvested sales proceeds subsequent to the sale of the land at time *t*. The fourth term represents the present value of PILT payments until the land is sold at time *t*.[16]

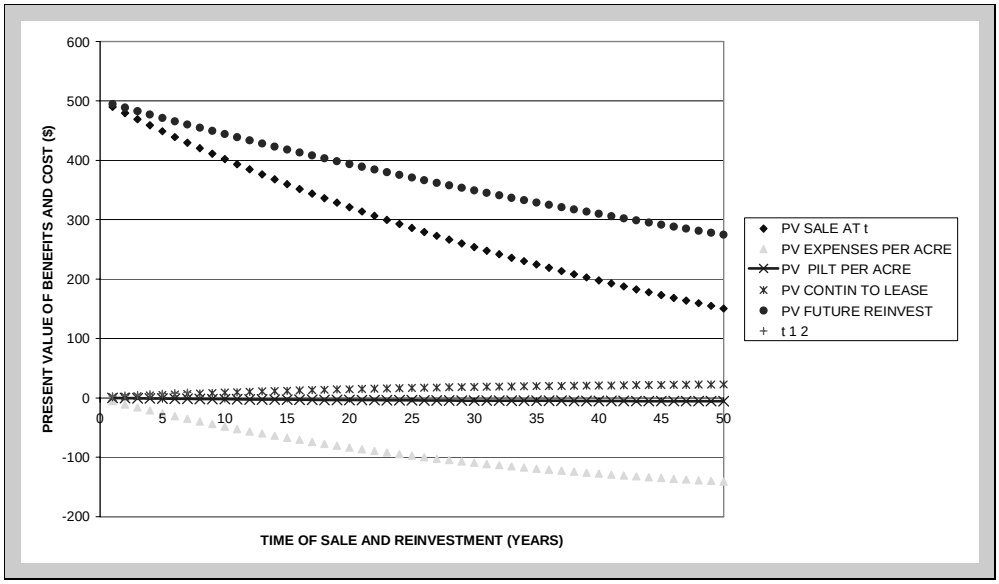
We base land policy decisions on nominal interest rates, and growth rates rather than real rates. Also, because of inflation and increasing demand for federal public land caused by population growth or other factors, we allow for different growth rates over time for annual surface right fee/lease payments, annual management operating budgets, and sale prices of the land parcels. The land management problem, under some circumstances, is to select an optimal date of sale. The normal approach for economists is to differentiate (1) with respect to t and setting each equal to zero to find the value maximizing sales date, *t**. However, $V_t$ in (1) is a function of three geometric series and may contain localized maxima or minima, a potential problem when solving for *t**. Thus, we consider the methodology used by Vitalliano and Hill (1994) as impractical in this application since it could result in suboptimal decisions. Rather than solving for *t**, we use a simple spread sheet iterative/graphical approach to find *t**. Graphs representing the iterative approach are displayed in Exhibits 1 and 2. The parameters for these exhibits are developed below.[17]

**Exhibit 1** | PV of USFS Benefits and Cost as a Function of Sale Date and Reinvestment




*Notes:* Lease rate = $1.79 per AUM, land value = $500.62 per acre, appreciation rate = 5%, lease appreciation rate = 2%, operating cost per acre = $25.52, U.S. Treasury rate = 6.2%.

**Exhibit 2** | PV of BLM Benefits and Cost as a Function of Sale Date and Reinvestment




*Notes:* Lease rate= $1.79 per AUM, land value = $500.62 per acre, appreciation rate = 5%, lease appreciation rate = 2%, operating cost per acre = $5.66, U.S. Treasury rate = 6.2%.

## Data and the Hedonic Model

Under current management policy, pecuniary revenues from surface rights on USFS and BLM lands are generated mainly from lease revenues and appreciation of surface right values. To determine the return on monetary investment that the USFS and BLM are currently achieving on these public lands, we must estimate the value of these lands. Public land values are estimated using hedonic MRA models for lands located in Wyoming.

Data used in pricing land consist of 1,725 private land sales from 22 of the 23 counties in Wyoming.[18] All sales occurred between January 1989 and June 2003. Land sales data include both productive and nonproductive characteristics of individual operating ranches and farms where some sales included only BLM or Forest Service leases.

Land sales with less than 100 deeded acres are omitted from the data set, because such parcels, generally hobby farms and ranches, would not represent tracts of land similar to public land parcels. Sales with deeded property and/or leases or permits outside of Wyoming are also eliminated from the data. Other exclusions are made because of incomplete data for individual sales. The resulting data set contains 1,431 land sales. The typical property sold for $605,884, with 3,691 acres of deeded land, 1,926 deeded animal unit months (AUMs), 510 leased AUMs,

and an average per acre price of $436. A description of the variables is included in Exhibit 3.

Since our objective is the estimation of the fair market value and capital appreciation rates of USFS and BLM lands located in Wyoming, price per acre is defined as the dependent variable. A linear functional form hedonic model is used to capture the effects of various attributes on land values. Explanatory variables incorporate and control for each unit's income producing ability, location, and market conditions. Results from previous studies and the availability of data also influenced the selection of explanatory variables.[19]

The log of deeded acres (*LDACRE*) is used to control for possible economies of scale and possible nonlinear relationships between deeded acres and the price per acre. The log of deeded acres is used to control of economies of scale since generally it is observed that larger farms and ranches sell for lower price per acre. *QUALITY*, the ratio of deeded AUMs to deeded acres, is employed to control for the difference in the productive quality of land.[20]

Land productivity or quantity of available forage (in AUMs) is divided into two groups, deeded forage and leased forage. Grazing leases consist of section 3 (Taylor Grazing Act) BLM, section 15 (Taylor Grazing Act) BLM, State of Wyoming school trust, USFS permits, and private leases. Each variable reflects the percentage of total AUMs represented by lease type. Section 3 BLM leases generally consist of larger acreage or tracts of land that may represent an interest in a grazing association or at least represent a larger scale lease. Section 15 BLM leases generally are those tracts that are interspersed among ranches' deeded acres. Often, section 15 tracts are lands that were never homesteaded or purchased from the federal government. These tracts usually have the least desirable terrain and usually contain little water. Since deeded AUMs, as a percentage of total AUMs, is not included in the model, the coefficients on these variables represent either a discount or premium in relation to deeded AUMs

Many land sales includes permanent improvements such as buildings and equipment essential to the agricultural operation, thus we include the estimated value of real improvements as an explanatory variable.

A major factor influencing the sale price is each property's unique scenic and/or recreational attributes. A subjective assessment of this factor is used as a basis for constructing five dummy variables: *POOR*, *FAIR*, *AVERAGE*, *GOOD*, and *EXCELLENT*.[21]

A USDA/USDI (1993) study, which includes Wyoming as one of the three test states, classified regionalized forage values into clustered intrastate allotments based on 21 different ecoregions. Six of these ecoregions (3, 4, 5, 7, 8, and 9) are found in the counties studied in Wyoming. The ecoregions represent a composite set of ecological boundaries identified by differences in soil, vegetation, landform, climate, and use. Using ecoregion to control for location in the model made more sense than the use of county lines, which are political and have no impact on value.

**Exhibit 3** | Description of Variables

| Variable | Descriptions |
|---|---|
| Grazing Lease Variables | |
| *BLM3AUM%* | Section 3 BLM Grazing Lease AUMs / Total AUMs |
| *BLM15AUM%* | Section 15 BLM Grazing Lease AUMs / Total AUMs |
| *STATEAUM%* | State Lease AUMs / Total AUMs |
| *FORSTAUM%* | Forest Service Grazing Permit AUMs / Total AUMs |
| *PRVTAUM%* | Private Lease AUMs / Total AUMs |
| Real Property | |
| *REAL / ACRE* | Real Property / Deeded Acres |
| Deeded AUM and Deeded Acres Variables | |
| *LDACRES* | Log of Deeded Acres |
| *IRCAUM%* | Irrigated Crop Land AUMs / Deeded AUMs |
| *IRHAUM%* | Irrigated Hay Land AUMs / Deeded AUMs |
| *DRYAUM%* | Dry Crop Land AUMs / Deeded AUMs |
| *SUBBAUM%* | Subirrigated, Improved, or Bottom Grazing Land AUMs / Deeded AUMs |
| *FTMNTPER%* | Foothills and Mountain Grazing Land AUMs / Deeded AUMs |
| *OTHERAUM%* | Dry Grazing Land or Undefined Deeded AUMs / Deeded AUMs |
| *QUALITY* | Deeded AUMs / Deeded Acres |
| Scenic / Recreational Dummy Variables | |
| *POOR* | Dummy Variable for Ranches with Limited Scenic and / or Recreational Value |
| *FAIR* | Dummy Variable for Ranches with Little Scenic and / or Recreational Value |
| *AVERAGE* | Dummy Variable for Ranches with Average Scenic and / or Recreational Value |
| *GOOD* | Dummy Variable for Ranches with Good Scenic and / or Recreational Value |
| *EXCELLENT* | Dummy Variable for Ranches with Excellent Scenic and / or Recreational Value |
| Ecoregion Dummy Variables | |
| *ECO3, ECO4, ECO5, ECO7, ECO8, and ECO9 ECEEE EC* | Dummy Variables Representing Location Based on Ecoregion |
| Condition of Sale Dummy Variables | |
| *ARMS* | Arms-Length Transaction Sale |
| *STRESS* | Stress Sale |
| *AUCTION* | Auction Sale |
| *LESSARMS* | Less than an Arms-Length Transaction Sale |
| *FORECLO* | Foreclosure Sale |
| Date of Sale Variables | |
| *B89S1 to B03S1* | Weighted time variable for the beginning of the semi-annual period listed. These variables are for the data from 1989–2003. |

The date of sale variable, as incorporated in the model, controls for changing market prices throughout the time period of the study. The method used is a variant of the time variable approach suggested by Bryan and Colwell (1982).[22] There is a date of sale variable for each half-year in which sales occurred, with half-years beginning on January 1 or July 1 for all years in the study.[23] This approach allows the rate of change in prices to be different for each half-year and allows a monthly price continuum rather than a step function.

Two additional criteria are used to eliminate very unusual sales. Sales are deleted if price is greater than three standard errors above or below the predicted sale price. This large predictive error may result from model misspecification, a lack of sufficiently detailed information regarding the property and/or incorrect sales data. The second criterion eliminates any sales with unusually large absolute values for Cook's distance ($>1.00$). This indicates that the property has one or more characteristics that are quite different from other sales, and whose presence has an unduly large influence on the overall predicted values generated by the model.[24] These additional criteria result in the removal of less than 1.2% of all data.[25]

The model is developed forcing the intercept through zero so that a land with zero acres and no other attributes will have a zero price per acre. A nonzero intercept implies that a property with no attributes would have a value equal to the intercept.[26]

## Empirical Results for Hedonic Pricing Model

Referring to Exhibit 4, the hedonic model represents a good fit where the adjusted $R^2$ is 0.8990. Due to possible concerns over multicollinearity among independent variables, variance inflation factors (VIF) were run on all model variables. It was found that except for the variables *LDACRES* and *ECO8* all were highly acceptable ($<10.0$), indicating that the model is not subject to problems of multicollinearity.[27]

Empirical results indicate that land type and productivity significantly impact price per acre. For example, higher percentages of total AUMs attributed to irrigated crop (*IRCAUM*), irrigated hay (*IRHAUM*), and subirrigated, improved, or bottom grazing land (*SUBBPER*) translate into higher per acre prices when compared to dry grazing land.

Similar to previous studies, scenic/recreational variables provide major contributions.[28] For land held primarily for production (*POOR* and *FAIR*), scenic/recreation attributes have little impact on the price per acre; however, more scenic land had scenic/recreation premiums of $105.42 (*AVERAGE*), $281.40 (*GOOD*), and $320.80 (EXCELLENT) per acre over lands rated as *POOR*. More scenic/recreational land values will translate into lands containing higher alternate or multiple-use attributes for public lands and may represent public lands more desirable for public use, such as forests, mountains, and wildlife habitat.

**Exhibit 4** | The Hedonic Model

| Variable | Parameter Estimate | *t*-Statistic |
|---|---|---|
| *BLM15AUM%* | −115.061 | −1.97 |
| *BLM3AUM%* | −0.962 | −0.02 |
| *STATEAUM%* | 259.204 | 4.70 |
| *FORSTAUM%* | −88.580 | −0.80 |
| *PRVTAUM%* | 332.872 | 1.63 |
| *IRCAUM%* | 253.338 | 8.65 |
| *IRHAUM%* | 138.417 | 6.06 |
| *DRYAUM%* | −5.563 | −0.16 |
| *SUBBPER%* | 95.147 | 2.28 |
| *FTMNTAUM%* | −33.786 | −1.73 |
| *OTHERAUM%* | — | — |
| *LDACRES* | −63.679 | −13.54 |
| *QUALITY* | 28.646 | 7.82 |
| *REAL/ACRE* | 1.667 | 41.36 |
| *POOR* | — | — |
| *FAIR* | 13.669 | 0.93 |
| *AVERAGE* | 105.421 | 6.08 |
| *GOOD* | 281.396 | 13.41 |
| *EXCELLENT* | 320.805 | 10.26 |
| *ECO3* | — | — |
| *ECO4* | 53.107 | 1.44 |
| *ECO5* | 63.896 | 1.65 |
| *ECO7* | 226.112 | 5.81 |
| *ECO8* | 42.081 | 1.22 |
| *ARMS* | — | — |
| *AUCTION* | −42.072 | −1.97 |
| *STRESS* | −61.867 | −1.38 |
| *LESSARMS* | −9.823 | −0.23 |
| *FORECLO* | 32.348 | 0.49 |
| *B89S1* | 381.855 | 5.36 |
| *B89S2* | 526.655 | 5.82 |
| *B90S1* | 424.427 | 6.98 |
| *B90S2* | 466.095 | 8.05 |
| *B91S1* | 400.383 | 6.83 |
| *B91S2* | 393.419 | 6.78 |
| *B92S1* | 405.269 | 7.05 |
| *B92S2* | 384.016 | 6.66 |

**Exhibit 4** | (continued)
The Hedonic Model

| Variable | Parameter Estimate | *t*-Statistic |
|---|---|---|
| *B93S1* | 458.603 | 7.94 |
| *B93S2* | 398.121 | 7.22 |
| *B94S1* | 481.627 | 8.47 |
| *B94S2* | 467.922 | 8.14 |
| *B95S1* | 510.975 | 8.54 |
| *B95S2* | 495.131 | 9.17 |
| *B96S1* | 510.222 | 7.77 |
| *B96S2* | 571.345 | 9.26 |
| *B97S1* | 591.426 | 9.33 |
| *B97S2* | 667.296 | 10.68 |
| *B98S1* | 543.295 | 8.25 |
| *B98S2* | 766.287 | 11.70 |
| *B99S1* | 666.339 | 10.35 |
| *B99S2* | 699.726 | 10.62 |
| *B00S1* | 770.911 | 12.07 |
| *B00S2* | 635.919 | 10.33 |
| *B01S1* | 785.068 | 11.15 |
| *B01S2* | 988.005 | 14.47 |
| *B02S1* | 842.241 | 12.59 |
| *B02S2* | 833.920 | 8.98 |
| *B03S1* | 1009.128 | 4.41 |
| Adj. $R^2$ | 0.8990 | |
| Observations | 1431 | |

Note: The dependent variable is *Price Per Acre*.

The ecoregion in which a land sale is located also significantly impacts the price per acre. This is also the case for land productivity (as measured by *QUALITY*), where as expected increasing productivity significantly impacts prices.

The impact on leased lands that accompany deeded land sales may have an impact on the total sales price. BLM leases tend to either reduce or have no impact on deeded land sales, whereas the transfer of state leases significantly increases property values.

The results also indicate that real improvements to the land, valued by the appraiser at $1.00 per acre, tend to increase property values by $1.67 per acre.

Agricultural operations with real improvements are generally those that are well maintained and have improved facilities. Therefore, real improvements may be acting as a comprehensive measure for all improvements.[29]

Using the results of the hedonic model displayed in Exhibit 4, the price per acre and the value of a section (640 acres) may be estimated for each ecoregion. The following assumptions were made to arrive at these estimates: (1) each USFS or BLM section has a *QUALITY* rating equal to the average value for the ecoregion in which it is located; (2) date of valuation is January 2003; (3) the scenic/recreational attribute used is the average observed value for the given ecoregion; (4) there are no real improvements; and (5) the land is assumed to be dry grazing land. The estimated values and the assumptions used are shown in Panels A and C of Exhibit 5.

Panel A of Exhibit 5 indicates that average land prices for ecoregions in Wyoming range from $500.62 to $900.33 per acre.[30] Price variation among ecoregions results from differing land quality and scenic/recreational characteristics. For example, ecoregion 7 on average is mountainous, very scenic, and annually produces 2.0162 AUMs per acre. Thus, prices in this ecoregion are higher. Alternatively, ecoregion 3, mostly farm land, has even higher productivity (2.5353 AUMs per acre), but because of poor scenic/recreational land potential, the values are significantly lower. Higher land values in ecoregion 7 also may be attributed to a greater desirability for alternate or multiple-uses, whereas, land values in ecoregion 3 are based more on productivity. Thus, it is argued that like ecoregion 3, land in ecoregions 4 and 8 are also likely held primarily for productivity and the potential multiple-use pecuniary value of public lands in these ecoregions may be relatively low.

Panel B of Table 3 displays the average AUMs per section, the expected lease revenue per section, assuming each section is fully leased, and the resulting percentage return on market values assuming a lease rate of $1.79 per AUM for federal lands in effect as of January 2005. In addition to returns resulting from lease revenues, total average pecuniary annual returns on USFS and BLM lands must also include the annual rate of appreciation of land values.[31] It was found that between 1989 and 2003 annual nominal appreciation rates for different ecoregions ranged between 4.95% and 11.16%.

The results from Exhibit 5 suggest that lease returns range from 0.17% to 0.91% for federal lands.[32] When land appreciation is included, returns increase; the highest return is in ecoregion 3 (12.26%) and the lowest return is for lands located in ecoregion 7 (5.35%). Given that the annual compound rate of inflation, as calculated from the Consumer Price Index from 1989 to January 2003 is approximately 2.86%, real rates of return, including price appreciation, were between 2.49% and 9.40%. Alternatively, given, an average nominal return of approximately 6.2% on 10-year U.S. Treasury bonds over this same time period, real rates of return that could have been received by investing in U.S. Treasury bonds could have been 3.34%.

**Exhibit 5** | Estimate of Value per Wyoming Ecoregion

| | ECO3 | ECO4 | ECO5 | ECO7 | ECO8 | ECO9 |
|---|---|---|---|---|---|---|
| Panel A: Estimate of Value[a] | | | | | | |
| Price Per Acre | $500.62 | $523.44 | $610.07 | $900.33 | $537.93 | $693.21 |
| Price per Section | $320,397 | $335,002 | $390,445 | $576,211 | $344,275 | $443,654 |
| Panel B: Estimated AUMs and Revenue | | | | | | |
| AUMs Per Section[b] | 1623 | 477 | 409 | 1290 | 1228 | 424 |
| Lease Revenue[c] Federal Lands | $2,905 | $854 | $732 | $2,309 | $2,198 | $759 |
| Return on Lease | 0.91% | 0.25% | 0.19% | 0.40% | 0.64% | 0.17% |
| Appreciation[d] | 11.16% | 10.38% | 8.24% | 4.95% | 9.94% | 6.91% |
| Total Return | 12.26% | 10.63% | 8.43% | 5.35% | 10.58% | 7.08% |
| Panel C: Section C—Assumptions[e] | | | | | | |
| Quality | 2.535 | 0.746 | 0.639 | 2.016 | 1.919 | 0.662 |
| Average Scenic Area Value[f] | 1.405 | 2.140 | 3.000 | 3.503 | 2.051 | 3.283 |

*Notes:*
[a]These estimates are generated from the hedonic equation shown in Exhibit 4 (see Endnote 30).
[b]This value is based on 640 acres times the quality figure.
[c]We are using the AUM figures from the previous row and the lease rates of $179 per AUM for Federal lands that were in place in 2005.
[d]See endnote 31.
[e]These assumptions are based on the average values for all sales in the given ecoregion.
[f]*POOR* = 1, *FAIR* = 2, *AVERAGE* = 3, *GOOD* = 4, and *EXCELLENT* = 5.

Using longer-term U.S. Treasury rates as the opportunity cost, annually compounded returns to taxpayers would have been lower in some ecoregions and higher in others if lands had been sold in 1989 and the proceeds used for public benefit. However, differences exist in implied pecuniary revenues received over this time period. If lands were sold and proceeds used for public benefit, all returns would have been realized and could have been used for the public good. By continuing to lease, only the portion of pecuniary returns represented by lease revenues would be realized and any opportunity cost would need to be compared to non-pecuniary multiple-use benefits enjoyed by society from using the land. Again, it must be pointed out that the above analysis does not take into consideration any operating expenses for managing the surface rights of public lands.

From the potential external investor viewpoint and actual realizable market prices, we may be upward biasing federal land values. Surface right value, as measured by hedonic models, implicitly assumes that each land parcel is priced as an integral component of an agricultural operation in which the federal land is currently included. Land values also may be biased upward because of the preferred right of renewal, the fact that some states are fence out states,[33] as well as possible access problems for outside investors. On the other hand, because of the low population density of Wyoming, federal public lands in Wyoming may have lower values than other states due to lower demand.

Due to structural factors that may affect the demand for public lands, we suggest that public land trustees evaluate the methods by which land is sold. Currently, it is required that state-managed school trust lands in Wyoming be sold at public auction. Our results demonstrate that public auctions, for structural reasons mentioned above, result in lower prices for sales of deeded properties than conventional arms length sales. We assume this would also be the case for USFS and BLM lands. Thus, if public lands were sold using a non-truncated bidding process with minimum acceptable bids, prices may more closely approximate estimated market values.

## Application of Model

Exhibits 1 and 2 represent respectively, an application of the policy model, equation 1, for individual USFS and BLM land parcels, and apply average parameter estimates for land located in Wyoming's ecoregion 3. Parameter averages for ecoregion 3 are a per acre value of $S_1$ = \$500.62, annual productivity of 2.5353 AUM per acre, estimated future growth rate in land values of $g_S$ = .05, estimated growth rate in lease fees of $g_L$ = .02 even though no increase in lease fees were observed during the duration of this study. Parameters also include an opportunity cost of an estimated return on long-term U.S. Treasury securities of $r$ = .062 and payment in lieu of taxes (PILT) for federal lands of 25% of lease fee revenue. Exhibits 1 and 2 would suggest that given the current (2005) annual lease fee of \$4.54 per acre (\$1.79 per AUM), the federal land parcel under

consideration should be sold and the proceeds be used for the public good with an opportunity rate equal to longer-term U.S. Treasuries.

The application of the policy models for ecoregion 3 represents, from a purely pecuniary or economic perspective, the most likely ecoregion for public lands to be retained and continued to be leased since this is essentially farmland, which sells at a lower price per acre, but has the highest productivity and highest lease rates per acre. However, even for this ecoregion, a decision based solely on pecuniary value would suggest that the land be sold. The public policy model observations for lands in other ecoregions, which sell for higher prices and with lower productivity and lease revenues, suggest that all lands be sold and proceeds reinvested if the decision is based only on pecuniary reasons. Continued ownership of these public lands must be justified mainly on non-pecuniary values or the property's recreation/scenic and multiple-use value.

Since the ''multiple-use'' mission of USFS and BLM lands emphasizes many non-pecuniary land attributes discussed above, we would expect that surface right returns on federal public lands to be relatively low. If a dollar value could be placed on non-pecuniary benefits of some land parcels, attributes such as forests, mountains, wildlife habitat, and other factors contributing to the scenic and recreation value, would provide a significantly high present value of benefits to cost ratio. However, a significant portion of the land inventory of the BLM and some of the land managed by the Forest Service contain minimal non-pecuniary value, thus the benefits of these parcels are mainly grazing leases. The returns on these parcels are characterized in Exhibit 5.

Annual budget information, revenues, and expenses for the USFS and BLM are presented in Exhibit 6. The USFS market-based annual returns (land market value roughly estimated at $192 billion) on surface rights, annual returns from grazing leases, are estimated at approximately 0.003%, and the overall net return from all revenues less budgeted expenses is between −2.3% and −2.9%. Annual returns on grazing for BLM lands (market value roughly estimated at $124.3 billion) are estimated at approximately 1%, and the overall net return from all revenues less budgeted expenses is between −0.8% and −1.8% from 2002 through 2006. USFS and BLM budgeted operating expenses per acre are estimated at $29.75 and $13.58, respectively, as estimated from their 2005 expected budgets; 2006 operating expenses per acre are slightly lower than for previous years. High budgeted operating budgets may result from management inefficiency and overstaffing. These chronic operating deficits result in public lands essentially being an expensive liability rather than an asset of the federal government.

The justification for incurring annual operating deficits of approximately $5.53 billion in 2005 for the USFS and $2.10 billion in 2005 for the BLM is the ''multiple-use'' objective and the non-pecuniary benefits to the American people. The question is: Are these non-pecuniary benefits worth the cost? This question should be answered for each land parcel.

An alternative application of the policy decision model is to estimate the minimum level and growth rate in lease fees that would be necessary to make policymakers

**Exhibit 6** | Annual Revenue, Expenses and Returns for Federal Public Lands

| USDA Forest Service ($ in Thousands)* | | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | 2006 |
| Receipts From Grazing** | 6,001 | 4,843 | 5,702 | 7,074 | 6,600 |
| Receipts From Grazing per acre ($) | 0.063 | 0.051 | 0.060 | 0.074 | 0.069 |
| Total Receipts to Treasury | 230,902 | 265,659 | 464,458 | 186,769 | 198,998 |
| Total-Forest Service Budget | 4,795,000 | 5,533,000 | 5,792,000 | 5,712,000 | 5,173,000 |
| Total Net Annual Operating Deficit | 4,564,098 | 5,267,341 | 5,327,542 | 5,525,231 | 4,974,002 |
| Total Annual Budget per Acre ($) | 24.97 | 28.82 | 30.17 | 29.75 | 26.94 |
| Total Estimated Mkt Value of Total Surface Rights*** | 192,000,000 | 192,000,000 | 192,000,000 | 192,000,000 | 192,000,000 |
| Estimated Net Return on Total Market Value (%) | -2.3771 | -2.7434 | -2.7748 | -2.8777 | -2.5906 |
| Estimated Net Grazing Return on Total Market Value (%) | 0.0031 | 0.0025 | 0.0030 | 0.0037 | 0.0034 |
| *Data obtained from USDA Forest Service Annual Budget Justification | | | | | |
| ** Currently there are approxmately 95 million acres under grazing lease | | | | | |
| ***The Average value of Forest Service Lands was assumed to be $1000 per acre | | | | | |

| USDI BLM ($ in Thousands)* | | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | 2006 |
| Receipts From Grazing | 12,788 | 11,828 | 11,840 | 12,180 | 12,180 |
| Receipts From Grazing per acre ($) | 0.076 | 0.070 | 0.070 | 0.072 | 0.072 |
| Total Receipts Excluding Land Sales | 136,871 | 278,307 | 236,678 | 317,147 | 440,675 |
| Total-BLM Budget | 2,158,866 | 2,143,324 | 2,395,219 | 2,418,620 | 1,476,675 |
| Total Net Annual Operating Deficit | 2,021,995 | 1,865,017 | 2,158,541 | 2,101,473 | 1,036,000 |
| Total Annual Budget per Acre ($) | 12.12 | 12.03 | 13.45 | 13.58 | 8.29 |
| Total Estimated Mkt Value of Total Surface Rights*** | 124,314,300 | 124,314,300 | 124,314,300 | 124,314,300 | 124,314,300 |
| Estimated Net Return on Total Market Value (%) | -1.6265 | -1.5002 | -1.7364 | -1.6905 | -0.8334 |
| Estimated Net Grazing Return on Total Market Value (%) | 0.0103 | 0.0095 | 0.0095 | 0.0098 | 0.0098 |
| *Data obtained from USDI BLM Annual Budget | | | | | |
| ** Currently there are approxmately 169 million acres under grazing lease | | | | | |
| ***Market value of BLM land was assumed to be $698 per acre. | | | | | |

**Exhibit 7** | Grazing Fees—USFS and BLM* from 1981 to 2006 ($ per AUM)

| Year | Fee | Year | Fee | Year | Fee |
|---|---|---|---|---|---|
| 1981 | $2.31 | 1990 | $1.81 | 1999 | $1.35 |
| 1982 | $1.86 | 1991 | $1.97 | 2000 | $1.35 |
| 1983 | $1.40 | 1992 | $1.92 | 2001 | $1.35 |
| 1984 | $1.37 | 1993 | $1.86 | 2002 | $1.43 |
| 1985 | $1.35 | 1994 | $1.98 | 2003 | $1.35 |
| 1986 | $1.35 | 1995 | $1.61 | 2004 | $1.43 |
| 1987 | $1.35 | 1996 | $1.35 | 2005 | $1.79 |
| 1988 | $1.54 | 1997 | $1.35 | 2006 | $1.56 |
| 1989 | $1.86 | 1998 | $1.35 | | |

*Notes:* Grazing lease fees on USFS and BLM Lands have been tied to the Public Rangelands Improvement Act of 1978 (PRIA) formula and have not tended to increase over the 1981 through 2005 time period. Fees are charged for grazing on approximately 169 million acres of BLM land and 95 million acres of Forest Service land. Lease rates were obtained from the CRS Report for Congress: http://www.nationalaglawcenter.org/assets/crs/RS21232.pdf.
*The national grassland fee is $1.90 per AUM in 2005, up from $1.52 in 2004.

indifferent between continued lease/ownership of the land and selling/proceed reinvestment. For USFS and BLM, land management and operating expenditures of approximately $25.06 per acre for USFS (see Exhibit 7) and approximately $13.59 per acre for BLM are observed. Thus, lease fees in ecoregion 3 would need to be in excess of $20 per AUM for USFS and in excess of $10 per AUM for BLM to economically justify the continued ownership of the lands. For other ecoregions this minimum rate would increase substantially because of lower productivity.

We do not display the tables for all ecoregions because of space limitations; only ecoregion 3 figures are displayed. Even with an increase in lease fees to $20 or $10 per AUM, it is difficult to justify retaining ownership of lands in ecoregions 4, 5, 7, and 9 unless alternative income is available and/or the non-pecuniary benefits on these public lands is high. Since we are assuming that each parcel is leased to capacity, these lease rates are probably unrealistic since most public lands are leased at significantly less than capacity.

## Conclusions and Policy Implications

We address the continued ownership and control of federal public lands, mostly located in the western U.S., when non-pecuniary attributes may not override a low benefits/costs ratio of pecuniary attributes. When pecuniary benefits fail to justify continued ownership and the land possesses insufficient non-pecuniary value to override the lack of pecuniary benefits, we assume an alternative action—selling the land parcel. Also, we question the control of public lands by two government agencies, each replete with its own bureaucracy.

This study develops a model that may be used as a management tool for individual parcels of federal public lands. This model may be used to improve the efficiency and effectiveness of surface right management policy and pecuniary and non-pecuniary return performance for managers of these lands. The model assesses the present value of future economic/pecuniary benefits derived from individual parcels of public land regarding whether each parcel should be sold or retained. The model may also assess the benefit/costs of other modifications of land use that may include alternatives other than maintaining the status quo. Other alternative management policies may also be compared to selling the lands to private ownership. Again, it is thought that a viable alternative may include turning control of some parcels over to the states in which the parcels are located.

The model may assist policymakers' estimates of the present value of pecuniary benefits relative to the management and opportunity costs for selected public land parcels. We also estimate the return on market value generated by pecuniary returns, allowing an estimate of the present value of non-pecuniary (multiple use value in addition to economic value) benefits that may be necessary to justify continued ownership. Market values of public lands are estimated using a data set of land sales in Wyoming. We apply hedonic modeling to estimate fair market

values of both USFS and BLM lands, allowing us to compare not only present value of benefits versus costs but also returns on these lands with an alternative scenario of selling the lands and using the proceeds for the public benefit.

Returns on USFS and BLM surface rights in Wyoming, as well as for many other western states, are generated from agricultural or grazing lease income and capital appreciation in land values. We find that returns generated on public lands in Wyoming were largely based on land appreciation and generally less than 1% return from grazing lease revenues. Even when including future appreciation, total returns would typically be less than 6%.

It is assumed that the opportunity cost of continued federal ownership of public lands is the long-term yield on U.S. Treasury bonds on the land's market value. For the previous ten-year period, the average 20-year bond yielded was approximately 6.2%, thus we considered this rate of return to be the alternative if public lands were sold and the proceeds from land sales either reinvested or used for the public good.

Results of the Management Policy Models for Public Land Surface Rights in the U.S., Exhibits 1 and 2 above, and the overall high management and operating expenses that are incurred by the BLM and USFS, Exhibit 6, raise serious questions whether the USFS and BLM are fulfilling their respective fiduciary obligations as stewards of those land parcels that contain little non-pecuniary or multiple-use potential other than grazing lease income. Since a large proportion of BLM land contains little multiple-use value other than grazing and are in many cases surrounded by privately owned land, these parcels should each be evaluated with respect to their future federal ownership.[34]

There are, of course, a contingent of policy advocates who assert that all undeveloped land provides a degree of natural ecological preservation that has value to society, and furthermore that the disposal of public lands, thus losing public control of future use, represents the giving up of a future option that has value. We recognize these arguments; however, it is our opinion that federal lands that contain little multiple-use value other than grazing are being retained at significant expense to taxpayers and place significant restrictions on western states, where these lands are located. If all land possesses natural ecological preservation that has value to society, why should we not have significant tracts of public lands in states other than those where most public lands are located?[35]

Our recommendation is that BLM lands containing significant scenic/recreational and other multiple-use attributes should be turned over to the USFS. The USFS will retain an exclusive inventory of lands with scenic, recreational value, and wildlife habitat, which will truly serve the multiple-use objective. The federal government may then use the proceeds from the sale of less scenic lands to consolidate and possibly purchase additional lands with scenic, recreational, and wildlife habitat value for future multiple-use. By essentially eliminating the BLM and consolidating truly multiple-use lands under the USFS, the existing

bureaucracy of the BLM can be merged with the bureaucracy of a potentially smaller, more efficient USFS. The net savings, subsequent to the consolidation, could be $2 billion to $3 billion per year.

By consolidating and purchasing additional scenic, recreational, and wildlife habitat lands under the USFS, the public will have access to even more land that serves the multiple-use purpose. These actions will also give additional economic control of less scenic lands to individual states and decrease the inequality of public land policy on those 11 western states containing most public lands. The concept of multiple-use should be reinforced for lands with scenic, wildlife habitat, and/or recreational attributes and federal programs, such as encouraging the purchase and retirement of grazing rights on the lands, should be encouraged. However, the value and applicability of multiple-use is minimal for lands containing little or no scenic and/or recreational value, their highest and best use, which is normally agricultural grazing, may be continued under each state's administration.

For each parcel of federal public lands with grazing as the highest and best use, AUM lease fees may be increased approaching comparable market rates, and the current formula discarded. The policy model may be used to determine minimum lease fees, which are necessary to continue ownership of lands containing little other multiple-use value. A variable lease rate based on the productivity and market value of each parcel of federal land may also be considered. We observe that productivity, as measured by AUMs per acre, varies considerably across Wyoming as it does across the western U.S. In some cases, where productivity is low and land prices are relatively high, no reasonable lease fee will make continuing to lease an economically viable alternative. Thus, we do not feel that an alternative policy of marking grazing and other leases to market and exploring ways of reducing operating costs are not viable alternatives.

## Endnotes

[1] The federal government owns about 671.8 million acres (29.6%) of the 2.27 billion acres of land in the U.S. Four agencies administer 628.4 million acres (93.5%) of this land: the Forest Service in the Department of Agriculture, and the Bureau of Land Management, Fish, and Wildlife Service, and National Park Service, all in the Department of the Interior.

[2] See http://www.sfrc.ufl.edu/Extension/ssfor11.htm.

[3] BLM manages 261.5 million acres, and is responsible for 700 million acres of subsurface mineral resources. BLM has a multiple-use, sustained-yield mandate that supports a variety of uses and programs, including energy development, timber harvesting, recreation, grazing, wild horses and burros, cultural resources, and conservation. USFS manages 192.5 million acres also for multiple use and sustained yields of various products and services, for example, timber harvesting, recreation, grazing, watershed protection, and fish and wildlife habitats.

[4] The USFS and BLM manage both sub-surface mineral and surface leasing and royalty collection functions. Substantial income is generated from mineral royalties. However,

this is irrelevant to the study since the general practice, even if the surface rights of a land parcel is sold, the agency would normally retain all mineral rights. It is assumed that this practice will continue in the future for any surface rights sold.

[5] This paper address management policies on Federal agency administered public lands by drawing heavily on previous work by Torell and Fowler (1986), Sunderman and Spahr (1994), Spahr and Sunderman (1995), Torell and Drummond (1997), Spahr and Sunderman (1998,1999), Torell and Bailey (2000), Sunderman, Spahr, Birch, and Oster (2000), Torell, Rimbey, Bartlett, Van Tassell, and Tanaka (2001), Moskowitz and Romaniello (2002), Sunderman, Spahr, and Runyan (2004) and Sunderman and Spahr (2006).

[6] See http://www.blm.gov/nhp/facts/index.htm and http://www.fs.fed.us/.

[7] See http://www.blm.gov/nhp/news/releases/pages/2005/pr050207_grazing.htm. An animal unit month (AUM) is a standardized measure of forage necessary to sustain a mature cow with calf, a horse, or five sheep for one month. Leased AUMs include a combination of USFS, BLM, and STL.

[8] See http://www.ams.usda.gov/.

[9] The percentages of value do not add to 100%, since other attributes also add value. A significant body of literature exists, which attempts to determine the value of recreation and other attributes of public lands (e.g., Bhat et al., 1998).

[10] Much of the public land in question is already an integral part of an agricultural operation and is surrounded by private land that leases for significantly higher rates. We feel that public land with very similar attributes to private lands should have essentially the same lease values. Thus, using market comparisons for similar parcels is hedonic modeling. Since the transfer of private grazing leases in the sale of private lands has no statistically significant effect on the price of the land (as shown later in Exhibit 4), we assume that private grazing leases are fairly priced.

[11] To allow wildlife, deer, buffalo, mustangs, and elk, to graze on these smaller parcels would be infringing on the right of private ownership. Should the fact that much of the land in western states is owned by the public suggest that we, the public, should infringe on private ownership of these lands more than we infringe on private ownership in other states that have little or no public lands? This is the ecological and environmental question regarding public versus private rights in different states.

[12] These studies realized that risk differences exist between U.S. Treasuries and returns on leased public lands; however, returns on public lands were compared with returns on the most likely investment that proceeds from the sale of these lands would be reinvested in—U.S. Treasuries. Given, in these studies, that U.S. Treasury returns stochastically dominate (first-order stochastic dominance) lease returns, this would seem to be sufficient incentive for considering the sale and reinvestment alternative.

[13] There may be other alternatives that would improve management efficiency and effectiveness. The model may also assess the benefit/costs of these other modifications of land use. A viable alternative may include turning control of some parcels over to the states in which the parcel is located.

[14] There may be valid concerns that if these federal lands were sold, the proceeds of the sales would not be used for the public benefit, but rather would likely be squandered. However, if Congress and the president were to ''squander'' the proceeds from the sale of public lands, this is irrelevant to our paper. Specific to Wyoming, proceeds from the sales of all school trust lands are invested in the State Trust Minerals and the State

Permanent Land Fund (http://slf-web.state.wy.us/). We suggest that Congress establish a fund similar to the State of Wyoming Permanent Land Fund to benefit the public for a longer term. However, what Congress and the president do with regard to their fiduciary responsibilities to the assets of the country do not justify continued mismanagement of current assets.

[15] In addition to the fixed income stream from reinvested sales proceeds to the state if lands were sold are property tax revenues, which are not collected on federal lands. Currently, states receive payment in lieu of taxes on federal lands to replace property taxes. Once the sale has occurred and the land is privately owned, property tax payments will begin.

[16] The first, second, and fourth terms on the right side of the equation represent the present value of a growing annuity for lease fees, expenses, and payment in lieu of taxes until the land is sold at time *t*. The third term represents the present value of the perpetual stream of earnings from the reinvestment of public land sales proceeds subsequent to a sale at time *t*.

[17] We find that *t**, under most circumstances, is to either immediately sell the land or never sell the land. We feel that a visual inspection of the graphs are sufficient to assess management policy since, in most cases, the present value of continued ownership is monotonically decreasing. This suggests that, from a pecuniary value only assessment, the land should be sold immediately. The justification for retaining ownership of a given tract of public land must lie with non-pecuniary values, such as esthetic multiple-use values to the public.

[18] Sales in Teton County, home of Grand Teton and Yellowstone National Parks, are excluded due to extreme land values. Land in Teton County, even though currently used for ranching, is valued based on factors other than for ranching. All sales were of private land where BLM or Forest Service leases may be included in the sale. Some of the sales, however, consisted of only BLM or Forest Service leases.

[19] For example, see Martin and Jefferies (1966), Winter and Whittaker (1981), Sunderman and Spahr (1994, 2006), and Sunderman, Spahr, and Runyan (2004).

[20] A recent study using data from Wyoming by Bastian and Hewlett (1997) found that the AUMs per acre ranged greatly across the state. For example, grazing land had a statewide productivity of 0.29 AUMs per acre, whereas irrigated cropland had a measure of productivity of 9.19.

[21] The authors determined the subjective assessment of scenic and/or recreational value, on a scale of 1 to 5, with assistance from appraisers from the Farm Credit Services offices in Casper and Worland, Wyoming. It is realized that it is difficult to test the reliability and validity of the scenic and/or recreational variable; however, because of the variable's significance and consistency in the hedonic model, it is our judgment that the variable is economically important and reliable.

[22] In the Bryan and Colwell (1982) approach, there is one variable to represent the beginning of each of the years in the analysis period. The two dummies closest to the sale date are assigned values that sum to unity, with the two values being proportionate in each case to the closeness of the sale to that year's beginning and end. The resulting estimated path of price is a point on a log-linear function that moves smoothly from the beginning of each year to the beginning of the next year. Shifts in log-linear slope occur only at the beginning of each new year. The system provides more annual flexibility than linear or quadratic movements, being essentially an unconventional piecewise linear technique, with nodes at each year end within the period analyzed.

[23] Since we assume that all sales take place in the middle of the month, to arrive at the weights, September 15, 1990 is 2.5 months from July 1, 1990 so B90S2 = 2.5/6 or 0.583. Since September 15, 1990 is 3.5 months away from January 1, 1991, B91S1 = 3.5/6 or 0.417.

[24] See Neter, Wasserman, and Kutner (1983) for a discussion of this concept.

[25] Removing the outliers resulted in an increase in adjusted $R^2$ from 0.7638 to 0.8990; however, all significant variables remained significant when outliers were removed. Removing sales outliers did not make a major change in results; however, since the objective of the model is to estimate fair market values and capital appreciation rates, it was our opinion that deleting the outliers improves the predictive accuracy of the model even though coefficients may be biased relative to alternative coefficients estimated from the full sample.

[26] The model was also estimated with an intercept and it was verified that the intercept is captured in each time variable. All coefficients remained the same and each date of sale variable was increased by the amount of the intercept, thus causing no change in our results.

[27] Variance inflation factors, one for each explanatory variable, measure the extent to which variances of the estimated regression coefficients are inflated as compared to the variance if explanatory variables were not linearly related. The largest factor among the variables is used as the indicator of the severity of multicollinearity. For a discussion of VIF, see Neter, Wasserman, and Kutner (1983).

[28] See Sunderman and Spahr (1994), Spahr and Sunderman (1995, 1998), and Sunderman, Spahr, Birch, and Oster (2000).

[29] Winter and Whittaker (1981), Torell and Fowler (1986), Sunderman and Spahr (1994), and Spahr and Sunderman (1995, 1998) all found that appraisers valued permanent improvements less than their effect on the sales price, which is consistent with current findings.

[30] Given the assumptions, the following variables were needed to arrive at the price per acre: (1) ecoregion, (2) QUALITY, (3) scenic area, and (4) date of sale. The formula used is:

$$\begin{aligned}\text{Price Per Acre} = {} & -63.679\,(\textit{LDACRES}) + 53.107(\textit{ECO4}) \\ & + 63.896(\textit{ECO5}) + 226.112(\textit{ECO7}) + 42.081(\textit{ECO8}) \\ & + 98.581(\textit{ECO9}) + 28.646(\textit{QUALITY}) + 13.669(\textit{FAIR}) \\ & + 105.421(\textit{AVERAGE}) + 281.396(\textit{GOOD}) \\ & + 320.805(\textit{EXCELLENT}) + 833.920(\textit{B03S1}).\end{aligned}$$

The *LDACRES* variable was used for a section, 640 acres, as most STL consist of a section of land. Price per acre is then multiplied by 640 to calculate the value of a section. Since we are arriving at an estimate of price per acre as of January, 2003, the value for B03S1 is 1.

[31] The annual appreciation rate was obtained by fitting a least squares linear regression model to the date of sale variables for each six-month time period (29 different periods from 1989 through first quarter 2003). Regression of the date of sale variable resulted in an estimated appreciation rate of 7.26% and regressing the natural log of the date of sale variable resulted in an estimated appreciation rate of 6.62%. The growth rate for each ecoregion was obtained by estimating the least squares predicted value of the school section in July 1989 and ending, January 2003 and applying the following expression:

$$(1+r)^t = V_{January\ 2003}/V_{July\ 1989},$$

where $r$ is equal to the annual compound rate of growth and $t$ is the annual periods or 13.5 years. There are actually 14.5 years of data; however, estimated growth rates we calculated as one half year from the beginning and end dates of data.

[32] These returns are higher than actual returns to beneficiaries since no adjustments were made for administrative expenses.

[33] Fence out states, such as Wyoming, have statutes requiring landowners to build fences to keep cattle off their property rather than requiring cattle owners to fence in their cattle. These statutes remain as a result of the open range history of the state.

[34] The authors are assuming that rates of appreciation on public lands are similar to rates estimated on private lands given that these lands were sold. We are not recommending that public lands with significant multiple-use value be sold; however, the value of these lands in the private market, without the use restrictions imposed under USFS or BLM ownership is the correct value to use in estimating a rate of return and for a benefit/cost assessment.

[35] Obviously, there may be some real option value whenever an irreversible decision is made. However, as with the real option literature in corporate finance, many decisions are not irreversible, thus substantially reducing real option value. Government, through the right of eminent domain that may be used to acquire properties for the public benefit, may significantly reduce real option value relative to an equivalent sale in the private sector.

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