The Potential of Valuing Rangeland Ecosystem Services on Public Rangelands[1]

L. Allen Torell[2], Gregory L. Torell[3], John A. Tanaka[4], and Neil R. Rimbey[5]

Introduction

The spring 2012 issue of the Western Economics Forum (WEF) highlighted issues related to the economic analysis of land management decisions and ecosystem service valuation on public lands. Two papers addressed issues related to the use of the contingent valuation method (CVM) (Little et al. 2012; Loomis 2012) and a third paper discussed the use of a state-and-transition model (STM) framework for valuing ecological change (Taylor and Rollins 2012). It was noted that in the past two decades there has been a shift of the federal land management agencies from multiple uses to ecosystem management and this has brought an increased recognition for the need to value ecosystem services in land management planning efforts (Loomis 2012). As noted by Taylor and Rollins (2012), despite a growing recognition of the need for placing an economic value on the ecosystem services provided from rangelands, there is a perception among scientists and public land decision makers that economic theory and methods are not up to the task of providing accurate, timely and policy-relevant estimates of the economic values associated with ecosystem changes. Taylor and Rollins dismissed this pessimistic view and suggested there are steps that can be taken to counter criticisms about attempting to place an economic value on the ecosystem services provided on both public and private lands. Loomis (2012) similarly dismissed the notion that economists are not up to the task and detailed ways to integrate non-market values into land agency decision making and planning.

We agree that resource economists can provide site-specific valuations of rangeland ecosystem services but believe there are major obstacles that will result in questionable reliability of those estimates at various levels. Some of those obstacles relate directly to the procedures and model extensions and extrapolations proposed in the Western Economic Forum papers. Most notably, the Forum papers suggest a reliance on the Contingent Valuation Method (CVM) with many noted shortcomings; an extrapolation of study results using benefits transfer; and reliance on rangeland state-and-transition models to measure ecosystem differences between management alternatives. In this paper we detail our concerns about relying extensively on these procedures and highlight what we perceive to be major obstacles for providing accurate, timely, and policy-relevant estimates of the ecosystem values associated with changes on rangeland. We conclude that land managers should maintain their justified concern about site-specific ecosystem service valuations as widely needed for policy analysis and planning. The linkages

---

[1] Research was supported by multiple Agricultural Experiment Stations under the regional research project W1192.
[2] Professor, Department of Agricultural Economics and Agricultural Business, New Mexico State University, Las Cruces, NM 88005. Email: atorell@nmsu.edu
[3] Graduate Research Assistant, University of Wyoming, Department of Economics and Finance, Laramie, WY
[4] Professor and Department Head, Renewable Resources, University of Wyoming, Laramie, WY
[5] Professor, Department of Agricultural Economics and Rural Sociology, Caldwell Research and Extension Center, University of Idaho, Caldwell, ID

required to value rangeland ecosystem services are poorly defined and with current staffing, land management agencies have a great potential to extrapolate economic values well beyond an appropriate level of applicability. This also assumes that the federal agencies will have adequate staff, expertise and budget to make the initial economic valuation estimate in the first place. Given the significant valuation limitations for rangeland ecosystem services we suggest that identifying an expected direction of change in the level of goods and services provided is a realistic goal of project assessments.

Limitations to Economic Valuation

Non-Market Valuation

In some environmental applications, revealed preference techniques such as the travel cost method and hedonic models are applicable and can be used for ecosystem service valuation (Champ 2003). But, for some public goods there are no behavioral trails or observed market transactions; thus, stated preference methods and surveys are needed to elicit a willingness to pay (WTP). Reliance on WTP studies to value ecosystem services should be of concern to land managers and decision makers given the hypothetical bias described by the WEF paper authored by Little et al. (2012) and widely discussed in the literature (see for example Champ 2003, Loomis 2011, List and Shogren 1998). As noted in the Little et al. paper, valuation responses in a survey setting are typically larger than in some actual settings involving net economic commitments. Little et al. (2012) noted that 60% of the 225 studies considered in their meta-analysis were found to show a statistically significant disparity between hypothetical and actual valuation responses. As further noted by Little et al. (2012), a 1993 "blue ribbon" NOAA panel report greatly increased and highlighted the concerns about hypothetical bias. The report recommended that hypothetical bids be deflated using a 'divide by 2' rule unless the bids can be calibrated using actual market data (List and Shogren 1998, Loomis 2011).

Traditional benefit/cost studies of range improvement projects have underestimated the net economic benefit of improvement practices because the economic value of conservation benefits have largely been excluded from the limited economic assessments that have been done (Tanaka et al. 2011). Using WTP studies with inflated values in the conservation benefit assessment has the potential to move the other way and overstate project benefits. Further, the comparison of non-market values for some public land uses (e.g. wildlife) to market-derived values for other uses (e.g. livestock grazing) is also an obvious concern given the bias of CVM valuation procedures. As noted by Loomis et al. (1989), an economically efficient allocation of forage would involve providing additional forage to wildlife until the marginal values between wildlife and livestock are equal. This optimal efficiency condition obviously assumes that both estimates of forage value are correct and comparable, a questionable result if valuation bias exists.

Undefined Linkages and Production Relationships

The most fundamental challenge for valuing ecosystem services is an adequate description and assessment of the linkages between the structure and function of natural systems and the goods and services derived under alternative actions (NRC 2005). Taylor and Rollins (2012) argued that the ecological site and State-and-Transition Model (STM) framework can provide the necessary detail needed to measure rangeland ecosystem provisioning under alternative management actions. Ecologists and other scientists suggested a similar promise for the ecological site description and STM framework (Bestelmeyer and Brown 2010; Herrick et al. 2010; Bestelmeyer et al. 2011). As Brown and MacLeod (2011) noted, the STM framework is a soil/vegetation-based system in which locations with similar climate, geomorphology and edaphic properties are grouped into ecological sites based on their response to disturbance. Within each ecological site, a unique STM describes the dynamics of vegetation and soil surface properties, and provides indicators of the vegetation structure and soil properties. Alternative management actions potentially move the process within and between states. Because the ecological model is soil/vegetation-based, provisioning of different types of ecosystem goods and services can be predicted if there is a defined and predictable linkage to soil and vegetation characteristics.

While vegetation conditions link directly to livestock grazing output potential and the potential benefits from vegetation management practices, estimating the complex linkage from altered soil and vegetation conditions to the provisioning of other rangeland outputs is complex and largely undefined. Even for the case of forage production, changes over time and space are not always well known. If an ecological site is over- (or under-) grazed in a drought year the impact on future long-term production is not known in many cases. Further, STMs have been developed using expert knowledge from primarily land agency personnel; site-specific and long-term ecological data are rarely available and used for STM development (Knapp et al. 2011). As noted by Allen-Diaz and Bartolome (1998, p. 803), "most of our information about rangeland ecosystem behavior is based on comparisons of deteriorated and protected areas, thus we really only have good information about the process of rangeland deterioration, not recovery. More and longer term studies of community behavior in response to changes in grazing, following fire, and following vegetation treatment, are sorely needed for rangeland ecosystems." An assessment of Natural Resource Conservation Service (NRCS) rangeland conservation efforts indicated that it was not possible to determine the magnitude or trend of conservation benefits originating from NRCS conservation investments because of the paucity of information documenting benefits (Briske 2011, P. 11). As documented in the various NRCS study chapters, the benefits of conservation practices are seldom quantified and lack consistent measurement over time and space.

In agreement with this observation, and considered as a specific example, a review article about the economics of prescribed burning noted that the major limitation for evaluating prescribed burning treatments is the lack of understanding between economic outcomes and ecological effects. Hesseln (2000, p. 332) suggested that future research should focus on defining a production function that describes the long-term relationships between prescribed burning and ecological effects and enhancement. Further, the author noted that beneficial effects of prescribed fire must be systematically identified and evaluated with specific land management objectives in mind. STM models can be useful in defining those relationships in some cases but will not be useful for valuing ecosystem goods and services that are not tied to soil and vegetation characteristics. An adequate description and assessment of the many linkages between the structure and function of natural systems and the goods and services derived under alternative actions remains the key challenge.

Economic Value Extrapolation

Taylor and Rollins (2012) cited the writings of Robert H. Nelson, an economist with a career in the Department of Interior. They used his writings as an example of the skepticism about economic valuations of rangeland ecosystem services. In the cited journal paper (Nelson 2006) and an earlier text book about the failures of public land management (Nelson 1995), Nelson detailed the history and minimal role of economic analysis in federal agency land use decisions. Many of his thoughts are relevant and should not be overlooked. As noted by Nelson, while the Office of Management and Budget (OMB) and others pushed for increased use of benefit-cost analysis within the Bureau of Land Management (BLM) the agency had few economists and little experience with doing economic analysis. This lack of social science expertise within the federal land agencies continues. Survey responses from an internal social and economic capabilities assessment conducted within BLM in 2007 (Tanaka et al. 2009) indicated that at that time only about 7% of BLM professional staff had significant training and/or experience in the social sciences and this expertise was especially lacking below the state level.

As noted by Loomis (2012), given limited social-science staff and economic analysis capabilities, economic analysis performed by public land management agencies has primarily been limited to standard regional economic analyses using IMPLAN. These regional assessments provide little insight into the nonmarket ecosystem values for which management actions are proposed. In some cases, crude estimates of nonmarket benefits are used in planning documents but usually with a single value for each output applied across broad areas and without consideration of local circumstances and conditions (Nelson 2006).

Legal mandates to consider social and economic impacts in planning efforts coupled with their own limited social science staff motivated the land agencies to seek economic models and tools for use in resource planning and assessment. They seek tools for estimating economic impacts of grazing decisions from the Resource Management Plan level all the way down to the grazing permit renewal level. Loomis (2012) and Taylor and Rollins (2012) noted similar agency needs for other landscape management decisions and planning efforts. The proposed solution suggested in the WEF papers would be to use benefit transfer which uses values and other information from a ‘study site’ where data are collected to a ‘policy site’ with little or no data. A site-to-site transfer function is defined that considers the spatial, temporal, and ecological details specific to the target ecosystem (Taylor and Rollins 2012, P. 14). Meta-analysis equations have been used to tailor the benefit transfer to a specific study site (Loomis et al. 2012). Taylor and Rollins (2012) suggested that with a rangeland application the benefit transfer would apply to other rangeland areas having the same ecological site characteristics.

Loomis (2012) noted that the land management agencies would find it most useful to have site-specific per acre values of ecosystem services for different landscape conditions. Land agencies seek a “turn-key” valuation of ecosystem services. As noted above, this implies that we know which ecosystem services each acre of land will provide (i.e., the production functions). Loomis recognized the challenge in generating site-specific values that can be spatially mapped onto GIS layers, but we believe he minimizes the challenge for rangelands in particular. As noted by Briske (2011, P. 11) there has been minimal investment by the USDA and the rangeland profession in assessing conservation practice effectiveness. Consequently, conservation practices have seldom been monitored across spatial areas (even within the same ecological site) and through time as needed to adequately assess conservation practice outcomes. The biggest problem we see for benefit transfer application on rangelands, besides the benefit estimation component, is the limited number of studies from which to extrapolate and project ecosystem service responses by ecological site, given the time, space, and response issues raised earlier. Yet, in many cases it may not be economical to undertake the long-term studies replicated across time and space required to fill the information void. As noted by Nelson (2006, p. 539) “It might cost more to collect the necessary data and to conduct the economic analysis than the total social benefits of doing the analysis in the first place.” Cost is an obvious reason why documentation of conservation benefits from rangeland improvements is lacking and long-term rangeland studies are rare. The wetland-area and wildlife valuation studies cited by Loomis (2012) may have much more potential for benefit-transfer extrapolation then do heterogeneous rangeland areas.

Valuation Alternatives

The pessimistic view that adequate definition of key linkages about the structure and function of rangeland systems limits our ability to provide reliable estimates of the economic value of many rangeland ecosystem goods and services is disheartening and a continuing dilemma. For the most part, selection of rangeland restoration projects and management alternatives has relied on the judgment of rangeland managers without economic consideration beyond project costs. Obviously, expanded benefit/cost assessments should be undertaken when sound data are available. Research should be undertaken to define key economic and ecological relationships when justified. But, with current knowledge, identifying the expected direction of change and relative magnitude of change may be more useful. This is the type of assessment proposed by the Sustainable Rangeland Roundtable (SRR)[6].The SRR framework compares the expected progression of biophysical conditions, natural resource capital, social capacity, economic capital, and human conditions when alternative management actions are followed (Fox et al. 2009). Assessment is more along the lines of direction of change, tradeoffs, and expected strength of change rather than applying values and conducting economic efficiency analyses. Kreuter et al. (2012, Table 1) applies the conceptual SRR framework to alternative energy development options, summarizing expected bio-physical and social-economic impacts with a relative ranking of +, ++, 0, - and --. Indicators of social, economic, and ecological sustainability are monitored over time and impacts assessed by the decision- or policy-maker. Ideally, the indicators would help decision- and policy-makers identify which data are important to collect and that more quantitative relationships can be developed over time. It is left up to the decision- or policy-maker to determine whether the direction of change is “good or bad.” We argue that in most cases this is the best that can reliably be done given the current state of knowledge about the critical linkages required for rangeland ecosystem valuation. We are far from being able to reliably estimate the levels of goods and services provided under alternative management actions, to extrapolate those value estimates across the western public lands, or to use those values to evaluate trade-offs in many management and policy decisions. Solutions to these problems will require consideration of current and foreseeable federal agency and research funding, staffing and resources, and the potential net social value of the information gained. It will require across-discipline cooperation and research efforts to describe and quantify the levels of key ecosystem goods and services realized under alternative management actions measured across broad landscapes.

[6] It is the ranking of alternatives that we find appealing about the SRR framework but alternative ranking models and processes could work equally well.

References

Allen-Diaz, B., and J. W. Bartolome. 1998. Sagebrush-grass vegetation dynamics: comparing classical and state-transition models. *Ecological Applications* 8:795-804.

Bestelmeyer, B. T., and J. R. Brown. 2010. An introduction to the special issue on ecological sites. *Rangelands* 32:3-4.

Bestelmeyer, B. T., J. R. Brown, S. D. Fuhlendorf, G. A. Fults, and X. B. Wu. 2011. A landscape approach to rangeland conservartion programs. *In:* D. D. Briske [ED.]. Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps. Washington, D.C.: USDA-Natural Resource Conservation Service. p. 337-370. Available online at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?&cid=stelprdb1045811. Accessed January 6, 2013.

Briske, D. D. 2011. Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps. Washington, D.C.: United States Department of Agriculture, Natural Resource Conservation Service. 429 p. Available online at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?&cid=stelprdb1045811. Accessed January 6, 2013.

Brown, J., and N. MacLeod. 2011. A site-based approach to delivering rangeland ecosystem services. *Rangeland Journal* 33:99-108.

Champ, P. A., K. J. Boyle, and T. C. Brown. 2003. A primer on nonmarket valuation. Dordrecht, The Netherlands: Kluwer Academic Publishers. 588 pp.

Fox, W. E., D. W. McCollum, J. E. Mitchell, L. E. Swanson, U. P. Kreuter, J. A. Tanaka, G. R. Evans, H. T. Heintz, R. P. Breckenridge, and P. H. Geissler. 2009. An Integrated Social, Economic, and Ecologic Conceptual (ISEEC) framework for considering rangeland sustainability. *Society and Natural Resources* 22:593-606.

Herrick, J. E., D. A. Pyke, L. Jolley, J. J. Goebel, R. S. Dayton, V. C. Lessard, K. E. Spaeth, and P. L. Shaver. 2010. National ecosystem assessments supported by scientific and local knowledge. *Frontiers in Ecology and the Environment* 8:403-408.

Hesseln, H. 2000. The economics of prescribed burning: a research review. *Forest Science* 46:322-334.

Knapp, C. N., M. Fernandez-Gimenez, E. Kachergis, and A. Rudeen. 2011. Using participatory workshops to integrate state-and-transition models created with local knowledge and ecological data. *Rangeland Ecology & Management* 64:158-170.

Kreuter, Urs P., William E. Fox, John A. Tanaka, Kristie A. Maczko, Daniel W. McCollum, Mitchell E. John, Clifford S. Duke, and L. Hidinger. 2012. Framework for comparing ecosystem impacts of developing unconventional energy resources on western US rangelands. *Rangeland Ecology & Management* 65:433-443.

List, J. A., and J. F. Shogren. 1998. Calibration of the difference between actual and hypothetical valuations in a field experiment. *Journal of Economic Behavior and Organization* 37:193-205.

Little, J., C. D. Broadbent, and R. O. Berrens. 2012. Meta-analysis of the probability of disparity between actual and hypothetical valuation responses: Extension and Preliminary New Results. *Western Economics Forum* 11:1-12.

Loomis, J. 2012. Ways to make stated preference methods more valuable to public land managers. *Western Economics Forum* 11:22-29.

Loomis, J. 2011. What's to know about hypothetical bias in stated preference valuation studies? *Journal of Economic Surveys* 25:363-370.

Loomis, J., D. Donnelly, and C. Sorgswanson. 1989. Comparing the economic value of forage on public lands for wildlife and livestock. *Journal of Range Management* 42:134-138.

Loomis, J., T. Kroeger, L. Richardson, and F. Casey. 2012. The benefit transfer and use estimating model toolkit. Colorado State Unversity, Dept. of Agric. and Resource Economics   Available at: http://dare.colostate.edu/tools/benefittransfer.aspx Accessed September 6, 2012.

Nelson, R. H. 1995. Public lands and private rights: the failure of scientific management. Lanham, Md, USA: Rowman & Littlefield, 1995. 373 p.

Nelson, R. H. 2006. Valuing nature: economic analysis and public land management, 1975-2000. *American Journal of Economics and Sociology* 65:525-557.

NRC. 2005. Valuing ecosystem services : toward better environmental decision-making / Committee on Assessing and Valuing the Services of Aquatic and Related Terrestrial Ecosystems, Water Science and Technology Board, Division on Earth and Life Studies, National Research Council. Washington, D.C. : National Academies Press. 277 p.

Tanaka, J. A., M. Brunson, and L. A. Torell. 2011. A social and economic assessment of rangeland conservation practices. In: D. D. Briske [ED.]. Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps. Washington, D.C.: USDA-Natural Resource Conservation Service. p. 371-422. Available online at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/ technical/nra/ceap/?&cid=stelprdb1045811. Accessed January 6, 2013.

Tanaka, J. A., B. A., K. Jensen, N. R. Rimbey, D. T. Taylor, L. A. Torell, and J. D. Wulfhorst. 2009. Assessment of social and economic capabilities – USDI Bureau of Land Management. Final Report. 430 p.

Taylor, M. H., and K. Rollins. 2012. Using ecological models to coordinate valuation of ecological change on western rangelands for ex post application to policy analysis. *Western Economics Forum* 11:13-21.