

Assessing the Ecological and Social Benefits of Private Land Conservation in Colorado

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Abstract: *Conservation of private land through conservation easements, development agreements, and clustered housing has increased greatly as have criticisms of the laws, public programs, and incentives that motivate landowners to use them. Rapid land-use change at the urban-rural interface in Larimer County, Colorado, has given rise to programs that provide a variety of land-conservation options for landowners. As of January 2005, roughly 60% of Larimer County was publicly owned, and 3% or 16,200 ha was privately owned with some form of protection. We used document analysis, a landowner survey, targeted interviews, and a landscape-level spatial analysis to analyze the patterns, quantities, and qualities of private land conservation. We created a jurisdiction-specific typology of desired benefits from local government-planning documents to help evaluate conservation parcels. Most easements and other conservation documents used general terms and did not describe the site-specific values of the land being conserved. Landowners were able to describe some benefits not included in parcel-specific documents, and our spatial analysis revealed parcel-specific and cumulative conservation benefits such as the amount of buffering, infill, connectivity, protected agricultural land, riparian protection, and other benefits not referenced by either documents or landowners. Conservation benefits provided by a parcel varied depending on its geographic location, the specific institution such as a land trust or open space program that a landowner worked with, and the conservation mechanism used, such as voluntary easement or residential clustering requirements. The methods we used provide a template for jurisdictions wishing to undertake a similar analysis. Our findings may assist other jurisdictions and institutions interested in improving how land-conservation benefits are described; justify and inform future investments in private land conservation; assist local governments and other institutions with the assessment of program effectiveness; and be useful for conservation planners who wish to become more involved in on-the-ground implementation of conservation actions.*

Keywords: conservation easements, clustered housing developments, landowner perceptions, spatial analysis, stakeholder analysis

Evaluación de los Beneficios Ecológicos y Sociales de la Conservación de Terrenos Privados en Colorado

Resumen: *La conservación de terrenos privados por medio de servidumbres ecológicas, acuerdos de desarrollo y viviendas agrupadas ha incrementado notablemente al igual que las críticas a las leyes, programas públicos e incentivos que motivan a los propietarios a utilizarlos. El acelerado cambio de uso del suelo en la interfase urbano-rural en el Condado Larimer, Colorado, ha dado lugar a programas que proporcionan una variedad de opciones de conservación a los propietarios. Hasta enero 2005, casi 60% del Condado Larimer era propiedad privada, y 3% o 16,200 ha eran propiedad privada con alguna forma de protección. Utilizamos el análisis de documentos, un muestreo de propietarios, entrevistas dirigidas y un análisis espacial a nivel de paisaje para analizar los patrones, cantidades y calidades de conservación de tierras privadas. Creamos una tipología específica para las jurisdicciones de los beneficios deseados por la planificación del gobierno local*

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para ayudar a evaluar las parcelas de conservación. La mayoría de las concesiones y otros documentos de conservación utilizaban términos generales y no describían los valores específicos de cada sitio de los terrenos conservados. Los propietarios pudieron describir algunos beneficios no incluidos en los documentos de las parcelas específicas, y nuestro análisis espacial reveló beneficios de conservación acumulados y a nivel de parcela específica tales como la cantidad de área de amortiguamiento, la conectividad, los terrenos agrícolas protegidos, la protección riparia y otros beneficios no referidos por los documentos ni los propietarios. Los beneficios de conservación proporcionados por una parcela variaron dependiendo de su localización geográfica, las instituciones específicas como un fideicomiso o un programa de espacio abierto con que trabajaba un propietario y del mecanismo de conservación utilizado, como una concesión voluntaria o requerimientos de agrupamiento residencial. Los métodos que utilizamos proporcionan un templete para jurisdicciones que deseen realizar un análisis similar. Nuestros resultados pueden ayudar a otras jurisdicciones e instituciones interesadas en mejorar la descripción de los beneficios de la conservación; justificar e informar sobre inversiones futuras en la conservación de terrenos privados; asistir a gobiernos locales y otras instituciones en la evaluación de la efectividad de programas; y ser de utilidad para planificadores de la conservación que quieran involucrarse en la instrumentación de acciones de conservación.

Palabras Clave: análisis espacial, análisis de intereses, desarrollos de vivienda agrupados, percepciones de propietarios, servidumbres ecológicas

Introduction

Across the United States pressure to subdivide private land for residential development at the urban-rural fringe encroaches on agricultural land, strains water resources, destroys wildlife habitat, and affects biological diversity (McKinney 2002; Hansen et al. 2005). Development adjacent to public lands increasingly complicates the management of fire, invasive species, wildlife, and other resources (McKinney 2002; Maestas et al. 2003). The public often perceives these changes in general terms as the loss of open space or diminished quality of life (Kline 2006). Citizens and governmental institutions in the United States have responded to the increasing scarcity of undeveloped land with more than 800 successful ballot initiatives in the last 15 years that legally enable, finance, and administer land-conservation programs (Kline 2006). The upsurge in public support for land conservation is particularly evident in areas with higher population density and per capita income (Kotchen & Powers 2006).

Typically, land-conservation programs use some combination of fee-simple purchase and private land conservation (PLC) in which land is protected but not transferred to the public domain (Fairfax et al. 2005). We focused on PLC or protection from development that is achieved by permanently or temporarily acquiring rights—usually development rights and other partial rights in land. These rights may be purchased from landowners or they may be donated fully or at a reduced cost (bargain sale) by landowners. Some programs use incentives that motivate landowners to maintain land in agricultural uses or to use development options that include conservation. Local governments may also create quasi-regulatory mechanisms that require, for example, developments to be clustered and restrictions on use of undeveloped portions of a parcel, or that require de-

velopers to purchase and transfer development rights from targeted conservation-sending areas. Incentives for voluntary PLC in Colorado and elsewhere include federal and state tax deductions, state tax credits, agricultural districts that provide incentives to landowners who agree to not develop, and housing-density bonuses for those undertaking conservation (cluster) developments. Most PLC initiatives rely heavily on the use of conservation easements and partnerships among land trusts, local and state governments, and other actors (Morrisette 2001; Merenlender et al. 2004; Fairfax et al. 2005).

Recently, PLC has come under scrutiny, especially in the western United States (Ring 2005; Stephens 2005). Responding to these criticisms requires improved descriptions of the public benefits of PLC (Merenlender et al. 2004; Bernstein & Mitchell 2005; Campopiano 2006), monitoring and maintenance of benefits over time (Block et al. 2004; Kiesecker et al. 2007), and the equitable administration of appraisals and tax incentives for cooperating land owners (Joint Committee on Taxation 2005; Stephens 2005). In recent court cases the U.S. Internal Revenue Service (IRS) challenged whether the monetary value of easements was fairly determined (Land Trust Alliance 2007). In Colorado \$193 million of conservation tax credits have been granted in the past 6 years, and critics are asking which lands and what values have been conserved (Imse 2006).

As defined by Section 170(h) of the Internal Revenue Code, the benefits include public outdoor recreation or education; protection of relatively natural habitat for fish, wildlife, or plants; the preservation of open space, including farmland and forest land for either public scenic enjoyment or pursuant to local governmental conservation policy; and preservation of historically important land or certified historic structures.

To answer the call for accountability anticipated by the question posed by Merenlender et al. (2004), "Who is conserving what for whom?" we linked general IRS standards to explicit conservation objectives as described in legally adopted local government documents such as master plans or open space plans "that further a specific conservation purpose" (Internal Revenue 2006). These documents guide land-use decisions and public investment. They contain vision statements and directives developed through due process and public involvement. As such, they provide the best rendering of the conservation benefits that a jurisdiction hopes to achieve. An analysis of these documents can provide a typology or list of benefit categories that gives community-specific meaning to general IRS language such as "pursuant to governmental conservation policy." Such a typology can serve as a frame of reference for the evaluation of parcel-specific benefits. It is also useful to understand how landowners themselves perceive ecological and social benefits provided by their conservation efforts that are overlooked by recorded documents. The benefits of PLC can also be revealed by a spatial analysis of the patterns, quantities, and qualities of the resources being protected. Quantifying the area of productive agricultural land or wildlife habitat protected, the length of corridors created, or protected area boundaries buffered by PLC enhances descriptions and evaluations of the benefits PLC provides (Theobald 2003; Prato 2006; Rissman et al. 2007).

Employing these concepts, we assessed PLC benefits at both the parcel and jurisdictional (landscape) level examining all private parcels conserved in Larimer County, Colorado, prior to 1 January 2005. The county (including municipalities) is the logical unit of analysis because it is where most land use decisions are made and recorded in the United States (Theobald et al. 2005). Our assessment is part of a larger study that compared the institutions involved in PLC, described the demographics, motivations, and management involvement of landowners engaged in PLC (Ernst & Wallace 2007), and developed a viability index for evaluating the long-term sustainability of PLC transactions. Although our results are specific to Larimer County, we believe our methods and findings may be readily generalized to other jurisdictions.

PLC Institutions and Mechanisms Used in the Study Area

Recent concerns have been raised about the gap between conservation science and the on-the-ground implementation of land conservation. More specifically, information is lacking about PLC institutions, programs, and the landowners they work with (Merenlender et al. 2004; Knight et al. 2005). To address these concerns we more thoroughly describe the diversity of programs, conserva-

tion mechanisms, and funding sources that have enabled PLC in the study area at <http://www.warnercnr.colostate.edu/nrrt/people/biowallace.htm>. An abbreviated description follows here.

Larimer County Colorado is a textbook illustration of the threats associated with rapid growth along Colorado's Front Range, where the Great Plains meet the Rocky Mountains (Duerksen & Snyder 2005). The county is 682,000 ha (1,685,000 acres), has a wide range of elevations and landforms, and supports high levels of biodiversity (Doyle et al. 2004). Although one-third of the land in the county is upper-elevation lands that have long been publicly owned, lower elevations have few state and federal protected areas, but have more productive soils and provide critical wildlife habitat (Scott et al. 2001; Maestes et al. 2003). These mostly private lands, which have a rich agricultural history and infrastructure, are being developed at an alarming rate. Between 1990 and 2000, rural areas of the county experienced a 17% growth rate (U.S. Census Bureau 2000). State law gives property owners the right to subdivide their land into a minimum of 16-ha (35-acre) parcels without county development review (1972 Colorado Senate Bill 35). Thirty-five acre "ranchettes" and large-lot rural subdivisions have proliferated.

More than a dozen local and state institutions have responded to increases in rural sprawl with a combination of voluntary, incentive-driven, and quasi-regulatory mechanisms designed to promote PLC. A revised Larimer County Master Plan specifies that new subdivisions outside city growth-management areas be designed as cluster developments and located away from natural areas and good agricultural land (e.g., Pejchar et al. 2007). County land-use code now provides 2 clustered-development alternatives, 1 voluntary and the other quasi-regulatory. City and county open-space programs purchase easements on private land. Two land trusts and a sportsman's foundation work with landowners who wish to conserve. Partnerships have been encouraged by the allocation of state lottery monies through competitive grants and required third-party involvement. A state program now allows landowners to take tax credits for up to 50% of the fair market value of a conservation easement up to \$375,000 and to sell credits to others. Tax credit transactions exceeded \$30 million statewide in 2005 (Hawn 2006; Ernst & Wallace 2007). There has been no previous attempt at an integrated description or analysis of these PLC efforts and the benefits they might be providing.

Methods

To take the initial steps needed to describe the ecological and social benefits provided to Larimer County by the PLC institutions described earlier, we used mixed

methods (Creswell 2003), including key contacts, document analysis, landowner surveys, interviews, and spatial analysis.

Database Compilation

Because no electronic database existed for PLC in the county, we manually acquired and examined the recorded documents associated with 178 conservation easements, 16 rural conservation developments (RCD clusters), and 40 rural land-use plans (RLUP clusters) that together represented all PLC activity in the county as of January 2005. Key contacts provided background information, a current list of conservation easements or protective covenants used in cluster developments, and the corresponding reception numbers assigned to the records for each parcel in the county Clerk and Recorder's office. The documents associated with each parcel (deeds of easements, declarations of conditions, covenants and restrictions, and development agreements) were then obtained from the Clerk and Recorder's office for analysis. Parcels and easements are not necessarily equivalent (some easements or restrictions do not apply to an entire parcel), which made mapping and linking PLC challenging.

To map privately conserved parcels, we used legal descriptions and examined property descriptions and terms of each easement, including allowed and prohibited uses, and looked for references to conservation values and benefits, primary land uses, and descriptions of the ecological and historical or cultural resources being protected. For the cluster developments (RCD or RLUP) that did not use conservation easements, we examined the protective covenants and development agreements, which provided similar information: the number and location of residential units that could be built and the size and location of the conserved lots and how they were to be used and managed. We then constructed a database that included the number and area of PLC parcels, names of the institutions responsible for the protection of the parcels, the types of landowners typically involved, and the mechanisms used to conserve these lands (Table 1).

Benefits Typology and Analysis

From the 24 available local-government planning documents that referenced desired outcomes for land conservation in the county, we compiled a master list of benefits and analyzed their content. This yielded a county benefits typology with 4 ecological and 4 social themes, each having multiple benefit categories. The typology provided a frame of reference for evaluating benefits referenced in easements and other parcel-specific documents. The benefits referenced in the documents were extracted, aggregated into 25 categories, and reported with the frequency with which each was referenced. We later compared parcel-specific benefits with the county

benefits typology, landowner perception of benefits, and the benefits revealed by spatial analysis.

Landowner Perceptions

A census survey was conducted with all 215 Larimer County Colorado landowners identified by agency or land-trust staff and the Larimer County Clerk and Recorder as having placed a conservation easement or cluster development with protected residual land on their property as of 1 January 2005. The survey contained open-ended and close-ended questions with ordered and unordered choices (Dillman 1978), which we used to probe landowner motivations, characteristics, and management actions; perceptions about the institutions they worked with and the PLC mechanisms used to protect their land; and perceptions about the social and ecological benefits provided by the parcels they conserved. A draft of the survey was reviewed by 9 professionals involved with PLC in Larimer County. Scaled and fixed-response items were analyzed with SPSS version 14 (SPSS 2005), and responses to open-ended survey items were transcribed, subjected to content analysis, and coded into themes common to multiple respondents by a group of 4 researchers (Miles & Huberman 1994). We used *t* tests to compare the perceptions of landowners for certain variables (e.g., perceptions of benefits produced by the land they conserved, motivations).

We developed interview questions to follow up on preliminary survey results and suggestions from reviewers. Semistructured interviews (Kvale 1996) were conducted with a subsample of 15 landowners chosen to represent the array of PLC mechanisms, the mix of landowners, and the geographic locations where PLC was concentrated. We used open-ended questions to further examine landowners' perceptions about the benefits provided by the parcels they conserved. Interviews were transcribed and transcript content was coded and categorized.

Spatial Analysis of Benefits

Information is needed about the quality of PLC lands and their ability to connect, buffer, or provide valuable habitat (Merenlender et al. 2004). We conducted a spatial analysis that included all PLC parcels in the county. Although many landscape metrics have been developed to examine landscape patterns of biophysical resources, little guidance on how to measure protected areas per se (defined by political and ownership boundaries) is available. Thus, we developed some initial methods to quantify the context of privately protected lands. We mapped all PLC parcels in ArcGIS (version 9; ESRI 2004) and labeled each parcel with the name of the institution primarily responsible for its protection (Fig. 1). We then manually overlaid the PLC parcels onto maps that were surrogates for social and environmental benefits. These included

Table 1. Private land conservation institutions, mechanisms used, and land protected in Larimer County, Colorado.

<i>Institution</i>	<i>Date</i>	<i>Holdings, no. acres^a</i>	<i>Conservation mechanism</i>	<i>Focus area/mission</i>	<i>Funding source</i>
Larimer County Rural Land Use Center (RLUC)	1996	41 (12), 6,776	rural land use (cluster) development with perpetual and 40-year covenants, development agreements and conservation easements	parcels of 70 acres or more outside municipal growth-management areas; voluntary program with density bonus incentives; used to curb proliferation of 35-acre parcels created by state 35-acre exemption	county general fund
Larimer County Planning, Rural Conservation Developments (RCD) 1225	2001	16, 1,225	rural conservation (cluster) development with development agreements, conservation easements, perpetual covenants	parcels of 30 acres or more outside municipal growth management areas, quasi-regulatory program when maximum density is sought using underlying county zoning	county general fund
Larimer County Parks and Open Lands Dept.	1995	29 (15), 7,422	fee-simple purchase and conservation easement	lands in the foothills transition zone, agricultural lands, and river corridors	county $\frac{1}{4}$ -cent sales tax
City of Fort Collins Natural Areas Program	1992	9 (7), 4,708	fee-simple purchase and conservation easements	foothills, river, stream corridors, prairie remnants, urban natural areas, comm. separators	county and city $\frac{1}{4}$ -cent sales tax
City of Loveland Natural Areas Program	1996	12 (3), 522	fee-simple purchase and conservation easements	river corridors, lakes, agricultural land, open space/natural areas around city's growth management area	county $\frac{1}{4}$ -cent sales tax, city cap. expansion fees, grants
Estes Valley Land Trust	1987	95, 5,075	conservation easements	upper elevation lands that enhance buffer zone around Rocky Mountain National Park and the Roosevelt National Forest	grants, private donations
Legacy Land Trust	1993	45 (14), 10,309	conservation easements	lands with agricultural, forestry or historical significance; riparian areas or endangered, threatened, or rare species	grants, private donations, landowner fees
Colorado Open Lands (<i>Statewide</i>)	1981	5 (3), 889	fee-simple purchase and conservation easements	productive agricultural land, threatened viewsheds, community separator areas, vital watersheds and critical wildlife habitat	grants, private donations, project fees
Rocky Mountain Elk Foundation (regionwide)	1984	2, 2,996	conservation easements	elk and other wildlife habitat/corridors, buffers to public land habitat	hunters, foundation donors
The Nature Conservancy	1987 local	20 (2), 10,670	fee-simple purchase and conservation easements	properties near Phantom Canyon Preserve and mountains to plains corridor	members, corporate, and other donors
USDA NRCS	1960s	3, 88	wetlands, riparian areas	agricultural producers wishing to protect habitat	federal funds
Total		40,000 acres + ^b			

^aIn parentheses are number of parcels held in partnership with other institutions.

^bTakes into consideration the parcels claimed by 2 or more organizations.

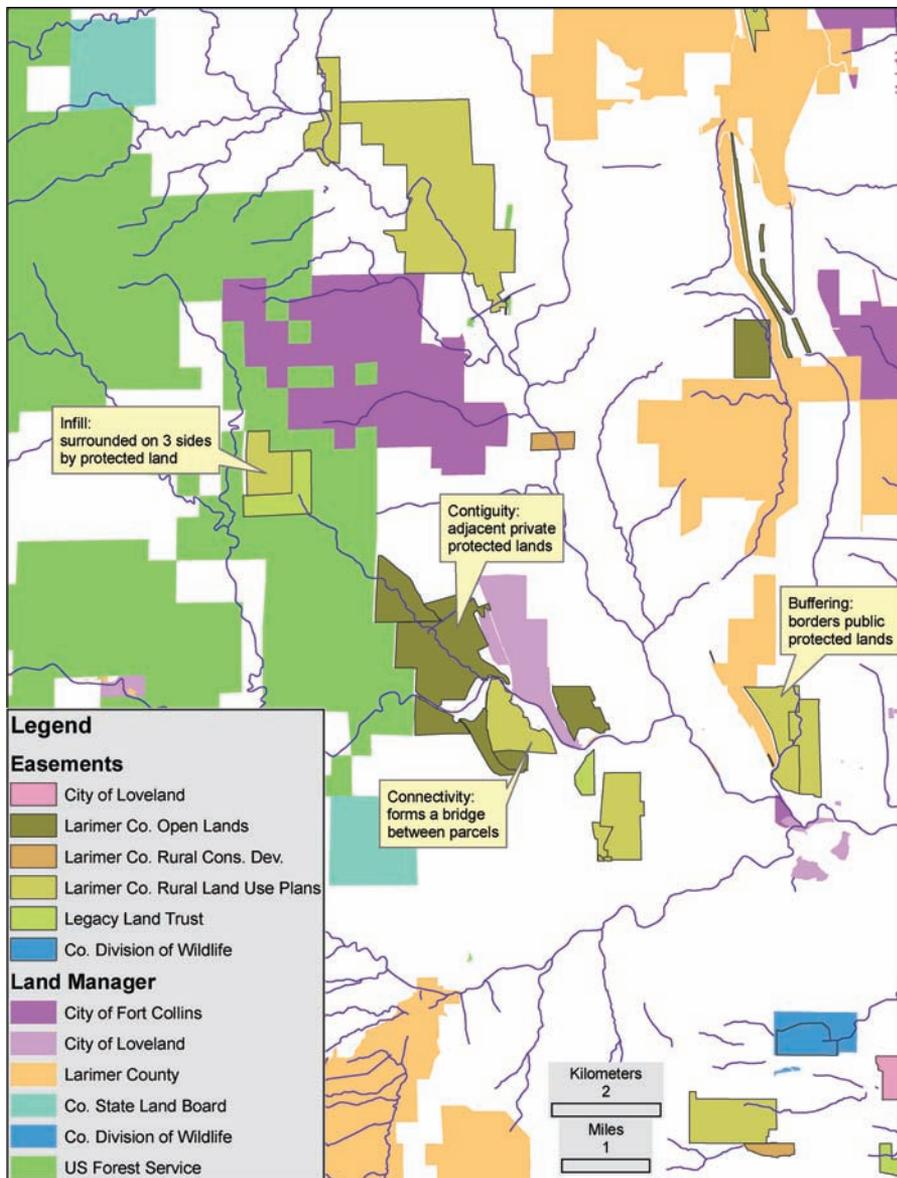


Figure 1. Visual depiction of terms used in the spatial analysis of the benefits of private land conservation.

maps of important wildlife habitat (i.e., wetlands, riparian areas, and neighborhood species richness); statewide potential conservation areas identified by the Colorado Natural Heritage Program (an indication of relative biodiversity significance); and a map of important farmlands based on a county-level Natural Resource Conservation Service survey. A “heads-up” expert analysis was used to examine the spatial context of each parcel and the degree to which a PLC parcel helped create an interface (adjacency) with other publicly protected land (federal, state, county, or municipal). We considered a parcel to have a buffering effect if it shared at least part of its boundaries with a publicly protected area. Parcels contributing to connectivity had the potential to or formed a corridor between protected lands by virtue of being within 400 m of other protected land. We define *contiguity* as any private protected parcel that is contiguous with another privately protected parcel. We noted parcels that

were located in designated community-separator areas (overlay zone where a variety of actions are taken to keep communities from growing together), river corridors, or regional trail routes according to local planning documents.

We also conducted an adjacency analysis in which we used GIS to quantify the length of interface between privately protected parcels and protected lands to estimate the buffering, infill, contiguity, and connectivity measures described earlier. We converted all protected parcels to a raster (0.22-ha resolution) with a unique identifier for each and summarized the total length and proportion of adjacent edge for each parcel (with ZONAL methods). We used the following adjacency classes, which were based on the proportion of a parcel’s perimeter that was adjacent to other protected land: no adjacency (0%), touching (0–1%), contiguous low (1–33%), contiguous high (33–66%), and infill (66–100%).

Results

Land Protected and the Actors Involved

Over 16,200 ha (40,000 acres) or 3% of the private land was conserved in 279 parcels (Table 1). Over time, local institutions have pooled their resources and 4,500 ha (11,000 acres) of the total acres conserved were protected through partnerships in conservation-target areas that were mutually agreed on, precluding roughly 6,305 land subdivisions and new housing units allowed under current zoning. There was noticeable diversity in the PLC institutions involved, conservation objectives, conservation mechanisms used, and types of landowners served by each institution (Table 1).

Conservation Benefits Desired

The analysis of 24 local, legally adopted, government land-use-planning documents (since 1993) yielded 399 references to benefits citizens hope to achieve that PLC might provide (Table 2). Of these, 244 were social benefits and 155 were ecological benefits, although there was overlap for categories such as “provision of environmen-

tal services.” This typology provides a baseline for the future evaluation of PLC programs.

Benefits Referenced in Conservation Easements and Related Documents

The most prevalent benefit of PLC referenced in all parcel-specific documents was open space, followed by scenic and aesthetic value and wildlife value (Table 3). Other commonly mentioned values included ecological value, environmental value, agricultural value, and retention of the land in a natural, undisturbed state. The level of detail in documents describing a property’s conservation benefits varied among the institutions undertaking PLC. Several institutions commonly used generic, IRS compatible terms (44% of documents analyzed) to describe a property’s benefits. Some elaborated on the generic terms (23% of documents analyzed), and just a little over one-fourth of the documents (27%) provided an original parcel-specific description of conservation values and benefits. In sum, there was a surprising lack of detail about the benefits provided by PLC. Although almost all the benefits mentioned in the documents fell within the previously described county benefits typology, more than

Table 2. Desired benefits from private land conservation in Larimer County, Colorado, as synthesized from 24 planning documents^a adopted since 1993.^a

<i>Social benefits^b</i>	<i>Ecological benefits</i>
Improve overall quality of life (8)	promote overall ecosystem health and functioning (4)
Protection of agricultural land	provision of environmental services
minimize the loss of ag land & water (33)	improved air, water quality (14)
maintain rural character (15)	protection of groundwater recharge areas (6)
create a transition zone at the urban/rural interface (7)	storage and filtration of storm drainage (4)
Growth management/sustainability	protection of flood plains & hazard areas (9)
reduction in costs of sprawl, vehicle miles traveled, services needed (14)	buffering and contiguity
Increase recreation, educational and historical resources	buffering of existing protected areas (10)
save land for local and regional trails (13)	contiguity between public and private lands and between privately protected parcels (7)
provide opportunities for outdoor education and study (16)	protection of natural features
provide open space for recreation and amenity values (24)	development precluded from sensitive natural areas (21)
protect historic, geologic, archeological and cultural sites (11)	protect watersheds, wetlands, and riparian areas (21)
Enhance community image, safety (9)	protect unique or outstanding physiographic features (1)
viewshed protection (25)	protection and restoration of wildlife and wildlife corridors (36)
create community separators (22)	protect threatened and endangered species (12)
attract tourism and commerce (11)	protect and enhance biodiversity (10)
attract new residents and retain current residents, maintains good tax base (9)	
development precluded from hazard areas (9)	
reduced costs by precluding development from hazard areas (18)	
total social benefits referenced 244	total ecological benefits referenced 155

^aDocuments may include references to fee-simple acquisition of private land as well as easements, subdivision regulations, and other public land conservation mechanisms.

^bNumbers in parentheses indicate the number of times these terms were referenced as goals or objectives in public documents reviewed—references were made to both the general categories above or as specific examples of each category. Some documents had multiple references to a given benefit. This was interpreted as adding to the strength of benefit category.

Table 3. Conservation benefits of private land conservation (PLC) in Larimer County, Colorado, as referenced in parcel-specific documents.*

<i>Conservation benefits</i>	<i>County & city open space programs (29)</i>	<i>Clustered housing (60)</i>	<i>Land trusts, NGOs (143)</i>	<i>All PLC (234)</i>
Open space	93	82	99	94
Scenic and aesthetic values	97	45	92	80
Wildlife habitat	90	27	92	75
General ecological/environmental value	21	10	71	49
General agricultural land protection	79	88	22	47
Land in natural, undisturbed state	76	33	28	35
Native plants/plant communities	38	20	30	28
Recreational opportunities	34	25	15	20
Wetlands, streams, and rivers	17	15	10	13
Irrigated farmland and/or high-quality soils	31	23	3	12
Buffering of private/public protected land	3	2	13	9
Historical value	17	3	8	8
Wildlife corridors and migration routes	21	5	6	7
Environmental education and outreach	7	3	3	4
Geologic sites	14	3	1	3
Parcels in strategic conservation area	14	0	2	3
Community separators	14	0	0	2
Buffers encroaching development	10	0	1	2

*This table represents the percentage of documents that reference particular conservation benefits. Numbers in parentheses are documents analyzed.

half of the documents provided no real parcel-specific description of the benefits a particular conservation property might be providing.

Landowner Perceptions of Benefits Provided

We received responses from 125 (60%) of the landowners surveyed and, with one exception, at least 50% of the landowners associated with each of the previously described PLC institutions responded. Landowners were asked to indicate the extent to which the land they had protected provided any of 13 benefits frequently referenced in the County benefits typology and parcel-specific documents (Table 4). As with document analysis, the

protection of open space, wildlife habitat, and scenic views garnered the highest scores. Perceptions of benefit varied according to parcel location and the PLC institution or mechanism used. For instance, Estes Valley Land Trust (EVLTL) easements were concentrated around Rocky Mountain National Park and within or adjacent to the Roosevelt National Forest. Higher elevations, forest cover and steep, rocky slopes provide little opportunity for agricultural operations. Accordingly, EVLTL landowners were much more likely to rate forest cover ($p < 0.001$) as a benefit their land provided and to rank the retention of agricultural land as the least significant or not to rank it at all ($p < 0.001$). Wildlife habitat also figured prominently in EVLTL responses.

Table 4. Landowner perceptions of the benefits their conserved land provides to the community.

<i>Perceived benefits</i>	<i>Composite mean scores^a</i>	<i>Reporting moderate to very significant perception of benefit (%)^b</i>	<i>n^c</i>
Protects open space	4.56	88.5	108
Protect wildlife habitat or corridor	4.32	81.9	100
Promotes scenic views or amenity values	4.00	69.2	83
Promotes a desirable pattern of growth	3.63	59.6	68
Maintains forest cover	2.92	43.4	49
Protects wetlands/watershed and water quality	2.89	39.7	46
Protects rare or endangered species habitat	2.85	34.2	38
Retains agricultural production	2.65	36.5	42
Protects unique/outstanding geologic features	2.53	27.6	32
Helps to separate communities	2.30	20.7	23
Preserves cultural/historical resources	2.18	21.9	25
Provides recreational opportunities	2.10	20.9	24
Provides educational opportunities	2.02	18.4	21

^aVariables coded on a 5-point Likert-type scale ranging from 1, not provided, to 5, provided and very significant.

^bRespondents reporting moderate to very significant benefit.

^cNumber of landowners sampled on each of the perceived benefits. Total number of landowners surveyed was 125.

Clustered housing occurs primarily on the plains near towns that were originally located next to and continue to spread onto irrigated agricultural land. As a result, landowners with RCD and RLUP were more likely to view their land as providing a considerable agricultural benefit than respondents working with other institutions ($p < 0.001$). Nevertheless, RCD and RLUP landowners diverged considerably in other aspects of perceived benefits. The RLUP landowners who voluntarily selected the more conservation-oriented development process with fewer housing units and landowners who voluntarily worked with local conservation institutions (e.g., land trusts) were both more likely to perceive their property as providing moderately significant wildlife habitat than RCD landowners ($p < 0.01$), who were more focused on compliance with subdivision regulations for cluster development and obtaining approval for the maximum number of housing units (Ernst & Wallace 2007). The RLUC landowners also appeared to be more likely than RCD respondents to recognize the growth-management benefits that clustering provides ($p < 0.001$).

Like cluster-development respondents, landowners with conservation easements purchased by or donated to Larimer County Parks and Open Lands (LCPOL) (often larger landowners and agriculturalists) were more likely to view their land as providing significant agricultural production benefits. In addition, many of the parks and open-lands easements were in the foothills region and provided unmarked vistas of natural landmarks and contained historic sites. As a result, landowners working

with LCPOL more frequently reported that their lands provided highly significant cultural and historical values, scenic views, and amenity values ($p < 0.05$).

Landowners working with The Nature Conservancy (TNC) demonstrated a stronger awareness of the environmental benefits provided by the parcels they conserved. About half of those surveyed purchased 16 ha (35 acre) parcels in the Phantom Canyon Ranch subdivision. This mid-elevation subdivision combined open space, grazing, and development before the county began requiring or facilitating cluster developments. The limited partnership responsible for the development carefully located building envelopes and encouraged buyers to donate conservation easements. These factors combined with the parcels' proximity to TNC's Phantom Canyon Preserve produced higher ratings for protection of wildlife habitat ($p < 0.001$) and, more specifically, for rare and endangered species ($p < 0.01$).

Not all respondents saw conservation-related benefits. A few landowners who did (quasi-regulatory) RCD reported that they viewed the setting aside of open space in perpetuity as a prerequisite for obtaining project approval and later as a marketable feature of their projects.

Spatial Analysis of Benefits

The most commonly observed spatial benefits provided by PLC parcels (Table 5) were conservation of riparian areas, contiguity with other protected parcels, protection of big-game concentration areas, and buffering public

Table 5. Conservation benefits derived from spatial analysis of private land conservation (PLC) in Larimer County, Colorado.^a

Conservation benefits	County & city open space programs (30)	Clustered housing (60)	Land trusts, NGOs (121)	All PLC (212) ^b
Riparian areas conserved	70	75	49	59
Contiguity with other PLC parcels	50	40	57	51
Big game concentration areas	17	27	68	49
Buffering of public land protected areas	43	17	46	38
Added to connectivity among multiple parcels	30	28	26	27
Part of community separator area	40	47	3	21
Regional trail or corridor	17	12	19	17
Moderate/high biodiversity	13	13	16	15
Wetlands conserved	10	33	7	15
Infilling of public land in-holdings	3	3	22	14
Prime irrigated agricultural land	30	23	2	12
Very high/outstanding biodiversity	17	8	8	9
Prime agricultural land	10	28	2	9
Buffering of lake or reservoir shoreline	23	17	1	8
Agricultural land (not prime)	13	13	2	7
Neighborhood species richness areas	d	22	— ^c	6
Rare vegetation	3	8	1	3
Cultural/historic sites	3	0	3	3

^aPercentage of parcels conserved by PCL programs or mechanisms that provide a given social or ecological benefit. Number of parcels examined.

^bSeveral PLC parcels were contiguous with other parcels and formed a polygon that became the unit of spatial analysis, resulting in a total of 212 rather than 234 parcels.

^cNeighborhood species richness not mapped near these parcels.

protected lands. These benefits again varied according to topography, soils and life zones, and geographic location. Benefits observed also changed according to the PLC program emphasis or mechanism used. For example, 81% of EVLT easements—most forested and above 1981 m in elevation—were located within big-game concentration areas and had almost no irrigated agriculture potential. In accordance with its mission to protect land adjacent to Rocky Mountain National Park, 41% of EVLT's parcels also contributed to the buffering of other protected land. Alternately, RLUC parcels mitigated sprawling development in community-separator areas (44%) and protected agricultural lands (54%). Although there were no references to community-separation benefits in RLUC or RCD documents, the spatial analysis of these parcels showed the majority of clustered developments were located in targeted community-separator areas. There were many other examples in which landscape-level benefits existed but were not reported in easement or other recorded documents or by landowners themselves.

The Nature Conservancy focuses its work in northern Colorado within what collaborating institutions are now calling the Mountains to Plains Corridor—a stretch of land 22,420 ha (55,400 acres) in size that links mountain and prairie ecosystems—the only such habitat corridor of this scale remaining in northern Colorado. Thus, it was not surprising to find that 100% of TNC's parcels were located within this area and that 69% protect areas had moderate to high biodiversity. The Nature Conservancy parcels also provided substantial buffering and contiguity because they partner with other institutions to purchase and protect land in this target area.

Over 1800 km of private-public interface land (about 6% of the public land edge) was generated through the protection of private parcels in Larimer County, and roughly 43% of PLC parcels were “islands” or not adjacent to other protected lands (Table 6). A small proportion (3%) simply touched other protected areas, contributing only about 13.4 km of interface. Nearly one-third (29%) of PLC had low contiguity, but these contributed to over 522 km of interface. About 16% had high contiguity (33–66%), and these contributed to over 676 km of interface. Only 8% provided public-land infill, but these

parcels contributed disproportionate amounts of interface (633 km).

Discussion and Recommendations

It is important to more thoroughly demonstrate the benefits of PLC at the parcel, landscape, and program levels and to describe the quality of that protection (Merenlender et al. 2004; Bernstein & Mitchell 2005; Yuan-Farrell et al. 2005). We have taken initial steps to look at benefits associated with land that is “protected” in the sense that it will not be subdivided or developed (over 6200 subdivision splits and housing units precluded prior to 1 January 2005). For the associated benefits or the quality of protection of any PLC parcel to be realized over the long term, however, will require limitations on permitted uses, the oversight of permitted uses, and good management and monitoring of conditions (Kiesecker et al. 2007; Taylor et al. 2007). Our recommendations focus on the importance of developing a PLC database that accurately reflects PLC activity in a given location and that can be analyzed more effectively over time.

Improving County-Level PLC Databases and Easement Descriptions

We suggest that the evaluation of benefits in any jurisdiction can begin with an analysis of legally adopted public documents to create a community-based benefits typology or baseline that adds specificity to the generic IRS standards for PLC benefits. Such a typology can help landowners and the institutions they work with recognize and more specifically describe the benefits provided by a parcel in easements in parcel-specific documents of record. Such descriptions will make individual PLC transactions and programs more defensible because they will be tied to IRS standards for “a clearly delineated . . . local government conservation policy” (Internal Revenue 2006). This is particularly important in light of the recent public scrutiny of land-trust practices, appraisals, tax benefits, density bonuses, and other publicly supported incentives available to landowners engaged in conservation (Joint Committee on Taxation 2005; Stephens 2005). Once benefits are more completely described in parcel-specific documents, it will also be possible to analyze to what degree the benefits sought by a community are being provided by the combination of PLC institutions and mechanisms—to a greater degree than we are able to do here.

Landowner perceptions of the benefits their conserved lands provide can improve the description of benefits but are likely to vary according to parcel location, landowner motivations, and the institutions they work with (Ernst et al. 2007). Nonetheless, landowners who know their land and understand the spectrum of potential benefits are likely to be able to provide more-detailed benefit descriptions for baseline and easement documents of record.

Table 6. Interface of privately conserved parcels with publicly protected areas in Larimer County, Colorado.

Type of adjacency	Private land conservation parcels (%)	Linear interface (km)
Not adjacent	43.4	0
Touching	3.2	13.4
Contiguous (1–33%)	29.1	522.2
Contiguous (33–66%)	16.1	676.7
Infill	8.3	633.4

Currently, landowners do not readily recognize benefits such as groundwater recharge, floodplain protection, community separation, connectivity, or the buffering of public lands as contributions, even though they may be providing them.

Our results also highlight the need for better coordination and precision in how PLC legal documents are categorized and linked within county record systems. Larimer County records lumped conservation easements with other types of easements and rights-of-way, thereby complicating document searches and the creation of a PLC database. Spatial and document analyses were hindered by lack of available data from some institutions and from the County Assessor's office, where there was no connection between parcel numbers for properties conserved and the reception numbers for the associated legal documents. Discussions with Clerk and Recorder office staff have since prompted creation of a category for tracking conservation easements. A unified database is prerequisite if institutions engaged in PLC are to be able to evaluate and report the benefits accruing from public and private investment in land conservation programs. Finally, to further enhance any PLC database or evaluation of benefits, we suggest that a spatial analysis can detect parcel-level and landscape-level benefits described in the conservation-planning literature but may not yet appear in either public documents or be recognized by most landowners or the general public.

Benefits Revealed by Spatial Analysis

To provide additional accountability at the parcel and landscape level, we believe it is useful to quantify how many PLC parcels provide contiguity, connectivity, buffering, or community separators; fall within important wildlife habitat and riparian areas; protect productive agricultural land; or otherwise contribute to stated community goals. Such benefits, although often discussed by conservation biologists and other scientists, were seldom explicit goals in the PLC documents of record. Although additional metrics may be needed to focus on particular conservation aspects, we have presented several relevant to the study area. When computing the proportion of land ownership types within 400 m of protected lands through a GIS buffer and overlay, for example, the average proportion of adjacency for local government easements was 35.5% (SD 27.1), for land trusts was 46.2% (SD 34.6), and for clustered-housing development plans was 5.4% (SD 15.7). Similarly, quantifying the proportion of wetlands, high biodiversity, and prime agricultural lands will also help document PLC benefits provided within a jurisdiction, which in turn may help land-trust boards, planners, and policy makers describe and defend the use of public money for PLC Programs. Recognizing the ecological and social benefits revealed by spatial analysis will

make it easier for individual landowners and the institutions they work with improve benefit descriptions and determine eligibility for tax deductions, credits, density bonuses, or other incentives and establish the indicators and standards for subsequent monitoring. As a community's benefits typology, parcel-specific documents, government records, landowner descriptions, and spatial data become more closely aligned, the analysis and long-term monitoring of PLC benefits will improve.

Cumulative Effects of PLC in Larimer County

The diversity of PLC institutions and mechanisms that have been created in Larimer County (Table 1 & <http://www.warnercnr.colostate.edu/nrrt/people/biowallace.htm>) has resulted in a considerable amount of land conservation among a diversity of landowners with differing motives. Landowners include those who might not have participated in cluster-development programs without innovative changes to county subdivision regulations that, in most cases, required them to cluster once they chose to develop at the maximum residential density permitted by an underlying zoning district. At the other end of the motivational spectrum were landowners who opted to work with TNC because they shared their objectives of protecting biodiversity and preserving agricultural land. Ernst and others (2007) provide a full rendering of how motivations for conservation differed among landowners in the study area and how the diversity of institutional options had the effect of involving a wider array of landowners with different motivations in PLC. Nevertheless, unplanned and serendipitous the combination of programs and land-conservation transactions may have been initially in the study area, the end result may still provide a partial model for other jurisdictions wishing to encourage the conservation of private lands in a manner that incorporates a diversity of institutions, conservation mechanisms, landowners, locations, and land types. Other institutions and mechanisms, such as conservation districts, transferable development rights, and efforts to keep water rights on PLC lands, were not fully functional in the study area but may be important additions to any regional PLC strategy—especially in arid areas and areas with increasing development pressure.

The cumulative momentum created by county PLC institutions and programs in Larimer County over more than a decade has naturally evolved to include more conservation planning and the acquisition of larger parcels. Since our data collection ended in January 2005, a series of transactions resembling true landscape-level conservation planning have occurred. After identifying common conservation-target areas Larimer County and the City of Fort Collins in partnership with TNC, Legacy Land Trust, Great Outdoors Colorado, and a number of landowners have protected an additional 10,100 ha (25,000 acres)

through fee-simple acquisition and easements within the Mountains to Plains Corridor. Several ranches and a grazing association became willing cooperators within a 2-year period, motivating PLC institutions to pool information, resources, and funding. This achievement is notable given its size, the connection of mountains and plains ecosystems, species diversity, the mosaic of protected and working landscapes (Resnik et al. 2006), and the support from officials and the public in multiple jurisdictions. This effort was helped along by the TNC, which has taken a more systematic approach to conservation planning (Kiesecker et al. 2007) for some time, even while other PLC occurred opportunistically in the county. Our results suggest the early use of integrated conservation targets and partnerships.

Implications for Conservation Planning

There is a considerable gap between the science used to conceptualize conservation planning and its on-the-ground application (Bernstein & Mitchell 2005; Knight et al. 2005). Moving beyond biological assessment techniques to implementation will require conservation biologists and other scientists to become involved in and learn from the land-use planning and decision processes already occurring at the level of local government (Theobald et al. 2005). This is where PLC is being operationalized, albeit often in a frequently opportunistic fashion driven by development pressure (Kline 2006). By helping existing PLC and open-space programs identify and describe the wider range of benefits they are already providing—either serendipitously or as a result of the leadership by those who do understand the importance of maintaining landscape level ecological processes—several things can be accomplished. First, there will be a better understanding of and value placed on social-ecological-economic systems at work in a given location (Knight et al. 2005) even if true conservation planning is lacking. Second, planners, landowners, and the public will be indirectly and directly exposed to many concepts (e.g., connectivity, critical habitat) that, once understood, may increase support for conservation planning in the future. Finally, a more careful response to the question of what is being conserved by whom (Merenlender et al. 2005) and to criticisms being leveled at the efforts to conserve private land can be provided.

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