A Framework for Understanding Conservation Development and Its Ecological Implications

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Suburban, exurban, and rural development is a leading cause of biodiversity loss and natural resource degradation in the United States. In response to this threat, conservation development has been advanced as a way to combine land development with functional protection for conservation resources. This article provides a review, analysis, and ecological critique of the four principal types of conservation development: (1) conservation buyer projects, (2) conservation and limited development projects, (3) conservation subdivisions, and (4) conservation-oriented planned development projects. Each approach can contribute to landscape-scale conservation, with benefits that include reducing the off-site impacts of development, buffering and connecting protected areas, and conserving imperiled species and ecosystems. However, the benefits of these approaches depend significantly on project density, design, and context. Accordingly, this article offers a framework for differentiating and analyzing these approaches to conservation development for the purposes of research, land-use planning, public policy, and conservation practice.

Keywords: conservation development, land conservation, biodiversity, land use, regional planning

Over the next quarter-century in the United States, 18 million hectares (ha) of land—an area larger than New England—will be converted to urban, suburban, and exurban development, if recent trends in land use change continue (USDA/NRCS 2007). Indeed, residential development is becoming a ubiquitous force on the American landscape, not only in metropolitan areas but also in amenity- and resource-rich hinterlands such as the Rocky Mountains, the southern Appalachians, and rural New England (Brown et al. 2005, Radeloff et al. 2005a, 2005b). This trend is likely to continue because of population and household growth, increasing land consumption per capita, growing numbers of retirees, and the centrifugal forces of high-speed travel and telecommunications (Heimlich and Anderson 2001).

The ecological impacts of land development are complex and often nonlinear (Hansen et al. 2005). Moderate levels of development—especially when it is carefully planned and designed—can sometimes increase species richness by increasing the diversity of habitat types available on the landscape (Marzluff 2005). On the other hand, conventional land development typically displaces sensitive native species, introduces and promotes the spread of nonnative species, degrades water resources, fragments habitat networks, and diminishes the land's cultural and aesthetic value (Radeloff et al. 2005b). Nationwide, land development is perhaps the foremost threat to endangered biodiversity, as well as a major threat to productive agricultural lands and other natural resources (Czech et al. 2000, AFT 2006). If left unchecked, suburban and rural sprawl will not only continue to degrade the matrix of private, unprotected land nationwide but, through its off-site impacts, also diminish the long-term viability of protected areas (Hansen et al. 2002, Ewing et al. 2005).

In the United States, conservationists typically seek to protect landscapes and their conservation values mainly by purchasing or obtaining land and conservation easements. Although this approach has been relatively successful in many regions—in part because of the recent growth of the land trust movement (LTA 2006)—it is proving inadequate in areas with substantial development pressure and escalating land values, where conservationists are losing ground to the larger, better-funded real estate development industry. From 1998 to 2002, for example, 500 state and local ballot measures in the United States earmarked a total of more than $20 billion for land conservation, but during the same period the nation's 10 largest real estate developers alone consumed $120 billion of land (TPL 2003, Budesilich and Binger 2004). Likewise, land-use regulation has generally proved too weak and too fragmentary to achieve meaningful conservation in rapidly developing landscapes (Beatley 2000). Given that much imperiled biodiversity exists in rapidly developing regions, conservationists cannot afford to ignore sprawl and the real

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estate market trends that drive it (Miller and Hobbs 2002). Instead, they must find new strategies that explicitly address these market realities.

One way to mitigate the negative ecological impacts of land development—and perhaps even to harness it as a positive force for conservation—is through conservation development. I define "conservation development" as comprising projects that combine land development, land conservation, and revenue generation while providing functional protection for conservation resources. Within the land-use planning, design, and conservation communities, there is much interest in conservation development, and numerous writings provide definitions, case studies, and guidelines. However, conservation development has received little attention in the peer-reviewed literature, and the work that has been done has focused almost entirely on clustered housing in residential subdivisions as an alternative to conventional sprawling development. Here I provide a broader perspective, arguing that conservation development is not limited to clustered housing but encompasses four categories of land-use strategies, including two that are used primarily as conservation finance mechanisms. Accordingly, this article defines, characterizes, and provides examples of these four approaches to conservation development and proposes this typology as a framework for guiding for future research and practice.

Rather than rely principally on the sparse academic literature related to conservation development, I assess practitioners' actual experience to date with conservation development in the United States and what this experience indicates about the benefits of such projects for landscape-scale conservation. To do so, I draw on four key sources of information: (1) interviews with conservation development practitioners and experts from 2004 to 2006; (2) data on a nationwide sample of conservation development projects; (3) an empirical evaluation of a subset of this sample of projects; and (4) a synthesis and analysis of the peer-reviewed and practitioner literatures in this emerging field.

Overview of conservation development

To understand the growing phenomenon of conservation development, it is helpful to consider the entire spectrum of land-use projects, which can be classified along two axes based on their development density and their level of conservation (figure 1). Within this spectrum, conservation development includes several different land-use techniques that incorporate varying amounts of development but always achieve a meaningful level of functional conservation. Thus, the distinction between conservation development and conventional development depends on the project's conservation outcome, not on whether a particular land-use technique was employed.

Although there are several types of conservation development—which this article will enumerate—the projects tend to have certain features in common. First, all such projects set

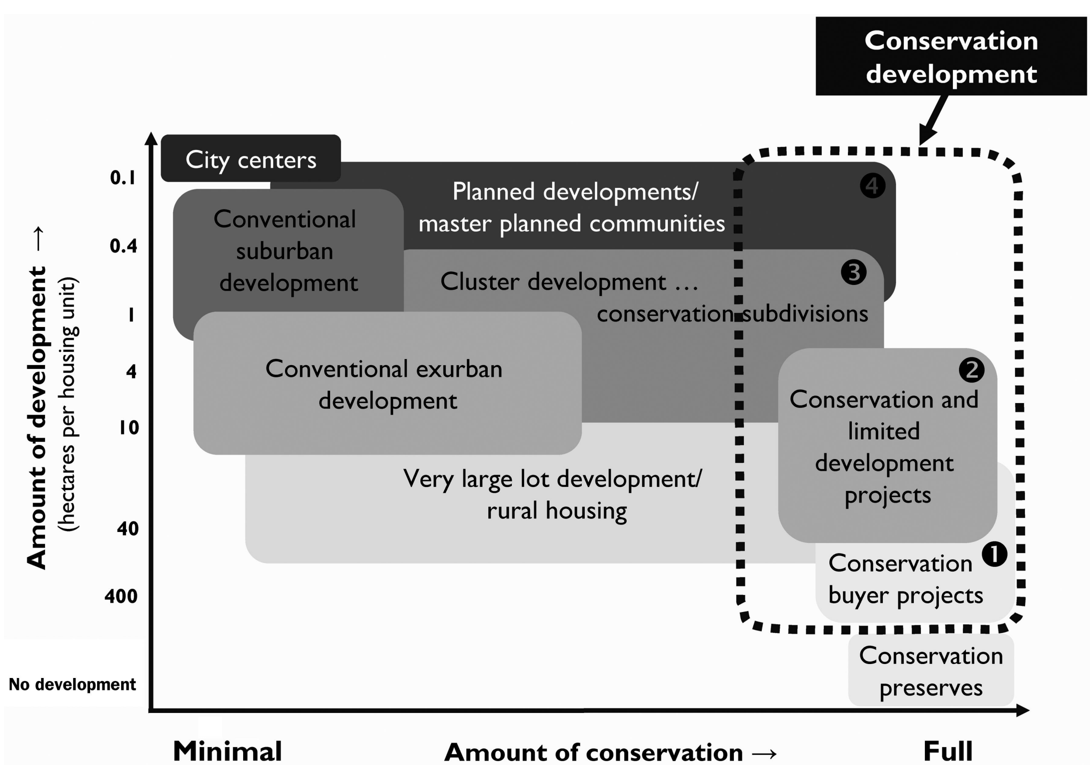

Figure 1. Land-use patterns and development or conservation techniques can be classified according to the level of conservation benefits they provide (x-axis) and the density of development they include (y-axis). The four different approaches to conservation development (numbered in the diagram and explained more fully in the text) involve different levels of development but, by definition, all provide significant conservation benefits.

aside conservation land, which is either held in fee ownership by a conservation organization or protected by a conservation easement. Second, all of these projects include development (or at least the possibility of development), and it is this development that finances or otherwise makes possible each project's conservation component. Third, conservation development is created through a process of ecologically based planning and design (McHarg 1969, Steiner 2000, Perlman and Milder 2005), whereby planners inventory a site's natural resources and environmental context, and use this knowledge to conserve portions of the site with high resource value while situating development to minimize environmental impacts (Pejchar et al. 2007). Since the boundaries of land parcels rarely coincide with the distribution of valuable natural resources, on most sites it is possible to identify an area of lower conservation value that can be made available for development without encroaching on the more valuable areas (figures 2, 3).

Conservation development also incorporates a variety of design features to reduce the negative impacts of development. For example, many projects situate development in one or more compact nodes to minimize its footprint. Low-impact stormwater management systems that promote natural flow patterns and infiltration are widely regarded as an important part of conservation development, as is a landscaping design that minimizes disturbance to existing vegetation, uses wildlife-friendly native species, and avoids invasive species (TNC/CW 2004). A minority of conservation developments go further to restrict disturbance vectors such as household pets and light pollution. Others address sustainability concerns by incorporating "green building" features such as energy efficiency, renewable energy, and low-impact building materials (Wilson et al. 1998).

Motivations and driving forces

Conservation development occurs as a result of three principal factors. First, in a growing number of jurisdictions nationwide, local land-use regulations encourage or require conservation development in lieu of conventional development as a means of reducing harmful environmental impacts and managing growth (Arendt 2004). Second, conservation development may be driven by the profit motive of private developers. Compared with conventional development, conservation development typically carries lower per-unit development costs and higher per-unit sales prices (Mohamed 2006). Some developers incorporate conservation areas into development plans to capture the premium that home buyers are willing to pay for access to natural amenities. Third, conservation development may be conducted or facilitated by land trusts or conservation-oriented landowners seeking to protect land and resources when protection by other means is unaffordable. In these instances, revenue from limited development is used to finance the protection, restoration, and management of conservation resources.

At present, conservation development remains a niche activity relative to conventional development, making up about 2.5% of total US real estate development (McMahon and Pawlukiewicz 2002). However, I estimate that conservation development accounts for about 10% of the private land conservation activity in the United States (J. C. M., unpublished data). In addition, there are indications that conservation development is becoming more mainstream,

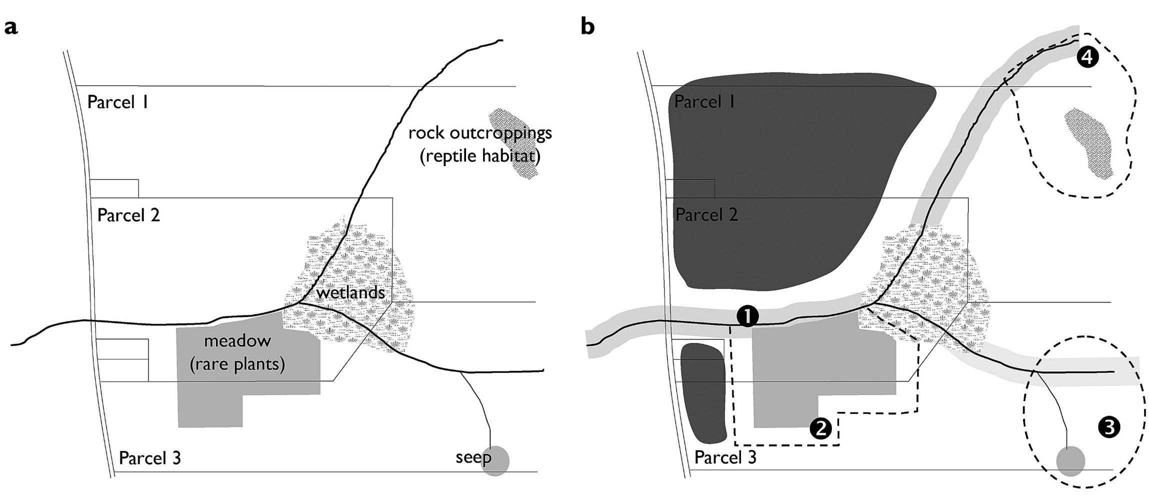

Figure 2. (a) Land parcels are artificial demarcations that rarely coincide with the distribution of natural resources. Thus, the conventional conservation approach of protecting individual parcels often fails to safeguard the full extent of critical resources while expending scarce funds to protect land of lower conservation value. (b) In conservation development, valuable resource areas with patchy distribution—such as streams and their riparian zones (1), a meadow containing rare plant species and a surrounding buffer (2), a seep and up-gradient areas that directly feed it (3), and a complementary set of reptile habitats (4)—can be protected while making less valuable areas (shown in dark gray) available for development. Development of the lower-value portion of each site finances protection of the higher-value areas, resulting in a cost-effective approach to natural resource conservation.

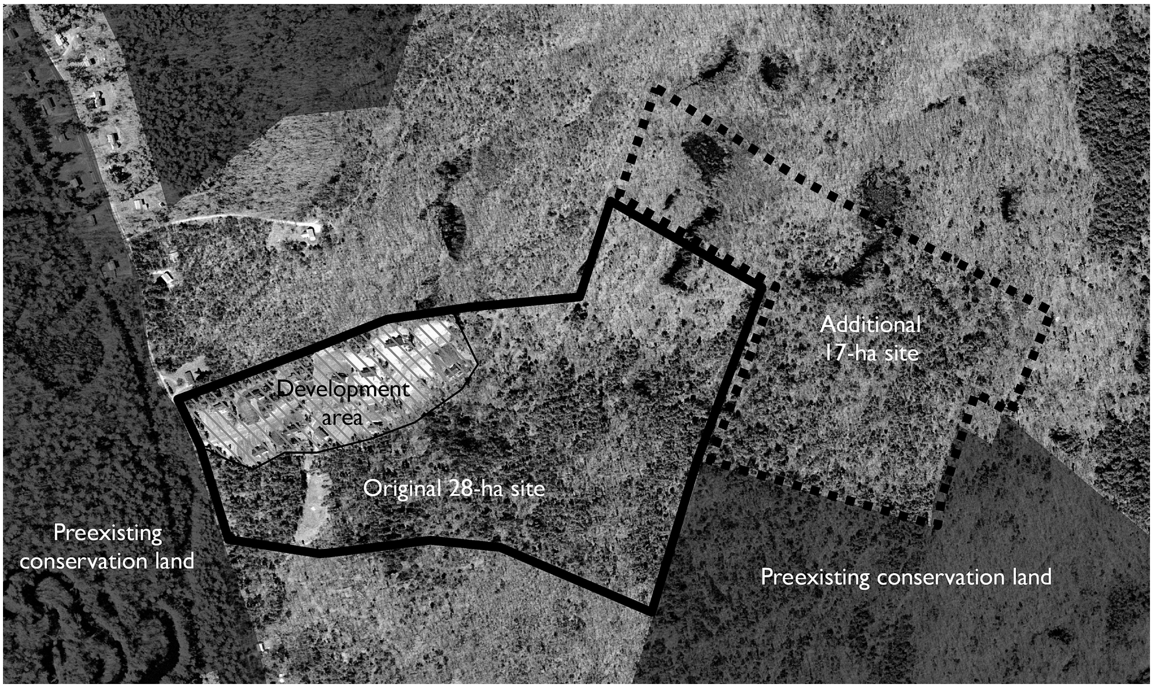

Figure 3. Example of conservation development conducted by the Groton Land Foundation, a land trust in Massachusetts. The original 28-hectare (ha) parcel (outlined in black) connects two larger preexisting conservation areas (shaded gray). Revenue from the 7-ha development (hatched) financed protection of the remainder of the 28-ha tract and of an adjacent 17-ha parcel (outlined with a dashed line). The complex of vernal pools and forest on the protected land helps support a population of the state-threatened Blanding's turtle.

driven by three key factors. First, shortfalls in conservation finance are motivating many conservation organizations to seek new cost-effective conservation strategies. Second, the booming demand for amenity-based real estate development in exurban and rural areas is creating a ready market for projects that situate housing in or near natural areas. Third, growing numbers of eco-entrepreneurs are capitalizing on these market opportunities and conservation needs to create economically viable conservation development projects in diverse settings nationwide.

A conservation development typology

Four principal conservation development techniques are currently used in the United States: (1) conservation buyer projects, (2) conservation and limited development projects (CLDPs), (3) conservation subdivisions, and (4) conservation-oriented planned development projects. In general, the first two techniques can be characterized as "conservation with development," meaning that conservation is a principal objective and development is used as a means to that end. The third and fourth techniques are "development with conservation" approaches, in which the main objective is usually to earn money through land development, but in a conservation-friendly manner. These techniques tend to stratify by development density (figure 1) but may also be differentiated by the set of actors involved, the project's economic model, and the resultant development patterns (table 1).

Although there are some gray areas between the project types (which are noted in the descriptions below), the typology is nevertheless valuable for understanding the differing goals, strategies, and outcomes of each type. The following section defines and characterizes each type of conservation development, and table 2 provides a range of examples.

Type 1: Conservation buyer projects. In this approach, land of conservation value is protected by a private "conservation buyer" who agrees to a conservation easement restricting development, often to a single house within a small, predefined "building envelope." Typically, a land trust will purchase a property, encumber it with a conservation easement, and then resell the property to a conservation buyer subject to the easement. The sale allows the land trust to recoup much of its initial acquisition cost, resulting in nearly full protection at a fraction of the cost of other conservation methods. Alternatively, the property may pass directly from its original private owner to the conservation buyer, with the land trust facilitating the transaction by accepting a conservation easement.

In a related technique, which could be called the "conservation owner" approach, landowners place a conservation easement on their property while retaining the right to develop one or more houses, often for themselves or their family members. Easements that allow the construction of multiple residences on separate lots to be sold on the open market may

Table 1. Summary of conservation development techniques.

Distinguishing characteristic	Conservation-with-development approaches: Type 1: Conservation buyer projects	Conservation-with-development approaches: Type 2: Conservation and limited development projects	Development-with-conservation approaches: Type 3: Conservation subdivisions	Development-with-conservation approaches: Type 4: Conservation-oriented planned development projects
Typical development density (see note)	Minimal: limited to housing for the landowners and their family	Limited: typically 5%–25% of ordinarily permitted density	Full: 100%–200% of ordinarily permitted density	Varies; typically relatively dense
Typical project proponents	Land trusts, landowners	Land trusts, landowners, developers	Developers	Developers
Typical economic model	Private owners agree to conservation restrictions while retaining the right to build a small amount of new development	Participants use limited development to finance conservation or to create a multiobjective for-profit project	Goal is to maximize developer profit	Goal is to maximize developer profit
Typical development patterns	One or a few houses in a rural setting	Single-family housing in a rural, exurban, or suburban setting	Single-family housing in a suburban or compact village layout	Mix of housing types and other land uses in a suburban, urban, or village layout
Most relevant public policies (local, state, and federal)	Tax incentives for donating conservation easements	Local zoning, tax incentives for donating conservation easements	Local zoning	Local zoning

Note: Development density is characterized in relation to the ordinarily permitted density in the area where the project is taking place, which may vary from region to region. To encourage developers to use the conservation subdivision technique, land-use regulations sometimes offer a "density bonus" permitting more houses than would be allowed in a conventional development; the size of this bonus varies by jurisdiction.

be more appropriately thought of as CLDPs (type 2, described in the next section). For farm, ranch, and forest landowners who wish to stay on their land, conservation owner projects are often economically attractive, because the sale or donation of the conservation easement provides immediate working capital (as direct revenue or tax deductions), reduces future property tax and estate tax liability, and allows continued farming or forestry (often subject to conditions in the easement).

Land trusts nationwide use these techniques to protect lands that either are not the highest priority for acquisition (e.g., buffers around core nature reserves) or are too expensive to protect outright. A recent study on conservation easements held by The Nature Conservancy suggests that conservation buyer and conservation owner projects are quite common: Of 119 easements studied, 18% allow the construction of one new residence, while 20% allow the construction of two or more new residences (Rissman et al. 2007). Furthermore, recent easements were more likely to allow residential development than older easements, suggesting an increase in the use of these techniques.

Type 2: Conservation and limited development projects. CLDPs use revenue from limited development to finance land conservation. These projects are often conducted or facilitated by land trusts, but can also be carried out by conservation-minded developers or landowners. CLDPs typically develop real estate for sale on the open market, but the total amount of development is a small fraction of what would be allowed under local zoning laws (Milder 2005).

Despite containing relatively little development, most CLDPs are financially self-sustaining, and many realize a profit. This is because the increase in monetary value per unit area from "raw," undivided land (such as a large tract of forest) to subdivided, permitted land ready for construction is quite high—often a factor of 2 to 10. Thus, the sale of a small amount of subdivided, buildable land can finance the protection of a much larger amount of raw, undivided land (Milder 2006).

About 12% of US land trusts currently engage in CLDPs (Rob Aldrich, Land Trust Alliance, Washington, DC, personal communication, 10 May 2007), and as of 1996, CLDPs accounted for roughly 2% of all projects undertaken by these organizations (Gustanski 2000). The past several years have also witnessed a growing number of CLDPs conducted by private landowners, developers, and investors. An intriguing model now being tested involves combining limited development with the provision and sale of ecosystem services from restored wetlands, forests, or wildlife habitat.

Recent empirical work on the conservation effectiveness of CLDPs found that a sample of projects from the eastern United States was protecting, restoring, and managing threatened conservation resources—including rare species and ecological communities—significantly more effectively than a comparison sample of conservation subdivisions or a corresponding set of conventional development scenarios (Milder et al. forthcoming). Aside from this study, an extensive literature search turned up about 20 articles on CLDPs, most of which are narrative descriptions of specific projects.

Type 3: Conservation subdivisions. Conservation subdivisions are the best known and best studied of the four conservation development types. A conservation subdivision is a residential development that sets aside a major portion of the site as conservation land by clustering development on smaller lots than would ordinarily be allowed. In contrast to

Table 2. Examples of US conservation development projects.

Project name	Location	Size (hectare)	Development component	Conservation component	Reference
Type 1: Conservation buyer projects					
Kachemak Bay Skyline Parcel/West	Alaska	81	One house within a 0.8-ha building envelope	80 ha (99%) protected for riparian corridor and habitat for mammal and bird species	*www.nature.org/conservationbuyer*
Type 2: Conservation and limited development projects					
Throne Hill	Massachusetts	45	12 single-family houses	38 ha (85%), including a complex of vernal pools and forest providing habitat for the state-threatened Blanding's turtle; corridor connecting two existing conservation areas	Milder 2005 (see figure 3)
Allis Ranch	Colorado	336	10 single-family houses	323 ha (96%), including 2.5 km of riparian corridor, critical wildlife habitat, and 258 ha of agricultural land	Milder 2006
Santa Lucia Preserve	California	8100	300 single-family houses, 18-hole golf course, equestrian center	7300 ha (90%) of central California coastal habitats, including oak woodlands and savanna, coastal scrub and chaparral, grasslands, and riparian habitat; research and education activities	*www.santaluciapreserve.com* *www.slconservancy.org*
Type 3: Conservation subdivisions					
Plumsock at Willistown	Pennsylvania	29	38 single-family houses	20 ha (69%), including riparian habitat, wetlands, a small pond, and adjacent forest	Milder 2005
Tryon Farm	Indiana	69	150 single-family houses	49 ha (71%), including farmland, forest, restored prairies, dunes, and constructed wetlands	*www.tryonfarminstitute.org* *www.tryonfarm.com*
Type 4: Conservation-oriented planned development projects					
Prairie Crossing	Illinois	274	359 single-family houses, 36 condominium units, retail space, low-impact stormwater system using constructed wetlands	142 ha (52%), including 65 ha of prairie restored from former agricultural use and actively managed with fire; organic farm; wetlands; connections to adjacent 2000-ha Liberty Prairie Reserve	Wilson et al. 1998; *www.prairiecrossing.com*
Spring Island	South Carolina	1215	400 single-family houses, 18-hole golf course	400 ha (33%) of forests, wetlands, and farmed and fallow fields; active management for biodiversity, especially grassland and forest birds; prescribed burning and invasive species eradication; environmental education center	*www.springislandtrust.org* *www.springisland.com*

CLDPs, conservation subdivisions are usually built at or near the maximum density allowed by zoning. Historically, projects of this type were known as cluster developments or open-space developments. However, the term "conservation subdivision" is now generally preferred, since it implies that protected areas are deliberately selected for their conservation value (Arendt 1996). By contrast, many cluster developments have been criticized for protecting mainly isolated scraps of land with little conservation value.

Conservation subdivisions often differ from CLDPs in their approach to managing protected land, with important implications for their conservation outcome. Whereas protected land in CLDPs is usually owned or managed by a conservation organization, protected land in conservation subdivisions is often managed by a homeowners' association. Unfortunately, such associations often lack the knowledge or skills to manage conservation land effectively. Furthermore, their management goals may favor aesthetics, privacy, and recreational use over natural resource conservation (Austin and Kaplan 2003). Homeowners' associations are also generally self-enforcing, and therefore may not adequately safeguard the land's conservation values. A superior model is for residents to comanage the conservation land with a permanently staffed conservation organization, which can also help encourage environmentally friendly behavior among homeowners (Thompson 2004).

The standard characterization of conservation subdivisions is provided by Arendt (1996), with a more recent perspective offered by Pejchar and colleagues (2007). A small number of empirical studies have examined the economic (Mohamed 2006), social and educational (Austin and Kaplan 2003, Thompson 2004), and ecological (Lenth et al. 2006) implications of conservation subdivisions. Lenth and colleagues (2006) found that six clustered housing developments in Colorado were not significantly different from nearby conventional, dispersed housing developments—and were worse than nearby undeveloped sites—with respect to measures of bird, mammal, and native plant conservation. This result is at odds with earlier literature predicting that the spatial pattern of clustered designs would lead to improved conservation outcomes (Theobald et al. 1997, Theobald and Hobbs 2002, Odell et al. 2003).

Conservation subdivisions have been criticized for protecting land at too small a scale to provide meaningful conservation benefits, while simultaneously promoting "leapfrog" development that ultimately exacerbates the problem of landscape fragmentation (Daniels 1997). To address these limitations, Arendt (2004) and others advocate incorporating conservation subdivisions into larger conservation networks, planned at the municipal or county level, that protect native habitats, agricultural lands, and water resources.

Type 4: Conservation-oriented planned development projects. Planned developments (also known as master-planned communities) are large-scale projects ranging in size from a few hundred to more than 5000 ha, with many falling in the range of 500 to 1500 ha (Heid 2004). Smaller planned developments tend to form neighborhoods within existing cities, while larger ones are often intended to be stand-alone communities, providing a range of housing types as well as commercial, recreational, and public spaces. Planned developments are a major landscape feature in the southern and western United States, where population growth is significant and there are many large tracts of buildable land.

The large size of planned developments means that when conservation land is set aside, it can potentially be done at a large enough scale to protect significant natural resources. Land-use regulations typically require planned developments to designate 10% to 50% of a project site as conservation land, and conservation-oriented planned developments protect additional natural areas for their conservation value or amenity value (City of Tucson et al. 2005). In addition, the large scale of planned developments means they are more likely to be able—and required—to design and manage environmental systems in a holistic manner. For example, projects may contribute to watershed protection by including landscaped areas that provide stormwater management functions, thus reducing runoff and increasing infiltration (Berke et al. 2003). In addition, development revenues can underwrite the costs of land protection, ecological restoration, and long-term management.

From the standpoint of regional planning, planned developments may help to avoid one previously mentioned concern with conservation subdivisions, that they aggregate conservation and development areas at too small a scale. By creating relatively compact, self-contained communities, planned developments can, at least in theory, reserve larger and less fragmented natural areas for conservation. On the other hand, protected land in planned developments can have the same problems as in cluster developments: namely, consisting of fragmented scraps too small or disconnected to provide important ecological functions, and being managed more for recreation and aesthetics than for conservation.

Contribution to landscape-scale conservation

Conservation development projects can seek to protect a variety of conservation values, including biodiversity, ecosystem services, working farm and ranch lands, scenic landscapes, outdoor recreation opportunities, and historic and cultural resources. The following discussion focuses on biodiversity and ecosystem services, which tend to be the values most sensitive to development, degradation, and landscape fragmentation.

Conceptualizing the benefits of conservation development. The benefits of conservation development depend on the project type and context. In the two "conservation with development" approaches (table 1), a conservation organization is typically the project proponent or at least a principal actor, and conservation is a primary project goal. In these projects, sites are usually deliberately selected for their conservation value, so the potential to protect critical natural resources is high. Although sites that conservation organizations select for conservation buyer projects or CLDPs may be lower priority than sites they select for full protection, site selection is still driven by the organization's conservation mission and by an assessment of how best to advance that mission in a given landscape. Furthermore, when conservation funding is scarce, conservation buyer projects and CLDPs can help conservation organizations move beyond opportunism (i.e., conserving only those properties that are offered as donations) to target high-priority lands in their service area.

In "conservation with development" projects, the proponents seek to strike a careful balance, developing enough to raise money to protect the conservation targets, but not so much that the development degrades the targets. In other words, such projects risk introducing some of the very threats (land development, roads, fragmentation) that they seek to guard against in the first place. The measure of project success, then, is in significantly reducing the threat of future impact to the conservation targets. For example, a CLDP that develops 20 houses but protects the site's key conservation targets and precludes a destructive full-density development may be considered a conservation success. Conversely, on a site with no foreseeable threats, even a low-impact conservation buyer project would be a net negative for conservation. Thus, the conservation effectiveness of conservation buyer projects and CLDPs can be understood by using a threat reduction assessment framework (Salafsky and Margoluis 1999) or by comparing the project outcome with the outcome of an alternative, conventional land-use scenario (Theobald and Hobbs 2002).

In the two "development with conservation" approaches, the principal objective is usually to make money through land development, so project sites are typically selected for their marketability and their development suitability, not for their conservation value. In fact, the presence of sensitive natural resources may be a negative factor, since it is likely to increase a project's environmental compliance and permitting requirements. Because "development with conservation" project sites are rarely selected for their conservation value, such projects cannot ordinarily be expected conserve rare or extraordinary natural resources, although some do. However, such projects can still contribute to landscape conservation objectives by protecting or restoring local matrix habitat types, maintaining landscape connectivity, and reducing negative impacts to off-site conservation resources relative to conventional project designs.

Overall, the cumulative benefit of the "development with conservation" project types could be enormous, because the volume of private land development is so large. If conservation development replaced conventional development as the standard approach to development, conservation subdivisions and conservation-oriented planned development projects could protect 3 million to 5 million ha of land per decade. Furthermore, these benefits would be in addition to existing conservation efforts, effectively opening up a major new source of conservation finance.

Conservation objectives and targets

To explore the conservation value of conservation development projects in greater detail, this section analyzes the ability of each project type to meet each of 10 objectives for conserving biodiversity and ecosystem services. These objectives are discussed below in three broad categories, ranging from the least difficult to the most difficult to achieve.

Mitigating the detrimental ecological effects of land development. The detrimental impacts of conventional land development rarely stop at the property boundary, but affect nearby terrestrial ecosystems and downstream aquatic systems, potentially undermining conservation efforts elsewhere in the landscape (Hansen et al. 2002). A critical goal for conservation development, then, is to minimize harm to the surrounding landscape.

Objective 1: Reduce off-site impacts. Conservation developments of any size and in any context can help protect aquatic systems by maintaining suitably wide riparian buffers, limiting impervious surface cover, and managing stormwater to remove pollutants and to approximate natural flow patterns. Projects can protect terrestrial habitats and species by retaining structurally complex native vegetation in lieu of simplified nonnative landscaping, by minimizing the size of clearings for roads and buildings, and by controlling disturbance vectors such as household pets and light pollution (Marzluff and Ewing 2001).

Improving the conservation value of the land-use matrix. This set of objectives is aimed at broadly improving the conservation value of the landscape matrix (i.e., land outside of protected areas) by increasing habitat suitability for native species and maintaining ecosystem services. For exurban and rural areas facing development pressure, an important goal of conservation development should be to create zones of low-intensity human use that complement protected-area networks, serving a similar function to the compatibly managed forests and farmland in core-buffer-matrix models (Noss and Harris 1986). In suburban areas, conservation developments can provide habitat refugia and help conserve ecosystem services. Specific objectives include the following:

Objective 2: Protect "green infrastructure." Green infrastructure is a community's network of natural areas that provide ecosystem services such as clean water, pollution abatement, and flood control, and is put forth as an essential complement to a community's "gray infrastructure" of roads and utilities (Benedict and McMahon 2006). Conservation developments in all contexts can help maintain green infrastructure by protecting resources such as wetlands, riparian corridors, and critical groundwater infiltration areas.

Objective 3: Provide habitat refugia. Refugia ranging in size from roughly 1 to 50 ha can accommodate breeding pairs of birds or small populations of various plant, insect, reptile, amphibian, and small-mammal species, thus helping to bolster metapopulations in fragmented landscapes (Perlman and Milder 2005). These refugia may be especially important in suburban areas, where protected land in conservation developments may provide among the last or most intact remaining natural areas in the landscape.

Objective 4: Maintain landscape connectivity. In exurban and rural areas, large conservation developments can maintain functional connectivity for target plant and animal species by creating corridors hundreds or thousands of meters wide. In urban settings, vegetated areas as small as 0.1 ha can provide valuable stepping-stones for maintaining functional connectivity, and many migratory bird species rely on urban corridors or habitat patches for stopover sites (Rudd et al. 2002).

Objective 5: Buffer nature reserves. Conservation developments can protect land or provide a zone of compatible low-intensity use adjacent to existing protected areas, thus expanding the functional size of core reserves while safeguarding them from the influences of higher-intensity development elsewhere on the landscape.

Objective 6: Conserve matrix habitat. Protecting large amounts of intact matrix habitat is critical for landscape-scale conservation, yet historically has been neglected by conservation organizations in favor of protecting rare and vulnerable elements of biodiversity (Anderson et al. 1998). Conservation development projects on large sites may help address this shortcoming by conserving large tracts of forest or rangeland not considered unique enough to justify acquisition using scarce conservation funds. To maintain habitat integrity on such lands, deliberate efforts may be required to mimic natural disturbance patterns while minimizing human disturbances.

Protecting or restoring site-specific conservation targets. The remaining four objectives focus on conserving specific elements of biodiversity that occur (or historically occurred) on conservation development sites. These objectives are based on the framework proposed by Poiani and colleagues (2000) for conserving species and ecosystems at multiple scales. However, in light of the modest scale at which conservation developments typically occur, their framework has been adapted to divide the local scale (square meters to thousands of hectares) into two separate scale ranges (microscale and mesoscale).

Objective 7: Conserve microscale species habitat and micropatch ecosystems. Micropatch ecosystems, occurring at the scale of 0.1 to 10 ha, are often associated with distinct physiographic features, such as serpentine soils, seeps, or depressions, and may harbor rare plant communities. Microscale species, including rare plants and invertebrates, are often associated with these localized ecosystems (Poiani et al. 2000). For microscale conservation targets, if the habitat or ecosystem itself plus a suitably wide buffer zone can be protected—and if appropriate restoration and long-term management are provided—limited development elsewhere on the same land parcel may have little detrimental effect (Milder 2005).

Objective 8: Conserve mesoscale species habitat and mesopatch ecosystems. Mesopatch ecosystems also tend to be defined by physiographic features, but these systems occur at the scale of 10 to 1000 ha and may include some internal heterogeneity. Mesoscale species include plants and other sessile species, animal species with small home ranges, and species that utilize localized habitat complexes, such as amphibians that require wetlands and adjacent uplands to complete their life cycle. Whereas microscale targets can be protected within any type of conservation development, mesoscale targets require larger patches of conserved land, which are less likely to be found in conservation subdivisions or in urban settings.

Objective 9: Conserve intermediate-scale species habitat and large-patch ecosystems. Large-patch ecosystems (hundreds to tens of thousands of ha) include various types of forests, wetlands, and grasslands that may have significant internal heterogeneity. Intermediate-scale species depend on large-patch ecosystems and the multiple habitat resources they provide (Poiani et al. 2000). The largest conservation development projects can conserve habitat patches of up to a few thousand ha, although patches of several hundred ha are more common. In addition, protected land in conservation developments that is adjacent to large tracts of public land or nature reserves can help support intermediate-scale species and large-patch ecosystems.

Objective 10: Conserve habitat for coarse-scale and regional-scale species. Although individual conservation developments by themselves are not large enough to accommodate coarse- and regional-scale species (which range over tens of thousands to millions of ha), they may support such species in conjunction with other public and private lands in the region. For example, existing large conservation developments provide habitat for large migrating ungulates in Colorado and for black bears in North Carolina. Projects' ability to support wide-ranging species depends on the space needs and disturbance sensitivity of species as well as the spatial configuration of the project. The degree of habitat fragmentation is likely to be a critical factor.

The ability of conservation development to meet each of the 10 objectives. The ability of conservation development to protect biodiversity and ecosystem services depends on (a) the scale of protected land relative to the scale of the conservation target's space needs, (b) the intensity of human disturbance relative to the target's disturbance sensitivity, and (c) the project's landscape context. These criteria mirror the triad of factors—size, condition, and landscape context—used by The Nature Conservancy and others to assess the viability of conservation targets (Anderson et al. 1998). On the basis of these three criteria, table 3 summarizes the degree to which each type of conservation development is capable of contributing to each of the 10 conservation objectives listed above. For example, conservation subdivisions typically protect land at too small a scale to meet several of the objectives. Planned development projects can protect land on a larger scale but, by virtue of their landscape context (typically in metropolitan areas), are unlikely to abut large wildlands that support regional-scale species.

Figure 4 provides additional analysis of the roles of conservation development in different landscape contexts. For example, suburban conservation development projects may play a vital role in maintaining local ecosystem services, but it is unrealistic to expect them to harbor area-sensitive species. On the other hand, even conventional development projects are likely to maintain many ecosystem services if they are built at exurban or rural densities (e.g., lot sizes of at least 4 ha), simply by virtue of their low density. For the designation of "conservation development" to be meaningful, projects in these contexts should be held to a higher standard that includes advancing one or more of conservation objectives 5–10.

Conclusions and directions for future work

Conservation development can play two key roles in landscape-scale conservation. First, it can provide an important source of conservation finance, allowing conservation organizations to select and conserve high-priority lands in a proactive manner while increasing their overall capacity to protect land and natural resources. Second, it can signifi-

Table 3. Matrix showing the frequency with which each type of conservation development is predicted to meet each of 10 conservation objectives, considering the typical size, layout, development density, context, and approach to land management for each project type.

Conservation objective		Conservation buyer projects	Conservation and limited development projects	Conservation subdivisions	Conservation-oriented planned development projects
1.	Reduce off-site impacts	Almost always	Almost always	Almost always	Almost always
2.	Protect green infrastructure	Almost always	Almost always	Almost always	Almost always
3.	Provide habitat refugia	Almost always	Almost always	Frequently	Frequently
4.	Maintain landscape connectivity	Almost always	Almost always	Frequently	Frequently
5.	Buffer nature reserves	Frequently	Frequently	Infrequently (S, LC)	Infrequently (LC)
6.	Conserve matrix habitat	Almost always	Frequently	Infrequently (S, LC)	Frequently
7.	Conserve microscale species habitat and micropatch ecosystems	Almost always	Almost always	Infrequently (C)	Frequently
8.	Conserve mesoscale species habitat and mesopatch ecosystems	Frequently	Frequently	Infrequently (S, C, LC)	Frequently
9.	Conserve intermediate-scale species habitat and large-patch ecosystems	Frequently	Frequently	Rarely or never (S, C, LC)	Infrequently (C, LC)
10.	Conserve habitat for coarse-scale and regional-scale species	Infrequently (S)	Infrequently (S, C)	Rarely or never (S, C, LC)	Infrequently (S, C, LC)

Note: Parenthetical notes indicate the principal constraints to meeting conservation objectives: Size (S) means that the project type typically conserves land at too small a scale; condition (C) means that the conservation land is typically too heavily affected by development; landscape context (LC) means that the project type usually occurs in settings that are not conducive to meeting the conservation objective.

"Almost always" indicates that the conservation objective is an integral part of that type of project. "Infrequently" indicates that the project type has the potential to meet the objective, but usually does not.

cantly reduce the negative impacts of for-profit land development in suburban, exurban, and rural areas, creating a landscape mosaic that is more hospitable and permeable to native species, and more capable of providing ecosystem services. In both instances, it is the revenue from real estate development that finances conservation that would not otherwise occur.

The experience with conservation development to date is promising, but poses some significant challenges. One concern is that developers will manipulate the conservation development label to attain advantages in project permitting and marketing in such a way that the concept functions as little more than a smoke screen for conventional sprawl. Indeed, this concern has already been borne out in some projects. Conversely, conservation organizations that adopt a pragmatic posture and choose to participate in development projects to fund their conservation work risk alienating their supporters, and have come under attack from environmental organizations that advocate a more "purist" approach to conservation (Milder 2005).

The creation of clear definitions, guidelines, and standards could help mainstream conservation development both by legitimizing good projects in the eyes of regulators and environmentalists and by preventing the conservation development concept from being used to "greenwash" projects with little conservation merit. Standards and guidelines can emerge voluntarily from consortia of conservation organizations and developers who engage in conservation development, or they can be incorporated into land-use planning and regulatory programs. Reliable statistics on conservation development are also needed to track the evolution of these practices over time.

From a research standpoint, empirical work is needed to evaluate both the economic and the conservation outcomes of all four conservation development techniques. The typology defined in this article offers hypotheses about the conservation benefits of each project type that could be tested through long-term monitoring at a network of conservation development sites. Studies that stratify across several parameters, including development density, design characteristics, geographic context, and profitability, can help reveal the factors that promote or undermine conservation effectiveness. Further work is also needed to integrate conservation development into the discourses on regional planning, land-use regulation, and conservation planning to ensure that this set of techniques contributes to large-scale conservation and development objectives. Interdisciplinary perspectives are critical to understand the effects of conservation development on multiple axes of landscape change—population growth, land values, land-use change, and biodiversity loss—and their interactions.

Finally, although this article focuses on conservation development in the United States—where it is by far the most advanced—models for conservation real estate have already begin to appear outside the United States, in countries such as Costa Rica (Langholz and Lassoie 2001) and Chile (Corcuera et al. 2002). Refining our understanding and use of conservation development in the United States could help guide further expansion of this conservation strategy in regions of high conservation need worldwide.

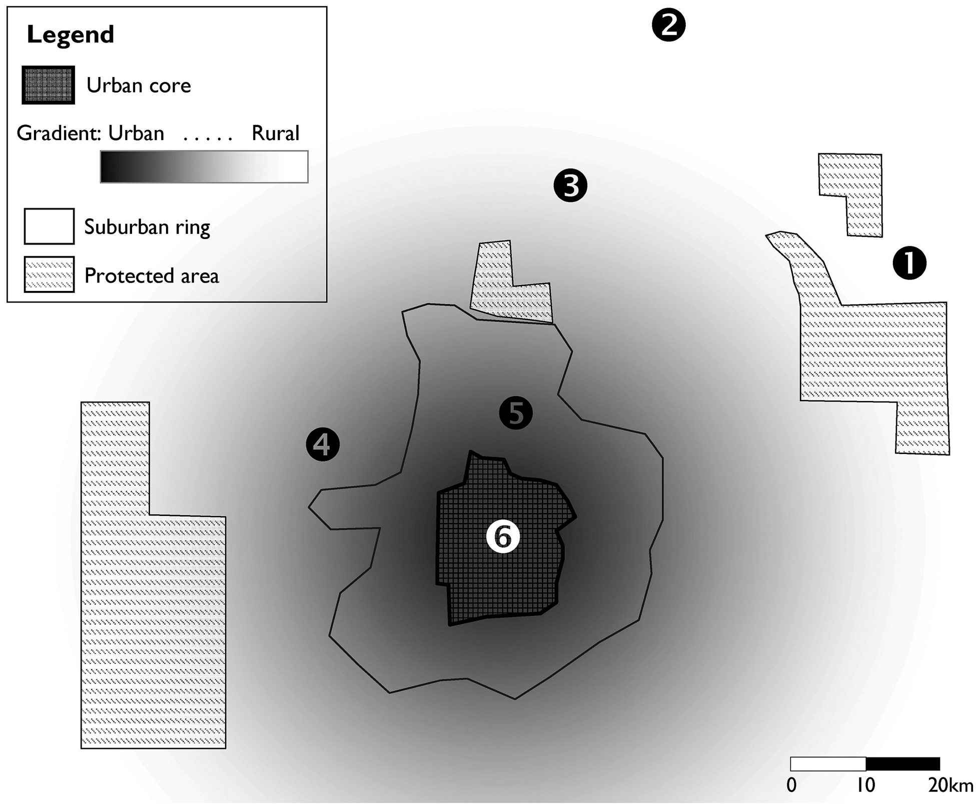

Figure 4. Conservation development can play different roles depending on its location in the regional mosaic. On rural sites where the goal is to buffer or connect core reserves (1) or conserve matrix habitat (2), conservation buyer projects and conservation and limited development projects (CLDPs) can be used to protect large habitat patches with little human disturbance. In exurban areas where the housing market favors low-density development (3), conservation buyer projects, CLDPs, and conservation subdivisions offer lower-impact alternatives to conventional large-lot development, and can help protect micro- and mesoscale biodiversity. On the periphery of fast-growing metropolitan areas (4), conservation-oriented planned development projects are a way to accommodate growth in compact settlement nodes while financing the creation of conservation networks at a relatively large scale. Within the suburban ring, where much development already exists and vacant land parcels are smaller (5), conservation subdivisions and CLDPs can provide habitat corridors and refugia, conserve microscale biodiversity, and maintain ecosystem services of value to the region's residents. In the urban core (6), land parcels are generally too small and land values too high to conduct conservation development projects. Here, other "smart growth" techniques, such as urban infill and brownfield redevelopment, can accommodate growth and thus help to relieve development pressures on outlying areas.

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