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Research Paper

How often are conservation developments managed for biodiversity protection? A case study in Colorado, USA

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ABSTRACT

Conservation Development (CD) is a strategy for conserving private lands with the potential to protect biodiversity while meeting growing demands for housing. Although CD is increasingly common, little is known about how CDs are implemented, and whether developers and homeowners follow best practices and achieve conservation objectives. We formally assessed the presence and content of management plans and conservation easements for CD subdivisions (n = 302) in six Colorado counties and documented the land uses and stewardship activities that are prohibited, permitted, encouraged, or required in the protected open space of each CD. We found that a majority (69%) of CDs had management documents on file, but their prevalence varied from 0 to 82% among the six counties. Fewer than one-third (29%) of the management documents stated a value or purpose for preserving the land, and objectives associated with human values (e.g., preservation of scenic or agricultural values), were far more prevalent (65–78% of documents with stated reasons for preservation) than objectives associated with conservation goals (e.g., preservation of wildlife, ecological/environmental values) (12–46%). Restrictions on land subdivision and regulation regarding the number and type of structures were most frequently included in management documents (84%), whereas guidelines for wildlife habitat improvement, species-specific monitoring and management, homeowner education, and access to the open space by domestic pets were rarely mentioned (all < 18%). By identifying common deficiencies in management documents, this study will help planners, developers, and homeowners more successfully implement CDs that effectively protect and maintain biodiversity on private lands over the long term.

1. Introduction

Effective preservation of private lands is a necessity for conservation; private and unprotected lands make up a majority of the world's land area and are disproportionately located in more ecologically diverse areas (Joppa & Pfaff, 2009; Knight, 1999). However, expanding housing needs and the desire to live, vacation, and retire near natural environments have resulted in the conversion of many private forests, grasslands, farms and ranchlands to residential development (Hansen et al., 2005). Effective tools for conservation on private lands are thus increasingly important for global biodiversity conservation (Norton, 2000).

Conservation development (CD) is a widely implemented private land conservation strategy that has potential to contribute substantially to the protection of private lands in countries around the world (Corcuera, Sepulveda, & Geisse, 2002; Langholz & Lassoie, 2001; Pejchar, Morgan, Caldwell, Palmer, & Daily, 2007). CD is an alternative to residential sprawl designed to decrease the negative environmental impacts of housing developments by clustering houses in a small portion of a property while preserving the remaining land as protected open space (Milder, 2007; Pejchar et al., 2007). CD has been in use for over four decades and occupies four million hectares of land in the United States, accounting for approximately one-fourth of private lands conservation (Milder & Clark, 2011). Although researchers are beginning to examine this strategy in more detail (e.g., Mockrin, Reed, Pejchar, & Salo, 2017), the overall contribution of CDs to private land conservation is poorly understood, and little research has assessed the degree to which CDs protect healthy and diverse ecosystems (Hostetler & Drake, 2009; Lenth, Knight, & Gilgert, 2006).

Long-term stewardship and effective management practices are critical for successful natural resource conservation in protected areas (Chape, Harrison, Spauling, & Lysenko, 2005; Hockings, 2003; Hockings, Stolton, & Dudley, 2004). Because CDs include both protected land and residential development, assessing and improving management practices in these subdivisions is especially important. Homeowner behaviors can negatively impact local plant and animal

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communities (Lerman, Turner, & Bang, 2012). For example, common practices in residential areas such as pruning shrubs and removing snags can decrease habitat for arthropods and cavity nesting birds (Faeth, Bang, & Saari, 2011; Mannan, Meslow, & Wight, 1980). Fertilizers and pesticides used on residential lawns can deposit excessive nutrients and toxins into local streams and water bodies (Hostetler & Drake, 2009), and plant communities altered by landscaping and gardening can also reduce the diversity and change the composition of species present in residential areas (Chamberlain, Cannon, & Toms, 2004; Lerman & Warren, 2011). Human behaviors in protected areas can cause significant disturbance to animals; recreation can increase wildlife flight and vigilance activities (George & Crooks, 2006; Mainini, Neuhaus, & Ingold, 1993; Ordeñana et al., 2010), and high levels of anthropogenic noise or light will decrease occurrence by certain species (Barber, Crooks, & Fristrup, 2010; Miller, 2006). Predation by domestic pets allowed to roam outdoors by homeowners (Clancy, Antony, Moore, & Bertone, 2003) can be extremely detrimental to local bird, reptile, and small mammal populations (Baker, Glynn, & Riegl, 2008).

Recent studies have pointed out the necessity of management plans and funding to support effective long-term open space stewardship in CDs (Hostetler, 2012; Hostetler & Drake, 2009; Hostetler, Allen, & Muerk, 2011; Pejchar et al., 2007; Reed, Hilty, & Theobald, 2014). Many CD residents are unaware of the many ways that human activities can diminish biodiversity, and they lack knowledge of effective strategies for open space management and environmentally sound land use (Youngentob & Hostetler, 2005). Without sufficient guidance for stewardship, residents could fail to act or engage in harmful practices in ways that undermine the CD's conservation objectives. Current guidelines for CD tend to focus on the design phase and neglect long-term stewardship of the protected land (Hostetler, 2012; Hostetler & Drake, 2009). For example, nearly three-quarters (72%) of CD ordinances in the western U.S. do not require a plan for protected land management (Reed et al., 2014). Several papers and books have used evidence from ecological research to provide suggestions to improve CD management for wildlife habitat conservation (Farr, Pejchar, & Reed, 2017; Hostetler, 2012; Hostetler & Drake, 2009; Milder, 2007; Pejchar et al., 2007). However, little is currently known about how often management plans and easements are implemented, and whether plans provide sufficient and ecologically sound guidance for residents.

In this study, we assessed the content of conservation easements and management plans for CD subdivisions in six Colorado counties. The content of these documents can provide valuable information about the land uses and human activities that could contribute to biodiversity conservation in CD open space. Our research questions were: 1) What proportion of CDs have management/stewardship documents?, 2) What are the stated reasons for preserving the open space?, and 3) Which stewardship activities and land use practices do these documents prohibit, permit, encourage, or require? By evaluating current guidelines for management, this research can help prioritize strategies to improve CD as an effective tool for conservation on private lands.

2. Methods

2.1. Data collection

We collected information from publicly available records for CDs in six Colorado counties in 2014: Boulder, Chaffee, Douglas, Larimer, Mesa, and Routt (Fig. 1). These counties contain 302 total CDs, which is the majority (86%) of the 352 CDs in the state (Hannum, Reed, Pejchar, Ex, & Laposa, 2012). For each CD, we recorded whether there was a document or plan on file that provided guidelines or regulations regarding stewardship of CD open space. We define stewardship as a holistic and directed approach to caring for a piece of land, which includes land uses and human activities, ecological restoration, revegetation, education initiatives, and management practices.

We used a set of detailed criteria to systematically review the content of each management document (Ordonez & Duinker, 2013; Reed et al., 2014) (Appendix A). We developed a list of stewardship activities and land uses that we expected to find in the management documents by referencing relevant literature that recommends guidelines for CD stewardship (Arendt, 1996; Hostetler, 2012; Hostetler & Drake, 2009; Lenth et al., 2006; Milder, 2007; Pejchar et al., 2007), and other literature regarding the content of land management plans (Ordonez & Duinker, 2013; Rissman et al., 2007; Wilhere, 2002). As we reviewed management documents, we added stewardship activities and land uses that appeared in the documents but were not included in our original list, and revisited previously reviewed documents to search for these items. For each stewardship activity and land use mentioned, we recorded whether the item was prohibited, permitted, encouraged, or required. We also noted whether the management documents included a stated value or purpose for preservation and/or stewardship of the open space.

The stewardship activities that we investigated were divided into three categories. The first, development and infrastructure, included the construction of new structures and buildings, fences, roads, and trails, and any rules regarding the maintenance or replacement of existing structures (Appendix A, 3a). The second, land use and activities, included human activities such as recreation, agriculture, grazing, mining, and other extractive land uses (Appendix A, 3b). When specified, we recorded whether land uses are restricted to take place during certain times of the year or to happen in certain areas. We also recorded any guidelines for how land uses are carried out in the protected space, including regulation for irrigation, pesticide, and herbicide use. The final category was habitat modification and management, which included access to the open space by people and domestic animals, and regulation for weed control, disturbance, monitoring, restoration activities, and mitigating human-wildlife conflict (Appendix A, 3c). In addition to recording specific stewardship activities and land uses that were permitted, required, encouraged, or prohibited, we also noted any additional recommendations regarding the implementation of those activities (e.g., reduce grazing during years of drought) (Appendix B).

2.2. Data analysis

We used a two sample *t*-test of proportions to determine whether the proportion of CDs with management documents differed between counties with CD ordinances that did or did not require a management document (Reed et al., 2014). We determined whether the document included a stated value or purpose for conserving the land, and we calculated the proportion of documents that included each stated value. We then analyzed the content of easements and management plans by calculating the proportion of documents that prohibited, permitted, encouraged, or required any items on the list of stewardship activities and land uses. We determined which activities were addressed most frequently to identify trends in the content of management documents and to identify stewardship activities that were lacking or rarely addressed.

3. Results

We obtained county record files for 296 CDs, or 98% of all of the CDs recorded in the six counties. Of the records that were unavailable, two files were withheld due to ongoing litigation and four were missing for unknown reasons.

A total of 214 CDs (69%) collectively had 256 documents on file that provided guidelines or regulations for stewardship of the protected open space: 158 conservation easements (52% of CDs), 75 habitat/land/outlot management/stewardship/use plans (25%), nine weed management/control plans (3%), six wildlife conservation/mitigation plans (2%), five forest management/stewardship plan (2%), two