Targeting Conservation Easements to Reduce Impacts of Private Land Development on Protected Areas

Tony Prato

Introduction

ECONOMIC GROWTH CAN ADVERSELY AFFECT THE ECOLOGICAL INTEGRITY of protected areas. Changes in ecological processes and natural resources stemming from economic growth include alterations in the availability of energy, water, and nutrients; lower soil and water quality; greater incidence of exotic species; reduced biodiversity; increased exploitation of species; and more fragmented landscapes (Adger and Brown 1994; Ojima et al. 1994; Turner and Meyer 1994; Vitousek et al. 1997; Pimm and Raven 2000; Solecki 2001; Foley et al. 2005; Ikerd 2005).

Counties in the western United States containing protected areas (i.e., national parks, national monuments, wildlife refuges, and wilderness areas) are growing more rapidly than counties without such areas (Rasker et al. 2004). Undeveloped private lands adjacent to these protected areas are especially vulnerable to economic growth, particularly rural residential development. Between 1970 and 2000, rural residential development in the Montana and Wyoming portions of the Greater Yellowstone Ecosystem, which includes Yellowstone and Grand Teton national parks, increased 400% (Williams 2001). This development has degraded and fragmented current and potential grizzly bear habitat on private lands in the ecosystem. Continuation of this trend could jeopardize grizzly bear recovery in the region (Johnson 2001). Double-digit growth in residential subdivisions adjacent to the National Elk Refuge in Jackson, Wyoming, has diminished winter range for the 10,000 elk that use the refuge, and has displaced corridors that they use to reach summer range in Yellowstone and Grand Teton national parks (Howe et al. 1997). Cumulative impacts of residential development and resource extraction on lands surrounding Glacier National Park in western Montana threaten the park's natural resources (Keiter 1985; National Parks Conservation Association 2002; Prato 2003b).

A primary way land trusts can control economic growth and protect natural resources on private lands adjacent to protected areas is through conservation easements. A conservation easement is a legally binding agreement between a private organization and landowner that limits certain types of land uses or prevents development from occurring on that property. It requires the landowner to voluntarily donate or sell certain property rights, such as the right to subdivide, to a private organization, such as a land trust, or a public agency. Cash compensation, tax benefits, and/or the desire to retain the open space character of a property are primary reasons why landowners grant conservation easements. As of 2000, more than 1,260 land trusts protected about 1 million ha of land in conservation easements in the United States (The Nature Conservancy 2003).

A combination of limited budgets and increasing ecosystem threats from economic growth make it imperative to target the acquisition of conservation easements to maximize ecological values per dollar expended on easements, or, equivalently, to maximize the efficiency of conservation easements. This paper discusses several targeting criteria for developing efficient easement acquisition plans.

Identifying an efficient easement acquisition plan does not mean a land trust will be able to purchase all the conservation easements called for in the plan. This can occur due to unwillingness of some landowners to sell conservation easements or inability of landowners and land trusts to reach agreement on the prices and terms of easements. This article focuses on criteria for developing efficient easement acquisition plans, not the barriers to achieving those plans.

Current targeting methods

Newburn et al. (2005) developed and compared four criteria for allocating a fixed conservation budget to private land conservation efforts. These criteria are applicable to the selection of parcels for conservation easements. The four criteria are: value-only targeting, value-loss targeting, value-cost targeting, and value-loss-cost targeting. Newburn et al. (2005) point out that "Any targeting approach that ignores either vulnerability [of parcels to development] or costs [of the conservation program] will result in suboptimal targeting." The value-only, value-loss, and value-cost targeting criteria are suboptimal or inefficient in this regard because they ignore vulnerability of parcels to development and/or costs of acquiring easements. In particular, value-only targeting considers the ecological values of easements, but ignores both the costs of acquiring easements and the vulnerability of parcels to development. Value-loss targeting considers the ecological values of easements and the vulnerability of parcels to development, but ignores the costs of acquiring easements. Value-cost targeting considers the ecological values of easements and costs of acquiring easements, but ignores the vulnerability of parcels to development.

Only the value-loss-cost targeting criterion considers all three elements: the ecological values of easements, the vulnerability of parcels to development, and the costs of acquiring easements. The original value-loss-cost targeting criteria proposed by Newburn et al. (2005) had two deficiencies. First, it assumed that development of a parcel resulted in a total loss of ecological value. Second, it did not consider how to make easement acquisition decisions over multiple time periods. Both deficiencies were alleviated by Newburn et al. (2006).

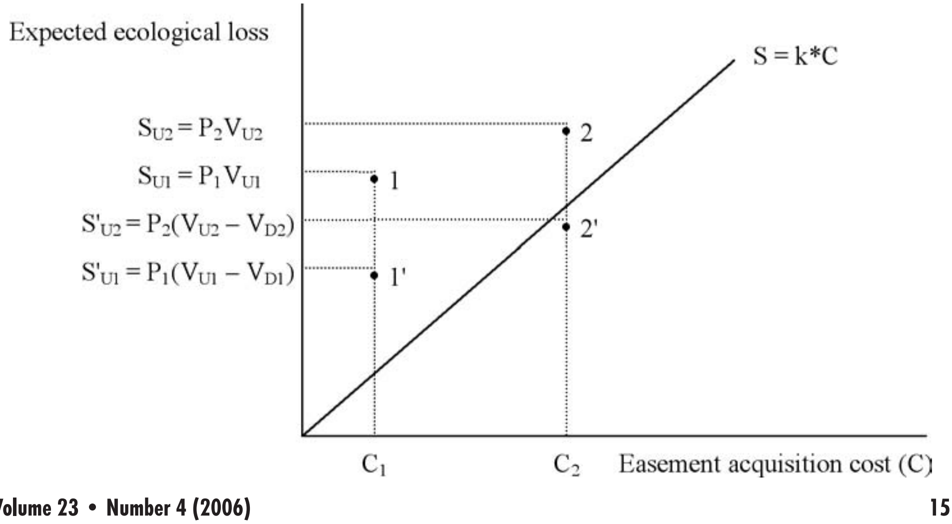
The targeting criteria discussed here extend the work of Newburn et al. (2005, 2006) by allowing a land trust to develop an efficient easement acquisition plan when: (1) the ecological values of conservation easements cannot be measured in monetary terms; (2) ecological values of conservation easements for different parcels are spatially correlated; and (3) the probabilities of parcels developing are unknown. The targeting criteria described here rest on two assumptions: that there are only two types of parcels, undeveloped and developed, and that once a parcel is developed it cannot revert back to an undeveloped state (i.e., irreversibility).

Value-loss-cost criterion

Since the targeting issues and criteria described here build on the value-loss-cost targeting criterion developed by Newburn et al. (2005), this section describes that criterion. Applying the criterion to conservation easements implies that parcels are selected for easements based on the ratio of the expected loss in ecological value to easement acquisition cost. Expected loss in the ecological value of a parcel integrates the ecological values of easements and the vulnerability of parcels to development. In particular, the value-loss-cost criterion selects parcels having the highest ratio of expected ecological loss ($S_U=PV_U$) to easement acquisition cost (C), where P is the probability that an undeveloped parcel is converted to its highest-valued permitted developed use, and V_U is the ecological value of the parcel in its undeveloped state. Considering only permitted developed uses of a parcel eliminates uses that are disallowed by zoning restrictions (e.g., residential and commercial development cannot occur on parcels located in the 100-year floodplain). The original value-loss-cost criterion described by Newburn et al. (2005) assumed that development of a parcel results in a complete loss of ecological value. For a conservation budget of B (i.e., the amount of money the land trust has to spend on acquiring conservation easements), the original value-loss-cost targeting selects parcels for which $S_U/C \geq k^*$ or $S_U \geq k^*C$, where k^*C is the critical line and k^* is the slope of the critical line (see Figure 1). The term k^* increases (decreases) as B decreases (increases).

If the ecological value of a developed parcel is greater than zero, then development of that parcel results in a partial loss in ecological value. In this case, the expected

Figure 1. Value-loss-cost targeting criterion, where k^*C is the critical line, $S_{U1} = P_1V_{U1}$ is the expected ecological loss for parcel 1, $S_{U2} = P_2V_{U2}$ is the expected ecological loss for parcel 2 when parcel conversion results in a full loss in ecological value, $S'_{U1} = P_1(V_{U1} - V_{D1})$ is the expected ecological loss for parcel 2, and $S'_{U2} = P_2(V_{U2} - V_{D2})$ is the expected ecological loss for parcel 2 when parcel conversion results in a partial loss in ecological value.



ecological loss from development of a parcel is $S'_U = P(V_U - V_D) = P\Delta V$, where V_U is the ecological value of the parcel if undeveloped and V_D is the ecological value of the parcel if converted to its highest-valued permitted developed use. Since development of a parcel is likely to reduce its ecological value, $\Delta V > 0$. The revised value-loss-cost criterion evaluates parcels for acquisition based on the ratio of $P\Delta V$ to C.

Figure 1 illustrates the application of the original and revised value-loss-cost criteria to two hypothetical parcels. A dot in front of the parcel number designates the combination of S_U and C for that parcel. For example, parcel 1 has an expected ecological loss of S_{U1} with the original value-loss-cost criterion, an expected ecological loss of S'_{U1} with the revised value-loss-cost criterion, and an easement acquisition cost of C_1. Parcel 2 has an expected ecological loss of S_{U2} with the original value-loss-cost criterion, an expected ecological loss of S'_{U2} with the revised value-loss-cost criterion, and an easement acquisition cost of C_2. The original criterion selects parcels 1 and 2 for acquisition because $S_{U1} > k^*C$ and $S_{U2} > k^*C$.

When parcel development results in only a partial loss of ecological value (as opposed to a full loss), it is still optimal to acquire parcel 1 because $S'_{U1} > k^*C$. However, it is not optimal to acquire parcel 2 because $S'_{U2} < k^*C$. Therefore, parcel 2 is selected for easement acquisition when development results in a full loss in ecological value but not when it results in a partial loss in ecological value for the relationships illustrated in Figure 1. In general, the revised value-cost-loss criterion can result in a different selection of parcels for conservation easements than the original value-loss-cost criterion.

Accommodating non-monetary ecological values

Parcels have ecological value because they provide ecosystem services that are typically not valued in the market place. Although economists have developed non-market valuation procedures for estimating the monetary value of ecosystem services (Prato 1998), use of these procedures is beyond the reach of most land trusts. Consequently, land trust managers generally cannot express the ecological value of parcels in monetary terms. Under these circumstances, the value-loss-cost criterion cannot be applied unless ecological values of parcels are evaluated in non-monetary terms. The latter can be done provided the land trust is able to score parcels based on the ecological value of the multiple ecosystem services they provide. For example, if a land trust is able to score ecological values of parcels (with and without development) between 0 and 100, where 0 implies no ecological value and 100 implies maximum ecological value, then V_U and $V_U - V_D$ are between 0 and 100. Undeveloped parcels are then selected for easements based on the values for PV_U/C or $P(V_U - V_D)/C$. When ecological values are scored in the above manner, these ratios are expressed in terms of expected units of ecological loss per dollar spent on easement acquisition. Other things equal, the higher these ratios, the more desirable are the parcels for conservation easements.

Land trusts can assign scores to V_U and V_D using a multiple-attribute evaluation (MAE) procedure in which the ecosystem services provided by parcels are the attributes. Application of a MAE procedure would require the land trust to: (1) enumerate the multiple ecosystem services provided by parcels; (2) develop measurable indicators for all ecosystem services; (3) measure the indicators and determine their relative importance (or weights); and (4) use a utility function to calculate scores for V_U and V_D for all parcels. The utility function integrates the indicators for ecosystem services and their weights. Prato (2003a and 2004) describe MAE procedures in more detail.

Accounting for spatial correlation in ecological values

Ecological values of parcels are spatially correlated when the ecological value of a conservation easement on one parcel depends on whether or not nearby parcels have easements. Selecting an optimal easement acquisition plan when there is spatial correlation among ecological values necessitates comparing the overall ecological value of alternative spatial patterns of easement acquisitions. To illustrate this procedure, suppose a land trust wants to select an optimal easement acquisition plan from a set of three mutually exclusive, financially feasible easement acquisition plans, namely $\{A_1, A_2, A_3\}$. Each of the three plans in this set represents a particular spatial pattern of easement acquisitions. A plan is financially feasible provided its present value cost is less than or equal to the present value of the conservation budget. Stated differently, financial feasibility requires

$$PV[C(A_i)] \leq \sum_{t=0}^{T} B_t(1+r)^{-t}$$

for all i=1, 2, 3, where $PV[C(A_i)]$ is the present value acquisition cost of plan A_i and

$$\sum_{t=0}^{T} B_t(1+r)^{-t}$$

is the present value of the budgets available for acquiring easements over a planning horizon of T time periods.

For simplicity of exposition, suppose a land trust has identified three future spatial patterns of parcel conversions in the absence of new conservation easements, namely $\{G_1, G_2, G_3\}$. If the land trust can assign probabilities to G_1, G_2, and G_3, say P_{G1}, P_{G2}, and P_{G3}, respectively, then the expected ecological losses with the three spatial patterns of parcel conversions are $P_{G1}L(G_1)$, $P_{G2}L(G_2)$, and $P_{G3}L(G_3)$, respectively. P_{Gi} is the probability of pattern G_i and $L(G_i)$ is the present value ecological loss with pattern G_i. The optimal easement acquisition plan for a planning period is the one that minimizes the maximum expected present value ecological loss from parcel development subject to the conservation budget for that period. For example, if $P_{G2}L(G_2)$ exceeds $P_{G1}L(G_1)$ and $P_{G3}L(_{G3})$, then G_2 has the maximum expected present value ecological loss. In this case, the optimal acquisition plan is to acquire conservation easements in a manner that circumvents the pattern of parcel conversions implied by G_2. Referring to Figure 2, the optimal easement acquisition plan is to acquire easements on parcels 1, 3, 6, 9, and 16.

Handling uncertainty

Uncertainty regarding future spatial patterns of parcel conversions implies the land trust cannot assign probabilities to G_1, G_2, and G_3. Although not considered here, it is also possible to account for uncertainty in the cost of acquiring easements. Uncertainty about patterns of parcel conversion necessitates using a different procedure to determine the optimal parcel acquisition plan than the one used in the previ-

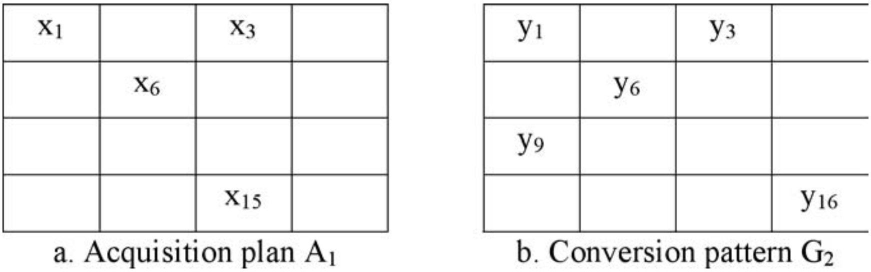


Figure 2. Spatial pattern of easement acquisitions with plan A_1 (panel a), and the spatial pattern of parcel conversions with G_2 (panel b).

ous section. Selecting an optimal easement acquisition plan under uncertainty is explained assuming that there is spatial correlation in the ecological values of parcels (see previous section).

Panel a of Figure 2 illustrates a hypothetical, feasible spatial pattern of easement acquisitions for an area consisting of 16 parcels, referred to as A_1. The x-entries in the grid indicate that A_1 involves acquiring easements on parcels 1, 3, 6, and 15. Panel b in Figure 2 illustrates a particular future parcel conversion pattern referred to as G_2. The y-entries in panel b indicate that parcels 1, 3, 6, 9, and 16 convert to developed uses with G_2 in the absence of conservation easements. With three feasible acquisition plans (i.e., A_1, A_2 and A_3) and three future parcel conversion patterns (i.e., G_1, G_2, and G_3), there are nine possible combinations of feasible acquisition plans and future conversion patterns.

The expected present value ecological loss for A_1 given G_2 occurs is determined by summing the present value ecological losses for all parcels with that combination. Present value ecological losses are determined by evaluating the matches and mismatches between A_1 and G_2. In particular, there is a match between A_1 and G_2 for parcels 1, 3, and 6 because the plan acquires easements on parcels 1, 3, and 6, and these parcels would be developed without the easements. There is a mismatch for parcel 15 because A_1 acquires an easement for this parcel, but G_2 indicates the parcel is not developed even without an easement. Additionally, there is a mismatch between A_1 and G_2 for parcels 9 and 16 because the plan says not to acquire easements on those parcels, but those parcels would be developed without conservation easements. Therefore, the present value ecological loss avoided with A_1 when G_2 occurs is the sum of the present value ecological losses for parcels 1, 3, and 6 (i.e., those for which there is a match) designated as ΔV_{12}. Repeating this procedure for all nine combinations of $\{A_1, A_2, A_3\}$ and $\{G_1, G_2, G_3\}$ gives a 3x3 matrix of values for ΔV (see Table 1).

A common criterion for making decisions under uncertainty is the minimax criterion. The minimax criterion selects the easement acquisition plan that minimizes the maximum present value ecological loss from future conversion of parcels from undeveloped to developed states unless the social cost of those conversions is unacceptably high (Bishop 1978; Prato 2005). The first step in determining an optimal easement acquisition plan based on the minimax principle is to identify the easement acquisition plan that results in the maximum present value ecological loss for each

Easement acquisition plan	Future parcel conversions pattern		
	G_1	G_2	G_3
A_1	$\Delta V_{11} = 58$	$\Delta V_{12} = 65$	$\Delta V_{13} = 85$
A_2	$\Delta V_{21} = 40$	$\Delta V_{22} = 55$	$\Delta V_{23} = 50$
A_3	$\Delta V_{31} = 75$	$\Delta V_{32} = 30$	$\Delta V_{33} = 45$
Acquisition plan that results in the maximum present value ecological loss, shown in parentheses	A_3 (75)	A_2 (65)	A_1 (85)

Table 1. Hypothetical present value ecological losses for three easement acquisition plans and three parcel conversion patterns.

future parcel conversion pattern. This step shows that the maximum present value ecological loss with G_1 is 75 for A_3, with G_2 is 65 for A_2, and with G_3 is 85 for A_1 (see the last row of Table 1). The second step is to select as the optimal plan the one that results in the minimum ecological loss of the three maximum ecological losses identified in the first step. Therefore, A_2 is the optimal easement acquisition plan for the values of ΔV given in Table 1.

Since land values and ecosystem services are likely to change over time, the land trust should periodically update the optimal parcel acquisition plan. To illustrate how updating is done, suppose the land trust has operated for five years under the initial optimal acquisition plan (i.e., the spatial pattern of parcel acquisitions determined using the minimax principle for the first five-year period). Updating has five steps. First, a revised set of developable parcels for the second five-year period is determined by excluding parcels for which conservation easements were purchased or conversion to developed uses occurred during the first five-year period. Second, the set of possible parcel acquisition plans and set of future spatial patterns of parcel conversions are determined based on the revised set of developable parcels. Third, the present value cost of the easements acquired during the first five-year period is subtracted from the initial present value budget to obtain a revised present value budget as of the beginning of the second five-year period. Fourth, the set of spatial patterns of parcel acquisitions determined in the second step is screened to eliminate parcel acquisition patterns that are not financially feasible based on the revised present value budget. Fifth, an optimal easement acquisition plan is determined for the second five-year period by applying the minimax principle to the revised set of spatial patterns of parcel acquisitions and revised set of future spatial patterns of parcel conversions. This adaptive planning procedure is repeated as often as the land trust updates the optimal parcel acquisition plan.

Data and information requirements

The original value-loss-cost criterion requires a land trust to specify the probabilities of parcels converting to developed states (P), and estimate the ecological values of parcels in their undeveloped states (V_U). Additionally, the revised value-loss-cost criterion requires a land trust to estimate the ecological values of parcels in their developed states (V_D). Both criteria require information on the present value cost of acquiring and maintaining easements and annual conservation budgets over the T-period planning horizon, as well as specify a discount rate (r).

Estimating the ecological values of parcels can be streamlined by incorporating parcel information in a geographic information system (GIS) and incorporating the GIS dataset and parcel selection criterion in a spatial decision support tool. A spatial decision support tool is a knowledge-based system that integrates data, information, and evaluation methods for the purpose of identifying and evaluating solutions to complex problems involving spatially distributed information (Djokic 1993). Having such a tool would make it easier for land trusts to develop and update optimal easement acquisition plans based on the procedures and informational requirements described above.

The value-loss-cost and minimax-based uncertainty criteria have different data and informational requirements. In the absence of spatial correlation among ecological values of parcels, use of the value-loss-cost criterion requires a land trust to specify the probabilities of parcels converting to developed uses, or, in the presence of spatial correlation, the probabilities of different future spatial patterns of parcel conversions. Use of the uncertainty criterion requires a land trust to estimate the present value ecological loss for each combination of easement acquisition plan and future spatial pattern of parcel conversions. Both criteria require the land trust to estimate the present value acquisition costs for parcels.

It may be easier for a land trust to specify alternative spatial patterns of parcel conversions than to estimate the probabilities of parcel conversions, unless conversion probabilities have already been estimated in land-use change studies for the area of interest. Specifying all future spatial patterns of easement acquisition requires eliminating from consideration: (1) parcels unsuitable for development because of their soil type, slope, and/or location relative to water bodies, floodplains, and environmentally sensitive areas; (2) parcels for which landowners are not interested in donating or selling conservation easements; and (3) easement acquisition patterns that are unaffordable due to limited conservation budgets. Limited budgets would eliminate many developable parcels from being considered for conservation easements, especially in areas where landowners are not willing to sell conservation easements without cash incentives from land trusts.

Summary and conclusion

This paper describes two kinds of criteria a land trust can use for targeting acquisition of conservation easements: a value-loss-cost criterion and an uncertainty criterion. Use of the value-loss-cost criterion requires a land trust to specify the probabilities of individual parcels converting from undeveloped to developed states, or if there is spatial correlation in ecological values of parcels, the probabilities of future spatial patterns of parcel conversions. The optimal easement acquisition plan with the value-loss-cost criterion is determined by minimizing expected ecological loss from parcel conversions subject to the conservation budget. Using the uncertainty criterion when there is spatial correlation in ecological values of parcels requires a land trust to specify alternative spatial patterns of parcel acquisition and alternative future spatial patterns of parcel conversion. Both criteria accommodate full or partial ecological losses from parcel conversion from undeveloped to developed states, and allow ecological values of parcels to be measured in monetary or non-monetary terms.

Although these criteria described here are flexible enough to accommodate a wide range of conditions, they have relatively high informational requirements. Before adopting these criteria, land trusts should determine whether or not the benefit of applying the criteria (i.e., maximizing ecological value per dollar of easement acquisition cost for a given conservation budget) exceeds the additional informational cost. If so, then application of the criteria results in a net gain. Otherwise, application of the criteria results in a net loss.

The conservation easement targeting criteria described here can be adapted to protected areas. For example, preserving biodiversity, which is a high priority for most protected areas (see IUCN 1994 and Davey 1998), can be given a higher weight than other ecosystem services in determining the overall ecological value of retaining parcels in an undeveloped state. This adaptation would increase the likelihood of acquiring conservation easements on private land parcels that are critical to preserving biodiversity. For example, much of the growth in rural residential development in the Greater Yellowstone Ecosystem has been concentrated in more remote rural areas (Glick and Haggerty 2000; Hansen et al. 2002). One study showed that 320 of the 400 new homes randomly sampled in Gallatin County, which covers a portion of the ecosystem, were constructed in prime wildlife habitat (Glick and Haggerty 2000). This ecosystem, and others experiencing rapid loss in open spaces and private land development, would benefit from the design and implementation of easement acquisition plans that target the preservation of biodiversity.

References

Adger, W.N., and K. Brown. 1994. *Land Use and the Causes of Global Warming*. New York: John Wiley & Sons.

Bishop, R.C. 1978. Endangered species and uncertainty: The economics of a safe minimum standard. *American Journal of Agricultural Economics* 60, 10–18.

Davey, A.G. 1998. Protected areas categories and management objectives. Appendix 2 in *National System Planning for Protected Areas*. Gland, Switzerland and Cambridge, U.K.: IUCN, 49–55.

Djokic, D. 1993. Towards general purpose spatial decision support system using existing technologies. In *Proceedings of the Second International Conference/Workshop on Integrating Geographic Information Systems and Environmental Modeling*. Breckenridge, Colorado: N.p.

Foley, J.A., et al. 2005. Global consequences of land use. *Science* 309, 570–574.

Glick, D., and M. Haggerty. 2000. Land use planning in Greater Yellowstone: Is it making the grade? *Greater Yellowstone Report* (winter).

Hansen, A.J., R. Rasker, B. Maxwell, J.J. Rotella, J.D. Johnson, A.W. Parmenter, U. Langner, W.B. Cohen, R.L. Lawrence and M.P.V. Kraska. 2002. Ecological causes and consequences of demographic change in the New West. *BioScience* 52, 151–162.

Howe, J., E. McMahon, and L. Propst. 1997. *Balancing Nature and Commerce in Gateway*

Communities. Washington, D.C.: Island Press.

Ikerd, J. 2005. *Sustainable Capitalism: A Matter of Common Sense*. Bloomfield, Conn.: Kumarian Press.

IUCN. 1994. *Guidelines for Protected Area Management Categories.* Gland, Switzerland, and Cambridge, U.K.: IUCN.

Johnson, V.K. 2001. Trends in rural residential development in the Greater Yellowstone Ecosystem since the listing of the grizzly bear, 1975–1998. *Yellowstone Science* 9, 2–9.

Keiter, R.B. 1985. On protecting the national parks from the external threats dilemma. *Land and Water Law Review* 20, 355–420.

National Parks Conservation Association. 2002. *State of the Parks, A Resource Assessment: Waterton-Glacier International Peace Park.* On-line at www.npca.org/stateoftheparks/glacier/.

Newburn, D., S. Reed, P. Berck, and A. Merenlender. 2005. Economics and land-use change in prioritizing land conservation. *Conservation Biology* 19, 1411–1420.

Newburn, D., P. Berck, and A. Merenlender. 2006. Habitat and open space at risk of land-use conversion: Targeting strategies for land conservation. *American Journal of Agricultural Economics* 88, 28–42.

Ojima, D.S., K.A. Galvin, and B.L. Turner. 1994. The global impact of land-use change. *BioScience* 44, 300–304.

Pimm, S.L., and P. Raven. 2000. Biodiversity: Extinction by numbers. *Nature* 403, 843–845.

Prato, T. 1998. Non-market valuation of natural and environmental resources. In *Natural Resource and Environmental Economics.* Ames: Iowa State University Press.

———. 2003a. Multiple attribute evaluation of ecosystem management for the Missouri River. *Ecological Economics* 45, 297–309.

———. 2003b. Alleviating multiple threats to protected areas with adaptive ecosystem management: The case of Waterton–Glacier International Peace Park. *The George Wright Forum* 20:4, 41–52.

———. 2004. Multiple attribute evaluation for national parks and protected areas. *The George Wright Forum* 21:4, 62–75.

———. 2005. Accounting for uncertainty in making species protection decisions. *Conservation Biology* 19, 806–814.

Rasker, R., B. Alexander, J. van den Noort, and R. Carter. 2004. *Prosperity in the 21st Century West: The Role of Protected Public Lands.* Bozeman, Mont.: Sonoran Institute.

Solecki, W.D. 2001. The role of global-to-local linkages in land use/land cover changes in South Florida. *Ecological Economics* 37, 339–356.

The Nature Conservancy. 2003. Conservation *Easements: Conserving Land, Water and a Way of Life.* On-line at http://nature.org/aboutus/howwework/conservationmethods/privatelands/conservationeasements/files/consrvtn_easemnt_sngle72.pdf.

Turner, B.L., and W.B. Meyer. 1994. Global land-use and land-cover change: an overview. In *Changes in Land Use and Land Cover: A Global Perspective.* W.B. Meyer and B.L. Turner, eds. Cambridge, U.K.: Cambridge University Press, 3–10.

Vitousek, P.M., H.A. Mooney, J. Lubchenco, and J.M. Melillo. 1997. Human domination of

the Earth's ecosystems. *Science* 277, 494-–499.
Williams, F. 2001. Between towns and wilderness: protecting the buffer zones. In *Return of the Wild: The Future of Our Natural Lands.* T. Kerasote, ed. Washington, D.C.: Island Press, 73–86.

Tony Prato, Center for Agricultural, Resource and Environmental Systems (CARES), 212 Mumford Hall, University of Missouri, Columbia, Missouri 65211; pratoa@missouri.edu