EVALUATING STRATEGIES TO MANAGE BIODIVERSITY IN CONSERVATION SUBDIVISIONS: LANDOWNER OPINIONS IN COLORADO, USA

By

DANIEL S. FEINBERG

A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

UNIVERSITY OF FLORIDA

2014

To my parents

ACKNOWLEDGMENTS

I would like to thank Dr. Mark Hostetler both for providing guidance on this project and for challenging me to work independently. I am also grateful to many other professors, including Drs. Susan Jacobson, Liba Pejchar, Elizabeth Pienaar, Sarah Reed, and Mickie Swisher. Additionally, I would like to thank the planners and developers who helped with my research. Finally, this project would not have been possible without the advice and encouragement of other graduate students and alumni, particularly Karen Bailey, Hal Knowles, Suzanne Simpson, and Rick Vaughn.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CD	Conservation Development
GCRT	Global Challenges Research Team
HOA	Homeowners' Association

Abstract of Thesis Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Science

EVALUATING STRATEGIES TO MANAGE BIODIVERSITY IN CONSERVATION SUBDIVISIONS: LANDOWNER OPINIONS IN COLORADO, USA

By

Daniel S. Feinberg

May 2014

Chair: Mark Hostetler
Major: Wildlife Ecology and Conservation

Conservation development (CD) refers to a set of land development initiatives aimed at minimizing impacts on natural resources. Typically, homes are clustered and open space is set aside for conservation. There is little evidence for the effectiveness of CDs in conserving biodiversity, with some studies pointing to a lack of management of built and conserved areas. The purpose of this research was to determine the opinions of landowners and developers about which conservation practices, as part of a policy scenario, could encourage the stewardship of CDs. We surveyed 25 landowners and developers who had created CDs in north-central Colorado; we solicited their attitudes about native wildlife conservation, willingness to adopt four conservation practices, and whether they would take advantage of a proposed incentive-based policy. We also conducted semi-structured interviews with 17 respondents to discuss different incentives, as well as two potential funding mechanisms for managing the open space for biodiversity (homeowners' association dues and a property tax). Overall, we found moderate support for the conservation practices, some interest in two types of incentives (a housing density bonus and fast-tracking permits), and opposition to the two proposed funding mechanisms for management. Our findings suggest that

developers in Colorado would be willing to adopt conservation practices, given a choice of incentives, but more education is needed to gain support for a funding mechanism.

CHAPTER 1
LITERATURE REVIEW OF URBAN BIODIVERSITY CONSERVATION

Human domination of the earth's ecosystems has caused global declines in biodiversity (Vitousek et al., 1997; Brown & Laband, 2006; McKinney, 2006; Luck, 2007; Butchart et al., 2010; Seto & Hutyra, 2012), threatening many ecosystem services that are essential to human well being, including clean air and water, agricultural production, and disease regulation (McKinney, 2002; Foley et al., 2005; Grimm et al., 2008; Cardinale et al., 2012; Aronson et al., 2014). The loss of these ecosystem services also has high economic costs (Daily et al., 2009; Gomez-Baggethun & Barton, 2013). Many of these environmental problems, along with their solutions, are rooted in cities (Johnson, 2001; Grimm et al., 2008; Nilon, 2011; Pickett et al., 2011; Pickett et al., 2013). The goals of this literature review are to describe (1) the importance of managing urban and suburban areas to conserve biodiversity, (2) theories from the natural and social sciences that provide a foundation for understanding how to conserve urban biodiversity, (3) innovative ways that some conservationists and built-environment professionals are conserving natural resources in urban development, and (4) gaps in the current literature regarding conservation developments and opportunities for further research.

Importance of Urban Biodiversity

The management of biodiversity in cities has implications both within and outside of cities in terms of the "ecological footprints" (Grimm et al., 2008; Nilon, 2010). Cities themselves contain native ecological communities (McKinney, 2002; Calhoun et al., 2005; Bateman & Fleming, 2012), which sometimes include rare and endangered species (McKinney, 2002; Olive & Minichiello, 2013), as well as endemic natives

(Aronson et al., 2014). They also offer unique opportunities for conservationists to reach the public and encourage stewardship through environmental education, since 80% of Americans live in or near cities (McKinney, 2002). Urban landscapes can be planned, designed, and managed with biodiversity in mind (Gobster et al., 2007), and then, if these landscapes appear aesthetically pleasing and well maintained, they can inspire environmental stewardship among urban residents (Nassauer, 2011).

Design and management of cities can also impact biodiversity in surrounding landscapes, particularly in nearby conserved areas both within and outside of cities. Designating urban open space in subdivisions does not necessarily mean that a diversity of native plants and animals will survive; for instance, when people landscape around homes with invasive exotic species, these species can spread from urban and suburban areas to nearby natural areas, where they outcompete and displace natives (Pimentel et al., 2001; McElfish, 2004; Hostetler & Drake, 2009; Gavier-Pizarro et al., 2010; Hostetler & Main, 2010). Another major threat stemming from the behaviors of residents in cities is the excessive use of fertilizer on turf-grass lawns, creating "nonpoint" pollution through stormwater runoff and causing the loss of species in nearby aquatic ecosystems (Carpenter et al., 1998; Smith, 2003; Cameron et al., 2012). Rainwater flows quickly across impervious surfaces, such as concrete, and deposits lawn chemicals (phosphorus and nitrogen) into streams and rivers, where the excess nutrients can cause algal blooms and reduce the water's oxygen to toxic levels, killing fish and disrupting aquatic food webs (Diaz, 2001). Species invasions and nonpoint source pollution are just two examples of how human behavior in cities can threaten biodiversity in and around urban areas. Others include residents letting domestic cats

and dogs roam outdoors, where they can displace, injure, and kill wildlife (Odell et al., 2003; Hansen et al., 2005), and built areas generating light and noise pollution that disturb wildlife (Longcore & Rich, 2004; Barber et al., 2011).

Restructuring cities to conserve biodiversity within and minimizing impacts on natural areas outside of cities will require an interdisciplinary approach that takes into account both the natural and social sciences (Balmford et al., 2005; Grimm et al., 2008; Nilon, 2011). The role of the natural science research is to determine the best management practices for conserving urban biodiversity, and the role of the social science research is to increase the uptake of the best management practices by assessing stakeholders' environmental knowledge, attitudes, and behaviors, and by using these assessments to guide behavior change through environmental education and policy (Jacobson, 2009; Manfredo et al., 2009).

Insights from the Natural Sciences

Biological research is fundamental in understanding how to conserve urban biodiversity, as it illuminates the basic needs of wildlife (e.g., how large a habitat needs to be to support a population of a given animal species) and the appropriate soil and climate conditions to support a variety of plant species (Williams et al., 2008; Lososova et al., 2010), as well as soil biota (Santorufo et al., 2012). Researchers often use birds as indicators of urban biodiversity since they are easily observable (Chace & Walsh, 2006; Sushinsky et al., 2012). Urbanization leads to declines in bird species richness and abundance, with the exceptions of exotic and urban-adapted species that can thrive in cities (Chace & Walsh, 2006; Pellisier et al., 2012; Rittenhouse et al., 2012). Urbanization can also reduce diversity within other taxa (McKinney, 2008), including

amphibians (Parris, 2006), invertebrates (McIntyre & Hostetler, 2001), and plants (Burton et al., 2005). Some of the research on urban ecology utilizes the theory of island biogeography, which demonstrates an inverse relationship between extinction rate and island size, meaning that larger islands are generally better at conserving species (MacArthur & Wilson, 1967). Urban ecologists have found that habitat patches in cities are often analogous to islands, with larger patches providing greater conservation value (Soule, 1991; Marzluff, 2005; Hensperger, 2006).

Many studies have compared urban habitat patches at different scales and explored their potential to conserve biodiversity. Odell et al. (2003) studied birds and medium-sized mammals in the natural areas within residential developments in Colorado. Odell et al. (2003) classified some bird species as “human-sensitive” and found that these species were most abundant in habitats that were distant from the homes. The authors recommend clustering homes and leaving larger open areas in order to provide the necessary distance to support human-sensitive species. In terms of mammals, the same study showed that domestic dogs and cats were primarily found near the houses, whereas native coyotes and foxes were found far from the houses. This finding provides additional support for protecting large open spaces and also highlights the threat of off-leash domestic pets to native biodiversity. In other studies, a variety of taxa have been shown to occupy urban habitat patches. For example, reptiles and amphibians inhabit small urban forest remnants in Florida (Hostetler & Dawson, 2008). In this case, the authors compared the animals’ use of the interior parts of the habitat versus the edges and did not find that species preferentially used interior or

edges because the vegetative structure between the edge and interior forest was not different in these patches.

Habitat fragmentation restricts the movement of populations and is a major threat to species richness and abundance (Debinski & Holt, 2000; Fahrig, 2003). In housing developments, the construction of roads and homes causes fragmentation and can reduce biodiversity directly (i.e., through roadkill) [Trombulak & Frissell, 2000] and indirectly (through habitat loss) [Bennett et al., 2013]. However, neighborhoods can be designed with connected open spaces (Freeman & Bell, 2011; Ahern, 2013) that make the landscape more permeable for species such as frogs (Freeman & Bell, 2011). On a regional scale, priority conservation areas can be identified during the development process and linked to create a larger network (Pejchar et al., 2007). Considerations of landscape permeability and minimizing fragmentation are increasingly important, as habitats are lost to both land-use change and climate change (Theobald et al., 2012).

Insights from the Social Sciences

Understanding the basic biology of urban plant and animal communities is only part of the solution to conservation problems. Jacobson and McDuff (1998) argue that traditional conservation biology creates “idiot savants”–biologists whose skillsets are too narrow to address management. Rather, as Balmford and Cowling (2006) put it, “conservation is primarily not about biology but about people and the choices they make.” In other words, once the designs and best management practices have been determined, how can people ensure that these designs and practices are adopted in the socioeconomic context of urban areas? This type of question falls under the domain of the social sciences, or the “human dimensions” of biological conservation, including

fields such as economics, political science, and social psychology (see Manfredo et al., 1998; Manfredo et al., 2009). Economics provides ideas such as land-market theory, arguing that humans seek to maximize utility through land-use decisions (see Verburg et al., 2004). Political science, on the other hand, often approaches conservation through collective action, meaning that people in a community must collaborate in order to manage a common resource (see Ostrom, 2000).

When it comes to the social psychology of changing human behaviors, one of the most widely cited ideas is the Theory of Planned Behavior (TPB) [Ajzen, 1991]. TPB states that a person behaves in a certain way after having the *intention* to adopt that behavior. The theory provides three constructs that influence behavioral intention: the person's attitude toward the behavior, subjective norms (i.e., perceived social pressure to behave in a certain way), and perceived behavioral control. When applied to conservation problems, TPB can predict and modify behaviors that help to provide habitat for urban plants and animals. For example, Lopez-Mosquera and Sanchez (2012) found that the constructs of TPB predicted willingness to pay for creating an urban park. TPB can also predict farmers' and ranchers' support for conservation easements (Beedell & Rehman, 2000; Brain et al., 2013a; b).

Social science research (e.g., TPB) can be combined with natural science research to ensure the effective conservation of urban biodiversity, through stewardship that is grounded in sound science. The next section of this literature review will explain how this interdisciplinary approach can be applied to the process of residential development.

Residential Development and Conservation

Conservation development (CD), which is sometimes coined as conservation subdivision, is a set of practices that strives to reconcile the growing, urbanizing human population with the needs of conserving natural resources (Arendt, 1996; Milder, 2007; Pejchar et al., 2007). The most prominent form of CD is where a neighborhood is designed and constructed in such a way that the homes are clustered together and a large open space is set aside for ecological or agricultural purposes (Milder & Clark, 2011). Other forms of CD include reserved-homesite projects, limited development projects, and conservation-oriented master-planned communities; these forms differ in the percentages of the land and sometimes the quality of land that they protect (Milder & Clark, 2011). Instead of approaching conservation in terms of extremes, with minimal conservation in city centers and full conservation outside city limits, all of these CD techniques fall along a spectrum that allows a given amount of construction while requiring some land conservation (Milder, 2007).

The landscape planner Randall Arendt popularized CDs through his 1996 book *Conservation design for subdivisions: A practical guide to creating open space networks*. The book describes many of the intended social, economic, and ecological advantages of CD, compared with conventional development. Examples of the social advantages include walkability, community activities, and opportunities for neighbors to meet in the green areas, while economic advantages include smoother review, lower costs, and marketing advantages (Arendt, 1996). Studies have reinforced the idea that homeowners value the social advantages of CD, such as walkability, which is part of the broader New Urbanism movement (Plaut & Bournet, 2003; Sohn et al., 2012). Other

social benefits can include scenic views, preservation of historical and cultural resources, and overall quality of life (Wallace et al., 2008), as well as safe places for children to play and access nature (NC State, 2011). Research has also supported Arendt's claims regarding the economic advantages of CD, with higher residential land values near open space (Bolitzer & Netusil, 2000; Geoghegan, 2002; Bowman et al., 2012a; b) and significant sales premiums on homes in CDs versus conventional subdivisions (Mohamed, 2006; Hannum et al., 2012). Another potential benefit of CD for developers is an expedited permit approval process (Arendt, 2009; Carter, 2009; Allen et al., 2012), although there is limited evidence of this benefit being implemented in communities.

A CD is intended to benefit plant and animal communities by setting aside the open space to provide extensive habitat (Arendt, 2004; Milder, 2007; Pejchar et al., 2007). As discussed above, larger habitats are often better at conserving native species, including many birds and mammals (e.g., Odell et al., 2001; Odell et al., 2003). However, the conservation value of open spaces can be compromised by human activities in built areas (Pimentel et al., 2001; Hostetler & Drake, 2009). Even with the clustered houses and open space design, some CDs are failing to conserve biodiversity. Lenth et al. (2006) looked at bird, mammal, and plant communities in the open spaces of neighborhoods in Colorado. They found that native species diversity was equal between CDs and conventional developments, and that both types of developments had lower diversity than undeveloped areas.

One of the major reasons why CDs fail to conserve biodiversity is that they lack long-term management plans (Lenth et al., 2006; Hostetler, 2010; Hostetler et al.,

2011). The process of creating a subdivision consists of three phases–design, construction, and post-construction–but CDs usually only consider ecology during the design phase, by setting aside the open space (Hostetler & Drake, 2009; Hostetler, 2010; Hostetler, 2012). In Colorado, for instance, the emphasis on design is clear in the Larimer County CD guidelines, which call for neighborhoods that “are creatively designed to maintain the character of open areas” but do not address sustainable construction or ongoing stewardship (http://www.larimer.org/planning/planning/ProjectDocuments/12-S3097_land_division_process_guide_-_conservation_development.pdf). In Florida, most of the counties that have open space regulations do not provide adequate management recommendations for the built or conserved areas (Wald & Hostetler, 2010). More broadly, Reed et al. (2014) studied CDs in 414 counties in the western United States and found that only 8% of CD ordinances included management plans or biological consultation.

Ultimately, homeowners hold much of the responsibility for how a neighborhood is managed over the long term (Peterson et al., 2007), but their knowledge of biodiversity conservation is limited (Hostetler & Noiseux, 2010; Stokes et al., 2010). Hostetler and Noiseux (2010) found that new homeowners in two green communities in Florida had low environmental knowledge and comparable environmental attitudes to those of homeowners in a conventional neighborhood. Therefore, conservationists need to educate homeowners about the benefits that biodiversity provides to people and how they can reduce their impacts on local natural communities. Even if homeowners intend to conserve biodiversity, they might not know enough about stewardship to do so

successfully, so education is needed (Austin & Kaplan, 2003; Hostetler & Noiseux, 2010). One way to educate and engage homeowners is by installing interpretive signage in the neighborhoods to provide information about local biodiversity and stewardship practices (see Hostetler et al., 2008). An environmental education program in the Town of Harmony, Florida, consisted of signage, a website, and a brochure, and demonstrated improvements in environmental knowledge, attitudes, and behaviors among homeowners, compared with homeowners in a conventional neighborhood (Hostetler et al., 2008). A homeowners' association can further help to conserve native biodiversity by establishing a neighborhood's standards for landscaping with native plants that can also provide habitat for native animals (Lerman et al., 2012).

As houses continue to be built to accommodate the growing human population, ecologists can minimize the impacts on natural communities by collaborating with stakeholders in the development process–namely, planners, developers, and homeowners (Broberg, 2003; Daniels & Lapping, 2003; Theobald et al., 2005; Hostetler, 2006; Miller et al., 2009; Hostetler, 2010; Stokes et al., 2010; Underwood et al., 2011; Reed et al., 2014). At the University of Florida, scientists formed the Program for Resource Efficient Communities (PREC), which provides workshops and continuing education courses for policymakers and other stakeholders (Hostetler, 2006). PREC has also been involved in the creation of sustainable neighborhoods, such as Madera in Gainesville, FL, which conserves wildlife, energy, and water (http://www.wec.ufl.edu/extension/gc/madera/). Similarly, the School of Global Environmental Sustainability at Colorado State University facilitates collaboration between conservation researchers and built-environment professionals through its

Global Challenges Research Teams (http://sustainability.colostate.edu/research/global-challenges-research-teams). However, there is still a need for further collaboration and greater ecological literacy among planners and developers (Felson et al., 2013; Reed et al., 2014). Also, some developers show resistance towards novel development practices because they are only experienced with conventional development and are unaware of the demand for CD from homebuyers (Bowman & Thompson, 2009). Ecologists and planners should continue to educate these developers about the benefits of, and demand for, CD.

Ecological knowledge and values can differ between new property owners and long-term residents, affecting the stewardship of the land (Smith & Krannich, 2000). In many parts of the American West, the long-term residents are ranchers (Brunson & Huntsinger, 2008; Gill & Chisholm, 2010) who, compared with newcomers, tend to be more concerned about environmental issues such as limiting population growth and development (Smith & Krannich, 2000). Due to these differences in attitudes, long-term residents and newcomers serve as two distinct stakeholder groups that ecologists and planners can target with different educational programs–newcomers would generally require a greater shift in attitude with regard to conservation practices.

Research Needs

Further research on urban biodiversity conservation is needed in both the natural and social sciences. Historically, most ecologists have studied natural ecosystems, such as forests, and have not researched the conservation of biodiversity in places where people live and work (Miller & Hobbs, 2002; Martin et al., 2012). As ecologists learn more about urban biodiversity, their science should continue to inform landscape

design professionals (Nassauer, 2012). In the case of CDs, however, the design phase is only the beginning, with the subsequent construction and post-construction phases having major impacts on biodiversity (Hostetler, 2010; Hostetler et al., 2011) and therefore requiring attention from both natural and social science perspectives.

Little research has addressed the long-term management of biodiversity in CDs, or the corresponding policy incentives and funding mechanisms that would engage stakeholders and make this management possible (Hostetler et al., 2011; Göçmen, 2013; Reed et al., 2014). Components of a management plan could include such practices as installing interpretive signage (Hostetler et al., 2008), landscaping with native plants and managing exotics (Hostetler & Drake, 2009), and adding environmental restrictions to a neighborhood's covenants (Göçmen, 2013). CDs also need to include long-term, quantitative monitoring to ensure that conservation goals are being met (Reed et al., 2014). In this way, biologists should play an ongoing role in the CD process, beyond the initial design phase (Hostetler, 2010), but research has not fully identified the types of education and incentives that would encourage developers to support biological consultation. As with other urban ecology problems, the solutions will lie in understanding both the needs of the native plant and animal communities and the means for changing human behavior to meet those needs.

CHAPTER 2
EVALUATING STRATEGIES TO MANAGE BIODIVERSITY IN CONSERVATION SUBDIVISIONS

Introduction

Urbanization negatively impacts biodiversity, in turn threatening ecosystem services, agricultural production, and human health (Vitousek et al., 1997; McKinney, 2002; Foley et al., 2005; Grimm et al., 2008; Cardinale et al., 2012). Conservation development (CD) aims to minimize these impacts by balancing urban development with conservation through land-use approaches such as the "conservation subdivision," a type of neighborhood that clusters homes and sets aside open space (Arendt, 1996; Milder et al., 2007). The goals of these neighborhoods are to provide social, economic, and ecological advantages over conventional developments (Pejchar et al., 2007). Socially, CDs offer opportunities for residents to meet and recreate in common areas; residents have reported a greater "sense of community" in CDs than in traditional neighborhoods (NC State University, 2011; Youngentob and Hostetler, 2005). In terms of economics, CD can be profitable for developers, with homes selling more quickly and for higher prices than in conventional subdivisions (Geoghegan, 2002; Mohamed, 2006; Bowman et al., 2012; Hannum et al., 2012).

In addition to the social and economic advantages, CDs are intended to have several ecological advantages over conventional subdivisions. For example, conserved areas can reduce stormwater runoff (Arendt, 1996) and can provide habitat for a variety of animals, including insects, birds, and mammals (McIntyre & Hostetler, 2001; Odell et al., 2003; Hansen et al., 2005). CD can also provide critical linkages that result in a network of protected landscapes (Pejchar et al., 2007), which benefit both birds and mammals by offering contiguous open space that is less fragmented than disconnected

patches in conventional subdivisions. This benefit is especially pertinent to conserving "human-sensitive" species–those that avoid built areas but use the large open spaces (Odell & Knight, 2001; Odell et al., 2003). For the purposes of this paper, CD will refer to the conservation subdivision approach of setting aside open space in order to conserve habitat for plants and animals.

Although the intent is there, many CDs have not been successful in conserving plant and animal habitat within a development and in minimizing impacts on surrounding habitats (Nilon et al., 1995; Lenth et al., 2006; Milder et al., 2008; Hostetler & Drake, 2009; Milder & Clark, 2011; Hostetler, 2012). Even if semi-natural to natural open space is conserved, human activities–during construction and after people purchase homes–are often detrimental to native plants and animals (McElfish, 2004; NC State University, 2011; Hostetler & Drake, 2009; Hostetler, 2010). For instance, the disturbances that occur during the process of constructing a neighborhood can facilitate the spread of invasive species through earthwork machine operations that introduce invasive plants or make the site attractive to invasive plant establishment (Trombulak & Frissell, 2000). Even after a neighborhood has been built, homeowners could landscape with invasive exotic plants, and these plants would then spread to nearby open spaces and threaten native flora and fauna by outcompeting native plant species (Pimentel et al., 2001; Hostetler & Drake, 2009). Other homeowner behaviors that could interfere with conservation goals include excessive irrigation, excessive fertilization and pesticide use, and feeding wildlife (Hostetler, 2010; Hostetler, 2012). In certain ecosystems where natural disturbances have been disrupted, management practices, such as prescribed burns, are essential to maintaining native plant communities (Hansen et al., 2005);

however, such practices are often missing in open spaces of CDs (Lenth et al., 2006). In one Colorado study, results demonstrated that, in terms of conserving biodiversity, CDs are no better than conventional subdivisions, perhaps due to the insufficient stewardship of both the built and conserved areas (Lenth et al., 2006).

In order to reverse this trend and enhance biodiversity, CDs need to have long-term stewardship plans with steady sources of funding (Arendt, 1996; Pejchar et al., 2007; Hostetler & Drake, 2009; Hostetler, 2010; Hostetler et al., 2011; Reed et al., 2014). Long-term funding mechanisms include homeowners' association (HOA) dues or a property tax levied on each individual lot within a CD. These funds would be used to pay for management practices, such as prescribed burns, control of invasive exotics, and also to hire environmental professionals that periodically educate and engage homeowners (Lenth et al., 2006; Hostetler & Drake, 2009). The extent of management practices in CDs is relatively unknown, yet these practices are important, with many of the impacts on open space stemming from the built areas (Lenth et al., 2006; Hostetler et al., 2011).

Despite the importance of management, very few CDs have implemented successful and lasting management practices. CD planning efforts are primarily focused on the design phase of developments, neglecting the stewardship that needs to occur during and after construction (Hostetler & Drake, 2009; Hostetler, 2012). County/city planning strategies that encourage CD typically do not require a robust management plan. For example, in most counties in the state of Florida, Land Development Regulations that stipulate the conservation of open space contained insufficient descriptions of management recommendations for both the built areas and the

conserved open space (Wald & Hostetler, 2010). A broader study of 414 counties in the western U.S. revealed that only 28% of CD ordinances required a management plan and only 8% of the ordinances encouraged biological consultation (Reed et al., 2014). Biodiversity-oriented regulations have also been shown to be uncommon in Seattle, Washington; Des Moines, Iowa; and the Research Triangle, North Carolina (Miller et al., 2009).

Thus, CDs need to have management practices that address conservation issues within built and conserved areas, but developers are reluctant to do so because such actions require funds and the adoption of novel practices (Hostetler & Drake, 2009; Hostetler, 2010). To help developers accept management alternatives for CDs, incentive-based policies are needed because conservation regulations are difficult to get passed in most cities and counties (Allen et al., 2012; Göçmen, 2013; Reed et al., 2014). Incentives include financial rewards such as density bonuses and fast-tracking permit applications (Arendt, 2009; Göçmen, 2013; Reed et al., 2014). Such incentives can offset the financial burden placed on the developer to pay for conservation practices initially and can be used to implement long-term funding solutions.

Little research has been conducted on what types of incentive-based policies developers and landowners would be most willing to support. In particular, there is a need for research that pinpoints the most appealing policy incentives for developers and landowners to adopt alternative built environment designs and biodiversity conservation practices (Allen et al., 2012; Göçmen, 2013), as well as mechanisms to manage the open space that include consultation with biologists (Reed et al., 2014). This research begins to address these needs by soliciting developers' opinions on native wildlife,

conservation practices, incentive-based policies, and funding mechanisms for management. Effective policies regarding environmental management often depend on stakeholder participation (Walker et al., 2002). Therefore, we conducted a case study to learn about the opinions of stakeholders (namely, landowners and developers) towards conservation practices and a policy scenario that could encourage the stewardship of CDs. As CD continues to be implemented and promoted to protect plant and animal habitat, understanding the potential of policies that support a long-term approach to managing CDs will become increasingly important.

Methods

Study site selection

We studied CDs in Colorado due to the state's extensive adoption of CD (see Hannum et al., 2012) and the availability of county development records via the CD Global Challenges Research Team (GCRT) at Colorado State University. We focused on four counties (Chaffee, Douglas, Larimer, and Routt) in north-central Colorado due to the region's rapid population growth; Larimer County, for instance, had a 19.14% increase in population between the years 2000 and 2010 (American FactFinder), almost double the 9.7% increase in the overall U.S. (U.S. Census Bureau, 2011).

We used county records to obtain the names of landowners and developers who had created CDs in north-central Colorado. Then, we screened our sample to focus on CDs containing potential wildlife habitat by excluding CDs where the open space consisted of exclusively row crops. We determined land use by using ArcGIS to inspect aerial photography, combining orthoimagery from the United States Department of Agriculture's Geospatial Gateway with shapefiles of the CDs, courtesy of the CD GCRT.

After individual landowners and developers were contacted, we used a snowball sampling method (see Rossi et al., 2004) to increase the number of respondents by asking for contact information of similar developers or landowners that had built a CD in their area.

Surveys

We created a survey instrument (Appendix) containing questions about (1) the property, (2) attitudes about conserving native plants and animals, (3) attitudes about adopting four conservation practices, (4) attitudes about adopting two funding mechanisms that would support conservation practices, and (5) whether the developers would adopt a specific incentive-based policy. Questions about the property not only gave details about the land, but also distinguished the respondent as a landowner that had worked the land previously versus a developer that had purchased the land specifically to develop it. An open-ended question allowed developers to report multiple uses of the open space. Attitude questions contained Likert-type answer choices (see Jamieson, 2004) on a scale from 1 to 5.

Survey questions about attitudes towards conservation and about the developers' perceptions of other developers and of members of their community were based on the theory of planned behavior (Ajzen, 1991). The goal was to get a sense of the subjective norms (perceived social pressure) regarding wildlife conservation on developed lands. The combination of attitudes and subjective norms is a predictor of whether people will change their behaviors (Ajzen, 1991).

We asked whether the developers would adopt four conservation practices: (1) landscaping around the homes with native plants; (2) adding wildlife-friendly language

to the neighborhood's codes, covenants, and restrictions (CCRs); (3) installing interpretive signage to educate the homeowners about the conservation goals of the CD; and (4) having a long-term management plan that involves removing invasive exotic plants from the open spaces and planting natives. These practices were selected based on a review of the literature that suggested which actions would most benefit the long-term conservation of biodiversity within CDs. Practices (1) and (4) were included in light of the threats to biodiversity posed by invasive plants in both the built and conserved areas (see Pimentel et al., 2001; Hansen et al., 2005; Hostetler & Drake, 2009). Milder & Clark (2011) emphasized the need for incorporating environmental CCRs in CD projects, leading us to include practice (2). Interpretive signage (practice 3) is an integral part of the stewardship process because even if homeowners intend to live sustainably, they often lack the necessary knowledge about how to conserve biodiversity (Austin & Kaplan, 2003; Youngentob and Hostetler, 2005; Hostetler & Noiseux, 2010).

For funding mechanisms, we asked developers to rate two options that would support long-term management: (1) a portion of homeowners' association dues used for management (if the CD had an HOA) or (2) a small property tax. Monies collected for both funding mechanisms would pay for an environmental professional that would implement the management actions over time and maintain any educational signage. The survey also asked developers to rate an incentive-based policy scenario in which, if the developer agrees to all four conservation practices, as well as a funding mechanism, then the developer would receive a home density bonus. The proceeds from the extra homes would cover the costs of the conservation management and

provide additional profits for the developer. The density bonus was selected as a regionally relevant incentive for north-central Colorado based on pre-survey telephone interviews with planners in Boulder and Larimer counties. The objective of the pre-survey interviews was to explore the planners' perceptions of current and potential future incentives for implementing and managing CDs.

In June 2013, we pre-tested the survey instrument by telephone with developers in Boulder County. Participants reported that the survey questions were too complicated to hear over the phone, so we decided to use a visual format for the final survey. We administered the survey from July through November 2013 using a modified version of the tailored design method (Dillman et al., 2009). We called developers in Chaffee, Douglas, Larimer, and Routt counties and asked if they would be willing to take the survey. Next, we offered them the choice to take the survey by mail, fax, or web, and we created identical versions of the survey for the three modes of distribution. For each developer who chose to take the survey online, we asked for an email address and sent a customized link to take the survey via Qualtrics. For each developer who opted to take the survey by mail, we sent a hard copy along with a personalized letter and a self-addressed, stamped envelope. We obtained additional addresses from the White Pages online for developers who had not responded to phone calls, and we mailed hard copies to these developers. The end of the survey noted that we would follow up by phone with a few additional questions to explore the reasons behind the developers' answers.

The survey sample consisted of 44 developers, of whom 25 (56.8%) responded to the survey; eighteen developers took the survey online, five responded by mail, and two responded by fax. Five developers answered phone calls but declined to participate

in the survey; four said that they were willing to participate but did not take the survey despite multiple reminders, and ten developers were unreachable despite multiple attempts. We conducted follow-up interviews with 17 survey respondents; the remaining eight respondents either were unreachable after returning the survey or expressed that they did not wish to be contacted again.

Semi-structured interviews

After the written survey, we interviewed 17 survey respondents by telephone for approximately 15 minutes each. The interviews focused on why or why not participants were comfortable with the proposed policy option, recommended practices, and funding mechanisms. We asked developers about other incentives, such as fast-tracking permits. We also asked developers to elaborate on their survey responses regarding their opinions on native wildlife and the proposed conservation practices (e.g., if they had expressed opposition to a conservation practice, we asked why they were opposed to it).

Data analysis

For the Likert-scale survey responses, we obtained median ratings on a scale from 1 to 5. We also collapsed the responses into a 3-point scale (oppose, unsure, support) and conducted Fisher's exact tests ($\alpha = 0.05$) due to the small sample size, to look for differences in landowners' and developers' opinions on native wildlife, proposed conservation practices, and funding mechanisms. We tested for differences between developers' attitudes towards conserving native wildlife and their perceptions of other developers' and homeowners' attitudes (i.e., subjective norms). We also tested for differences in attitudes towards the four proposed conservation practices and, within

each practice, differences between landowners and developers. Finally, we tested for differences in attitudes regarding the two proposed funding mechanisms. We transcribed the interviews and used a modified version of conventional content analysis (see Hsieh & Shannon, 2005) to organize the responses into categories representing emergent themes, such as support or opposition for each type of incentive, along with developers' reasons for giving their responses.

Results

Characteristics of survey respondents

Of the 25 respondents, 13 had bought the land specifically to develop it, whereas 12 had already owned the land. On average, respondents had lived in Colorado for 45 years (ranging from 10 to 72 years), and they or their families had owned the land for 44 years (ranging from 2 to 114 years). Developers who had created more than one CD were asked to choose just one CD as the focus of their responses.

Characteristics of CDs

Developers provided the numbers of homes that had been built and platted for 18 CDs (two pairs of respondents had worked together on the same CDs, while the remaining five respondents did not provide specific numbers of homes). The 18 CDs had an average of 38 lots where houses had been built (ranging from 0 to 500 built lots). On average, 133 lots had been originally platted (ranging from 2 to 800 platted lots). For five of the CDs, all of the platted homes have been built, whereas for the rest, construction was still underway or planned. Developers representing 19 CDs reported that 15 of the CDs (79%) had HOAs. An additional developer expressed the intention to create an HOA in the future, after more homes have been sold.

We found that for most of the CDs, the open space was owned by the developer (85%) and managed by the developer (63%). Less commonly, the open space was owned or managed by homeowners, a previous landowner, or a non-profit group (Table 1). The most common use of the open space (for 46% of the CDs) was rangeland (Figure 1), with other developers reporting recreation (e.g., walking trails), wildlife conservation, or no uses at all. Even though wildlife conservation was not the primary goal in many of the CDs, 86% of respondents reported having seen native plants and animals in the open space, with commonly reported species including deer, elk, fox, and various birds and plants. Three of the developers described having wetland habitat in the open space.

Opinions on conserving native plants and animals

Twenty-one developers answered the questions about conserving native plants and animals. Most of these developers (76%) expressed that native wildlife was important to them and 81% felt that native wildlife was important to other members of the community (i.e., homeowners), although about half (52%) were unsure of how other developers felt about native wildlife (Table 2). There was no difference between developers' own opinions about conserving wildlife and their perception of homeowners' opinions (P = 0.13). However, developers' opinions about conserving wildlife were significantly higher than their perception of other developers' opinions (P = 0.0036). Similarly, their perception of homeowners' opinions was significantly higher than their perception of other developers' opinions (P = 0.0012).

On the survey, half of the developers expressed concern about impacts on the open space from homeowner actions in the built spaces, while 45% were not concerned

and 5% had no opinion. In follow-up interviews, three developers gave specific examples of negative behavior stemming from the built areas. These examples included homeowners treating the open space like a lawn (mowing grasses and cutting down trees), domestic cats killing birds, off-leash dogs leaving droppings in the open space, and floodlights from homes shining into the open space.

During the interviews, three developers traced their interest in wildlife to a desire to leave the land in its “natural state,” to preserve beauty, and to maintain family tradition. All three of these developers had owned the land prior to subdividing it. One of these developers explained that, “management practices have been the same for 40 years” and intended to “keep all aesthetics the same” in conserved areas by continuing with farming and ranching in the open spaces, while avoiding a new management plan for the built spaces. Two of these developers expressed least concern (Likert scale = 1) about the impacts of activities in the built spaces on conservation in the open spaces, and the third did not express an opinion.

Two developers described native wildlife that they consider to be nuisances in the CDs. Both developers put prairie dogs in this category, with one expressing concern about horses breaking their legs in prairie dog holes. The other developer listed rattlesnakes and coyotes as additional nuisances and felt that these species hurt the marketing of the neighborhood. One developer was not concerned about the impacts from the built areas, due to a belief that no one valued the open space (in this case a wetland) in the first place. The developer stated, “this is not a quality wetland…it’s causing us more problems than it’s worth,” there are “no waterfowl” and “nobody wants it.”

Opinions on conservation practices

The developers tended to express moderate support for the proposed conservation practices, with an overall median rating of 4 on a scale of 1 to 5, with 1 representing strong opposition and 5 representing strong support. Attitudes varied for each of the four proposed practices (Figure 2), with significantly lower support for landscaping around the homes with natives, compared with each of the other practices (all $P < 0.05$). The median rating for native landscaping around the homes was a neutral 3, compared with a median of 4 for each of the other individual practices. There was also slightly lower support for environmental CCRs than for signage ($P = 0.048$), although there was no difference in support between management and CCRs ($P = 0.076$) or between management and signage ($P = 0.088$). Developers who had previously owned the land were more supportive of CCRs than those who had purchased the land to develop it ($P = 0.037$), with a median rating of 4.5 among the prior landowners and a median rating of 4 among the other developers. There were no differences between the two groups of respondents regarding their support for other three conservation practices (all $P > 0.05$).

Opinions on incentive-based policy scenario

Seven developers supported the proposed scenario, four opposed it, and the remaining 14 did not express an opinion about it. In follow-up interviews, two developers, both of whom had owned the land prior to subdividing it, attributed their hesitation to a lack of experience with the practices in the scenario. Interviews also revealed some disagreement among developers about which incentive would be the most appealing. Four developers expressed interest in fast-tracking, with one saying

that fast-tracking would be better than a density bonus because, “it takes forever to get through the permitting process.” In contrast, another developer downplayed fast-tracking and said, “I wouldn’t be much worried about how long it would take,” opting instead for a density bonus.

Two developers specified that incentives depend on the context and on the developer’s priorities. Density bonuses, for instance, can work well for urban and brownfield neighborhoods (where land is scarce) and for senior communities (where homeowners are not looking for large lawns). Fast-tracking, on the other hand, can be attractive if the developer is on a tight schedule. Two developers explained that they opposed the policy on the basis that any government involvement in private land management felt intrusive. One of the developers stated, “I just don’t want a government agent telling me how to landscape my property,” and the other felt that the government was, “stepping on me.”

Opinions on funding mechanisms

Developers were opposed to funding conservation through HOA dues and a property tax, with median ratings of 2.5 and 1, respectively, on a scale of 1 to 5, and overall there was no statistical difference between the developers’ attitudes towards the two proposed funding mechanisms ($P = 0.081$). Despite the higher median rating for HOA dues, two developers pointed out an advantage of the property tax: unlike HOA dues, a tax would be deductible automatically from homeowners. Another developer who opposed using HOA dues to fund conservation described this approach as a “negative marketing tool,” and believed that HOA dues are already “almost prohibitively

high," so adding a conservation fee might cause prospective homebuyers to avoid buying homes in CDs.

Discussion

Characteristics of CDs and open space

Developers' perceptions of the biodiversity value in the open spaces varied among the CDs, ranging from the wetland that one developer described as having virtually no wildlife, to a meadow that another developer described as containing "all of the native plants from that area," as well as several species of native animals. An implication for management is that homeowners are typically more committed to environmental stewardship if they view the land as aesthetically pleasing and valued (Gobster et al., 2007; Nassauer, 2011). Therefore, the adoption of conservation management practices seems more likely in the CDs where stakeholders view the open spaces as high quality natural areas.

The incomplete construction of many of the CDs (with the number of built homes averaging only half of the originally platted homes) has implications for the management of both the open spaces and the built spaces. As more homes are built, management of the open space has the potential to change. For example, one developer described plans to create an HOA once more homes have been sold. Although we found that the open spaces in most of the CDs were managed by the developers, management could shift to an HOA over time, which would be consistent with Milder and Clark (2011), who found that the open space in most of the CDs in the United States was managed by HOAs. Further, as the neighborhoods become more built-up and homeowners move in,

the developers' perceptions could change with regard to how homeowner actions in the built areas impact the conservation goals of the open space.

Opinions about native plants and animals

Only half of the developers were concerned about negative impacts from the built areas on the conservation of biodiversity in the open space, contrary to the ecological realities of urban impacts from introduced invasive species, domestic pets, and other anthropogenic phenomena (see Pimentel, 2001; Odell et al., 2003; McElfish, 2004; Hostetler & Drake, 2009; Hostetler, 2010; Hostetler et al., 2011; Hostetler, 2012). These same developers who advocated traditional management were not concerned about the impacts of built areas on the native plant and animal communities in conserved areas. Therefore, workshops need to inform developers of the threats to biodiversity that can stem from household activities, such as planting invasive exotics and letting pets roam free. If the developers had a better understanding of the footprint of these activities on the ecological integrity of the open space, they might be more supportive of the proposed management plan.

In a few cases, developers were not interested in conserving wildlife in the open space. The two developers who mentioned prairie dogs raised a concern that seems relevant to other landowners who similarly intend to have horses in the open space, but less so to homeowners who do not own horses. Also, the perspective of one developer that "nobody wants" the open space suggests that a lack of stewardship has become the norm in that CD. Conversely, if habitat is aesthetically pleasing and appears well cared for, it can spark further stewardship in nearby areas through a "halo effect," by making stewardship the norm (Nassauer, 2011). However, some types of aesthetically

pleasing landscaping, such as turf-grass lawns, do not serve as healthy ecosystems, providing a range of ecosystem services (Gobster et al., 2007). Developers seeking to increase stewardship among homeowners could do so by balancing aesthetics and ecology through maintaining open spaces that are both aesthetically pleasing and native species-rich. One way to do this is to set aside “wild areas” that are bordered with landscaped or mowed areas (Hostetler, 2012).

Responses to the subjective norm questions suggest that the developers perceive social pressure regarding wildlife conservation coming from members of the community (i.e., homeowners) but not necessarily from other developers. Ajzen’s (1991) theory of planned behavior states that subjective norms influence an individual’s intention to carry out a given action, and accordingly, we believe that the developers’ perceptions of homeowners’ values contribute to their support for conservation practices. Their support might be even greater if they also perceived support for conservation as a social norm among other landowners and developers. The developers seemed to underestimate their peers’ support for conservation, highlighting a need for workshops where prospective developers would learn from other developers who have successfully adopted the CD practices.

Conservation practices

In terms of conserving native plants in CDs, actions that involve managing open space seem more supported by developers than requiring native landscaping around homes, as developers seem resistant to regulating how homeowners manage their individual lots. Building on the conclusion by Reed et al. (2014) that most CDs lack consultation with biologists, our study showed developers’ support for adopting a

management plan that involves removing invasive exotics from the open space and replacing them with natives. Biological consultation would play an important role in this process, as biologists would periodically visit the neighborhoods to identify and help manage the native and invasive species. However, the built space also has to be designed and managed to limit impacts on the open space and to increase stewardship of the property. One technique that developers can use to encourage native landscaping in yards is to create a native plant nursery that sells native species to homeowners. A neighborhood in Larimer County has used this technique both to make native plants readily available to homeowners and to raise funds for ongoing management (J. Tolstrup, personal communication, March 5, 2013; http://suburbitat.org/native-plant-nursery-sustainable-stormwater-demo-area/).

The overall higher support for environmental CCRs among developers who had previously owned the land is consistent with these developers' desire to keep the land in its "natural state." In contrast, some developers who had bought the land with the intention of developing it were opposed to CCRs and seemed to hold broader anti-regulation views. For instance, one developer who did not wish to impose environmental regulations on homeowners stated, "I'm not into controlling people," and that covenants should be "as easy to live with as possible." The differences in attitudes towards environmental regulations between the two groups of developers are consistent with Smith and Krannich (2000), who found that long-term landowners were more concerned than newcomers regarding the environmental impacts of population growth and development in the western U.S. Thus, it may be more difficult for policy makers to

encourage environmental CCRs among the “newcomer” developers who did not previously own the land.

Incentive-based policies

Previous studies have highlighted the need for pinpointing appropriate incentives that would motivate developers to adopt conservation practices (Allen et al., 2012; Göçmen, 2013), and our results move a step closer towards this need by demonstrating support for both density bonuses (seven developers expressed support on the survey) and fast-tracking permits (four developers expressed support in interviews). The variety of opinions among developers suggests that offering a choice of incentives would be more effective than taking a “one size fits all” approach. Planners could offer either a density bonus or a faster permit approval (see Arendt, 2009) and let each developer choose one, based on the context of the neighborhood and the individual developer’s priorities. Also, an incentive might be seen as more attractive if it is not already available in a given county. For instance, Larimer County already offers density bonuses, so fast-tracking might be used to encourage additional conservation practices, complementing the existing incentive of density bonuses. The anti-regulation sentiments that some developers expressed underscore the importance that CD policies remain incentive-based, as opposed to regulatory.

Funding mechanisms

Funding mechanisms for management seem to be the greatest challenge in moving forward with a policy to manage biodiversity in CDs, as developers were resistant in this. Both the property tax and HOA dues could make CDs more expensive for homeowners and, as one developer pointed out, the added expense could

discourage homeowners from moving to CDs. However, this perspective contradicts the evidence that homeowners are often willing to pay for conservation: they view open space as an amenity (Geoghegan, 2002) and will pay more to live in a CD than in a conventional development (Mohamed, 2006; Bowman et al., 2012; Hannum et al., 2012). By the same token, a well-managed open space could benefit the marketing of a neighborhood and boost property values.

The developers' resistance to requiring conservation fees from homeowners suggests that they were not aware that homeowners are willing to pay more for conservation. Previous research by Bowman and Thompson (2009) found that developers underestimated homeowners' willingness to pay for CD, basing their perceptions of demand on past experiences with conventional development procedures. Similarly, in our study, developers who expressed concern about homeowners' willingness to pay might be unfamiliar with homeowners' demand for CD. Workshops could increase developers' support for the proposed funding mechanisms (charging homeowners for ongoing conservation through HOA dues or a property tax) by educating the developers about homeowners' willingness to pay for CD. Also, future research could conduct cost-benefit analyses to determine whether the increased profits from well-managed CDs exceed the expenses of management. If so, the results might convince more developers to adopt the proposed management practices.

Conclusions

Our findings indicate that developers of CDs in several Colorado counties potentially are interested in conserving native animal and plant communities and would be willing to adopt biodiversity management practices, given the appropriate incentives

and long-term funding mechanisms. The broader implication is that incentive-based policies that address management can be effective tools for maximizing biodiversity in CDs in conjunction with design. Further research should explore the policy options for managing biodiversity in other geographic regions and should take into account the perspectives of other stakeholders, such as homeowners (e.g., their willingness to pay conservation fees to an HOA; their willingness to landscape yards with native species). Additional research could look for an alternative funding mechanism that is more appealing to developers than the mechanisms proposed in this study, while also maintaining the support of policy makers.

In addition to the idea of offering different incentives and allowing developers to choose, we suggest having two types of workshops where planners and environmental professionals would collaborate with local landowners to educate prospective developers about conservation practices and policy options. The audience for the workshops would be segmented according to the type of developer: one type of workshop would target long-term landowners who wish to subdivide their property, and the other type would be aimed at professional developers. The workshop for prior landowners could focus on familiarizing them with the novel conservation practices and policy options, as well as educating them about the impacts of built areas on nearby conserved areas, whereas the workshop for professional developers could focus on the importance of creating environmental CCRs for maintaining the habitat quality in the open space. We also recommend establishing several model CDs that have adopted novel management approaches of the open and built space (e.g., interpretive signage), so that prospective developers can visualize CD that has adopted innovative

approaches. Previous studies have called for engaging and educating stakeholders–policy makers, developers, and homeowners–about biodiversity conservation in CDs (see Stokes et al., 2009; Hostetler et al., 2011; Reed et al., 2014). This study and others (e.g., Bowman & Thompson, 2009) suggest that developers resist adopting novel development practices due to a lack of familiarity; education is needed in order to overcome this inertia barrier. The combination of workshops and model CDs would help to address this need.

Table 2-1. Ownership and management of the open space in 18 CDs in Colorado, as reported by developers, in terms of the number and percentage of owners and managers.

Stakeholder type	Owners	Owners (%)	Managers	Managers (%)
Developer	17	85	12	63
Homeowner	1	5	3	16
Previous Landowner	1	5	1	5
Non-Profit Group	1	5	3	16

Table 2-2. The percentages of 21 developers in Colorado who rated native wildlife conservation as important, unimportant, or neither, along with these developers' perception of this importance to other developers and to members of the community.

View of native wildlife	Importance "to me" (%)	Importance "to developers" (%)	Importance "to community" (%)
Important	76	48	80
Unimportant	10	0	10
No Opinion	14	52	10

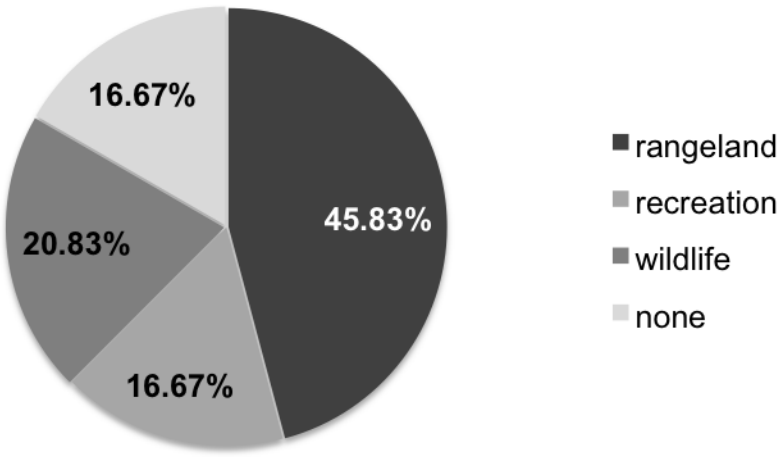

Figure 2-1. Activities in the open spaces within 18 of Colorado's CDs, as reported by the developers.

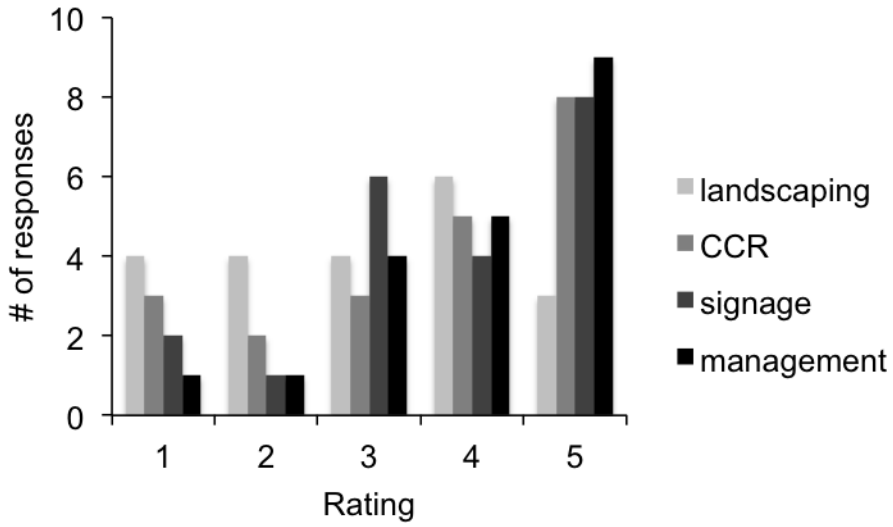

Figure 2-2. Frequency of ratings for each proposed conservation practice, with "5" representing strong support and "1" representing strong opposition, according to 21 developers of CDs in Colorado.

APPENDIX
SURVEY QUESTIONS

The following questions are about the conservation development and the property itself. Please write your responses in the space below each question.

Q-1 Did you purchase the land specifically to develop it? If not, then how many years did you or your extended family own the land before you decided to subdivide the land?

Q-2 How many acres of land are set aside as conserved open space?

Q-3 What is the purpose of the conserved open space and what are the main activities on the conserved open space?

Q-4 Who owns the conserved open space?

Q-5 Who manages the conserved open space?

Q-6 To the best of your knowledge, does the open space within the development contain any native plants and animals? If so, what species have you seen?

Q-7 Does your development have a homeowners' association?

Q-8 How many individual lots have been built, and how many were platted?

The following statements have to do with how you feel about different aspects of conserving native plants and animals within or near a development. Native plants and animals are defined as those species that have not been introduced by humans and have historically been found in Colorado before modern humans arrived. After each statement, please check the box that best describes how you feel.

Q-1 It is important to me that the open spaces within my development contain native plants and animals.

☐Strongly Disagree

☐Somewhat Disagree

☐Neither Disagree nor Agree

☐Somewhat Agree

☐Strongly Agree

Q-2 I am concerned about how the built spaces and homeowner actions will negatively impact native plants and animals in the conserved open spaces.

☐Strongly Disagree

☐Somewhat Disagree

☐Neither Disagree nor Agree

☐Somewhat Agree

☐Strongly Agree

Q-3 I believe other developers and landowners would like the open spaces within their developments to contain native plants and animals.

☐Strongly Disagree

☐Somewhat Disagree

☐Neither Disagree nor Agree

☐Somewhat Agree

☐Strongly Agree

Q-4 I feel that my friends and my local community value conservation developments that retain or restore native plant and animal communities.

☐Strongly Disagree

☐Somewhat Disagree

☐Neither Disagree nor Agree

☐Somewhat Agree

☐Strongly Agree

I will briefly describe four conservation practices that can help to conserve native plant and animal species. After each practice, please select the response that best reflects your opinion of adopting that practice.

Q-1 The first practice is to landscape 50% of the area within 30 feet of homes using native plants in order to provide wildlife habitat.

☐Strongly Oppose

☐Somewhat Oppose

☐Neither Oppose nor Support

☐Somewhat Support

☐Strongly Support

Q-2 The second practice is to adjust the neighborhood's codes, covenants, and restrictions (CC&Rs) to include wildlife-friendly practices, such as keeping pets on leashes.

☐Strongly Oppose

☐Somewhat Oppose

☐Neither Oppose nor Support

☐Somewhat Support

☐Strongly Support

Q-3 The third practice is to install several educational signs in common areas to engage residents about conservation goals.

☐Strongly Oppose

☐Somewhat Oppose

☐Neither Oppose nor Support

☐Somewhat Support

☐Strongly Support

Q-4 The fourth practice is to develop a management plan in the open space that potentially includes methods to control invasive exotic plants and to plant some native vegetation to support wildlife.

☐Strongly Oppose

☐Somewhat Oppose

☐Neither Oppose nor Support

☐Somewhat Support

☐Strongly Support

The following questions ask for your opinions about funding mechanisms, as well as an incentive-based policy scenario that would encourage conservation practices.

Q-1 I will list two mechanisms that could provide long-term funding for the four conservation practices mentioned previously. Such funds could be used to maintain educational signs, plant native vegetation, and monitor the status of local plant and animal communities. Below each mechanism, please select the response that best describes how you feel about that mechanism.

Mechanism #1: If applicable, a portion of the HOA dues would be set aside to hire an environmental professional to manage the development through yearly visits.

☐Strongly Oppose

☐Somewhat Oppose

☐Neither Oppose nor Support

☐Somewhat Support

☐Strongly Support

Mechanism #2: A small property tax assessment would be attached to each lot and the funds would be collected by the county and made available to the subdivision for hiring the environmental consultant (one way to do this would be placing the open space under a special planning district such as a Public Improvement District).

☐Strongly Oppose

☐Somewhat Oppose

☐Neither Oppose nor Support

☐Somewhat Support

☐Strongly Support

Q-2 Scenario: If a developer agrees to all four conservation practices (again, those would be **native landscaping**, **environmental CC&Rs**, **educational signage**, and a **management plan)**, as well as a **long-term funding mechanism**, then a density bonus would be awarded. The density bonus would cover the costs of the conservation practices and would provide additional profits for the developer. For this scenario, please check the box that best describes your opinion:

☐Strongly Unsupportive

☐Mildly Unsupportive

☐Neither Unsupportive nor Supportive

☐Mildly Supportive

☐Strongly Supportive

The next few questions are the final questions.

Q-1 How long have you lived in Colorado?

Q-2 What is your main occupation?

Q-3 Is there another person that had a financial stake in this development that we could contact and ask these questions?

Q-4 Do you know of any other landowner or developer in the area that is contemplating or is in the process of subdividing their land? Could you provide a contact number?

Do you have any further comments or questions? Would you like me to send you more information about the survey or future results?

LIST OF REFERENCES

Ahern, J. (2013). Urban landscape sustainability and resilience: the promise and challenges of integrating ecology with urban landscape design. *Landscape Ecology*, 28(6), 1203-1212.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211.

Allen, S. C., Moorman, C. E., Peterson, M. N., Hess, G. R., & Moore, S. E. (2012). Overcoming socio-economic barriers to conservation subdivisions: A case study of four successful communities. *Landscape and Urban Planning*, 106(3), 244-252. doi – 10.1016/j.landurbplan.2012.03.012

American Fact Finder. Retrieved from http://factfinder2.census.gov/faces/nav/jsf/pages/community_facts.xhtml

Arendt, R. (1996). *Conservation design for subdivisions: A practical guide to creating open space networks.* Washington, DC - Island.

Arendt, R. (2004). Linked landscapes: creating greenway corridors through conservation subdivision design strategies in the northeastern and central United States. *Landscape and Urban Planning*, 68, 241-269.

Arendt, R. (2009). *Land conservation and developers* [Video file]. Retrieved December 30, 2013 from https://www.youtube.com/watch?v=L836CvS8aw4

Aronson, M. F. J., La Sorte, F. A., Nilon, C. H., Katti, M., Goddard, M. A., Lepczyk, C. A., Warren, P. S., Williams, N. S. G., Cilliers, S., Clarkson, B., Dobbs, C., Dolan, R., Hedblom, M., Klotz, S., Kooijmans, J. L., Kühn, I., MacGregor-Fors, I., McDowell, M., Mörtberg, U., Pysek, P., Siebert, S., Sushinsky, J., Werner, P., & Winter, M. (2014). A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers. *Proceedings of the Royal Society B*, 281, 1780.

Austin, M. E., & Kaplan, R. (2003). Resident involvement in natural resource management: open space conservation design in practice. *Local Environment*, 8, 141-153. doi – 10.1080/1354983032000048460

Balmford, A., & Cowling, R. M. (2006). Fusion or failure? The future of conservation biology. *Conservation Biology*, 20(3), 692-695. doi – 10.1111/j.1523-1739.2006.00434.x

Balmford, A., Bennum, L., Brink, B., Cooper, D., Cote, I. M., Crane, P., Dobson, A., Dudley, N., Dutton, I., Green, R. E., Gregory, R. D., Harrison, J., Kennedy, E. T., Kremen, C., Leader-Williams, N., Lovejoy, T. E., Mace, G., May, R., Mayaux, P., Morling, P., Phillips, J., Redford, K., Ricketts, T. H., Rodriguez, J. P., Sanjayan, M., Schei, P. J., van Jaarsveld, A. S., & Walther, B. A. (2005). Science and the convention on biological diversity's 2010 target. *Science*, 307(5707), 212-213.

Barber, J. R., Burdett, C. L., Reed, S. E., Warner, K. A., Formichella, C., Crooks, K. R., Theobald, D. M., Fristrup, K. M. (2011). Anthropogenic noise exposure in protected natural areas: Estimating the scale of ecological consequences. *Landscape Ecology*, 26(9), 1281-1295.

Bateman, P. W., & Fleming, P. A. (2012). Big city life: carnivores in urban environments. *Journal of Zoology*, 287(1), 1-23.

Beedell, J., & Rehman, T. (2000). Using social-psychology models to understand farmers' conservation behavior. *Journal of Rural Studies*, 16(1), 117-127.

Bennett, V. J., Sparks, D. W., & Zollner, P. A. (2013). Modeling the indirect effects of road networks on the foraging activities of bats. *Landscape Ecology*, 28(5), 979-991.

Bolitzer, B., & Netusil, N. R. (2000). The impact of open space on property values in Portland, Oregon. *Journal of Environmental Management*, 59(3), 185-193.

Bowman, T., & Thompson, J. (2009). Barriers to implementation of low-impact and conservation subdivision design: Developer perceptions and resident demand. *Landscape and Urban Planning*, 92(2), 96-105.

Bowman, T., Thompson, J., & Tyndall, J. (2012). Resident, developer, and city staff perceptions of LID and CSD subdivision design approaches. *Landscape and Urban Planning*, 107(1), 43-54. doi – 10.1016/j.landurbplan.2012.04.011

Bowman, T., Tyndall, J. C., Thompson, J., Kliebenstein, J., & Colletti, J. P. (2012). Multiple approaches to valuation of conservation design and low-impact development features in residential subdivisions. *Journal of Environmental Management*, 104, 101-113. doi – 10.1016/j.jenvman.2012.02.006

Brain, R., Hostetler, M., & Irani, T. (2013). Why do cattle ranchers participate in conservation easement agreements?: Key motivators in decision making. *Agroecology and Sustainable Food Systems*, 38, 299-316.

Brain, R. G., Irani, T. A., & Monroe, M. C. (2013). Researching and communicating environmental issues among farmers and ranchers: implications for extension outreach. *Journal of Extension*, 51(3), 3FEA4.

Broberg, L. (2003). Conserving ecosystems locally: a role for ecologists in land-use planning. *BioScience*, 53, 670-673.

Brown, R. M., & Laband, D. N. (2006). Species imperilment and spatial patterns of development in the United States. *Conservation Biology*, 20(1), 239-244.

Brunson, M. W., & Huntsinger, L. (2008). Ranching as a conservation strategy: Can old ranchers save the new west? *Rangeland Ecology & Management*, 61(2), 137-147.

Burton, M. L., Samuelson, L. J., & Shufen, P. (2005). Riparian woody plant diversity and forest structure along an urban-rural gradient. *Urban Ecosystems*, 8(1), 93-106.

Butchart, S. H., Walpole, M., Collen, B., van Strien, A., Scharlemann, J. P., Almond, R. E., Baillie, J. E., Bomhard, B., Brown, C., Bruno, J., Carpenter, K. E., Carr, G. M., Chanson, J., Chenery, A. M., Csirke, J., Davidson, N. C., Dentener, F., Foster, M., Galli, A., Galloway, J. N., Genovesi, N., Gregory, R. D., Hockings, M., Kapos, V., Lamarque, J. F., Leverington, F., Loh, J., McGeoch, M. A., McRae, L., Minasyan, A., Hernandez Morcillo, M., Oldfield, T. E., Pauly, D., Quader, S., Revenga, C., Sauer, J. R., Skolnik, B., Spear, D., Stanwell-Smith, D., Stuart, S. N., Symes, A., Tierney, M., Tyrrell, T. D., Vie, J. C., & Watson, R. (2010). Global biodiversity: indicators of recent declines. *Science*, 328(5982), 1164-1168.

Calhoun, A. J. K., Miller, N. A., & Klemens, M. W. (2005). Conserving pool-breeding amphibians in human-dominated landscapes through local implementation of Best Development Practices. *Wetlands Ecology and Management*, 13, 291-304.

Cameron, R. W. F., Blanusa, T., Taylor, J. E., Salisbury, A., Halstead, A. J., Henricot, B., & Thompson, K. (2012). The domestic garden – its contribution to green infrastructure. *Urban Forestry & Urban Greening*, 11(2), 129-137.

Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. U., Perrings, C., Venail, P., Narwani, A., Mace, G. M., Tilman, D., Wardle, D. A., Kinzig, A. P., Daily, G. C., Loreau, M., Grace, J. B., Larigauderie, A., Srivastava, D. S., & Naeem, S. (2012). Biodiversity loss and its impact on humanity. *Nature*, 486(7401), 59-67. doi – 10.1038/nature11148

Carpenter, S. R., Caraco, N. F., Correll, D. L., Howarth, R. W., Sharpley, A. N., & Smith, V. H. (1998). Nonpoint pollution of surface waters with phosphorus and nitrogen. *Ecological Applications*, 8(3), 559-568.

Carter, T. (2009). Developing conservation subdivisions: Ecological constraints, regulatory barriers, and market incentives. *Landscape and Urban Planning*, 92(2), 117-124.

Chace, J. F., & Walsh, J. J. (2006). Urban effects on avifauna: a review. *Landscape and Urban Planning*, 74, 46-49.

Daily, G. C., Polasky, S., Goldstein, J., Kareiva, P. M., Mooney, H. A., Pejchar, L., Ricketts, T. H., Salzman, J., & Shallenberger, R. (2009). Ecosystem services in decision making: time to deliver. *Frontiers in Ecology and the Environment*, 7(1), 21-28.

Daniels, T., & Lapping, M. (2003). Land preservation: an essential ingredient in smart growth. *Journal of Planning Literature*, 19: 316-329.

Dawson, D. E., & Hostetler, M. E. (2008). Herpetofaunal use of edge and interior habitats in urban forest remnants. *Urban Habitats*, 5. http://www.urbanhabitats.org/v05n01/edgehabitat_pdf.pdf

Debinski, D. M., & Holt, R. D. (2000). A survey and overview of habitat fragmentation experiments. *Conservation Biology*, 14(2), 342-355.

Diaz, R. J. (2001). Overview of hypoxia around the world. *Journal of Environmental Quality*, 30(2), 275-281.

Dillman, D. A. , Smyth, J. D. , & Christian, L. M. (2009). *Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method.* 3rd ed. New York - Wiley.

Fahrig, L. (2003). Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology, Evolution, and Systematics*, 34, 487-515.

Felson, A. J., Oldfield, E. E., & Bradford, M. A. (2013). Involving ecologists in shaping large-scale green infrastructure projects. *BioScience*, 63(11), 882-890.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, F. S., Coe, M. T., Daily, G. C., Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Prentice, I. C., Ramankutty, N., & Snyder, P. K. (2005). Global consequences of land use. *Science*, 309(5734), 570-574. doi – 10.1126/science.1111772

Freeman, R. C., & Bell, K. P. (2011). Conservation versus clustered subdivisions and implications for habitat connectivity. *Landscape and Urban Planning*, 101, 30-42.

Gavier-Pizarro, G. I., Radeloff, G. C., Stewart, S. I., Huebner, C. D., & Keuler, N. S. (2010). Rural housing is related to plant invasions in forests of southern Wisconsin, U.S.A. *Landscape Ecology*, 25(10), 1505-1518.

Geoghegan, J. (2002). The value of open spaces in residential land use. *Land Use Policy*, 19, 91-98. doi – 10.1016/S0264-8377(01)00040-0

Gill, N., Klepeis, P., & Chisholm, L. (2010). Stewardship among lifestyle oriented rural landowners. *Journal of Environmental Planning and Management*, 53(3), 317-334.

Gobster, P. H., Nassauer, J. I., Daniel, T. C., Fry, G. (2007). The shared landscape: What does aesthetics have to do with ecology? *Landscape Ecology*, 22, 959-972. doi – 10.1007/s10980-007-9110-x

Göçmen, Z. A. (2013). Barriers to successful implementation of conservation subdivision design: A closer look at land regulations and subdivision permitting process. *Landscape and Urban Planning*, 110, 123-133. doi – 10.1016/j.landurbplan.2012.11.002

Gomez-Baggethun, E., & Barton, D. N. (2013). Classifying and valuing ecosystem services for urban planning. *Ecological Economics*, 86, 235-245.

Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X., & Briggs, J. M. (2008). Global change and the ecology of cities. *Science*, 319, 756-760. doi – 10.1126/science.1150195

Hannum, C., Reed, S. E., Pejchar, L., Ex, L., & Laposa, S. (2012). Comparative analysis of housing in conservation developments: Colorado case studies. *Journal of Sustainable Real Estate*, 4, 149-176.

Hansen, A. J., Knight, R. L., Marzluff, J. M., Powell, S., Brown, K., Gude, P. H., & Jones, K. (2005). Effects of exurban development on biodiversity; patterns, mechanisms, and research needs. *Ecological Applications*, 15, 1893-1905. doi – 10.1890/05-5221

Hensperger, A. H. (2006). Spatial adjacencies and interactions: Neighborhood mosaics for landscape ecological planning. *Landscape and Urban Planning*, 77(3), 227-239.

Hostetler, M. (2006). With one stroke of the pen: How can wildlife extension specialists involve developers and policy-makers in wildlife conservation? *Proceedings, 11th Triennial National Wildlife & Fisheries Extension Specialists Conference,* Retrieved from http://www.nifa.usda.gov/nea/nre/pdfs/fish_hostetler.pdf

Hostetler, M. E. (2010). Beyond design: the importance of construction and post-construction phases in green developments. *Sustainability*, 2, 1128-1137. doi – 10.3390/su2041128

Hostetler, M. E. (2012). *The Green Leap: A Primer for Conserving Biodiversity in Subdivision Development*. Berkeley, CA: University of California Press.

Hostetler, M., Allen, W., & Meurk, C. (2011). Conserving urban biodiversity? Creating green infrastructure is only the first step. *Landscape and Urban Planning*, 100(4), 369-371. doi – 10.1016/j.landurbplan.2011.01.011

Hostetler, M., & Drake, D. (2009). Conservation subdivisions: A wildlife perspective. *Landscape and Urban Planning* 90(3-4), 95-101. doi – 10.1016/j.landurbplan.2008.10.018

Hostetler, M. E., & Main, M. B. (2010). Tips to create biodiverse, urban communities. *Journal of Extension*, 48(5), 5TOT1.

Hostetler, M., & Noiseux, K. (2010). Are green developments attracting environmentally savvy homeowners? *Landscape and Urban Planning*, 94(3-4), 234-243. doi - 10.1016/j.landurbplan.2009.10.008

Hostetler, M., Swiman, E., Prizzia, A., and Noiseux, K. (2008). Reaching residents of green communities: Evaluation of a unique environmental education program. *Applied Environmental Education & Communication*, 7(3), 114-124.

Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15(9), 1277-1288.

Jacobson, S. K. (2009). *Communication Skills for Conservation Professionals* (2nd ed.) Washington, DC: Island Press.

Jacobson, S. K., & McDuff, M. D. (1998). Training idiot savants: the lack of human dimensions in conservation biology. *Conservation Biology*, 12(2), 263-267. doi – 10.1111/j.1523-1739.1998.97235.x

Jamieson, S. (2004). Likert scales: how to (ab)use them. *Medical Education*, 38, 1212-1218.

Johnson, M. P. (2001). Environmental impacts of urban sprawl: a survey of the literature and proposed research agenda. *Environment and Planning A*, 33(4), 717-735.

Lenth, B. A., Knight, R. L., & Gilgert, W. C. (2006). Conservation value of clustered housing developments. *Conservation Biology*, 20(5), 1445-1456. doi – 10.1111/j.1523-1739.2006.00491.x

Lerman, S. B., Turner, V. K., & Bang, C. (2012). Homeowner associations as a vehicle for promoting native urban biodiversity. *Ecology and Society*, 17(4), 438-450.

Longcore, T., & Rich, C. (2004). Ecological light pollution. *Frontiers in Ecology and the Environment*, 2(4), 191-198.

Lopez-Mosquera, N, & Sanchez, M. (2012). Theory of planned behavior and the value-belief-norm theory explaining willingness to pay for a suburban park. *Journal of Environmental Management*, 113, 251-262.

Lososova, Z., Milan, C., Tichy, L., Danihelka, J., Fajmon, K., Hajek, O., Kintrova, K., Kuhn, I., Lanikova, D., Otypkova, Z., & Rehorek, V. (2012). Native and alien floras in urban habitats: a comparison across 32 cities in central Europe. *Global Ecology and Biogeography*, 21(5), 545-555.

Luck, G. W. (2007). A review of the relationships between human population density and biodiversity. *Biological reviews of the Cambridge Philosophical Society*, 82(4), 607-645.

MacArthur, R. H., & Wilson, E. O. (1967). *The Theory of Island Biogeography.* Princeton, N.J.: Princeton University Press.

Manfredo, M. J., D. J. Decker, & M. D. Duda. 1998. "What is the future for human dimensions of wildlife?" *Trans 63rd No. Am. Wildl. and Natur. Resourc. Conf.*

Manfredo, M. J., Vaske, J. J., Brown, P. J., Decker, D. J., & Duke, E. A. (Eds.). (2009). *Wildlife and Society: The Science of Human Dimensions.* Washington, DC – Island.

Martin, L. J., Blossey, B., & Erle, E. (2012). Mapping where ecologists work: biases in the global distribution of terrestrial ecological observations. *Frontiers in Ecology and the Environment*, 10(4), 195-201.

Marzluff, J. M. (2005). Island biogeography for an urbanizing world: how extinction and colonization may determine biological diversity in human-dominated landscapes. *Urban Ecosystems*, 8(2), 157-177.

McElfish, J. M. (2004). *Nature-Friendly Ordinances: Local Measures to Conserve Biodiversity*. Washington, DC – Environmental Law Institute.

McIntyre, N. E., & Hostetler, M. E. (2001). Effects of urban land use on pollinator (Hymenoptera: Apoidea) communities in a desert metropolis. *Basic and Applied Ecology*, 2, 209-218.

McKinney, M. L. (2002). Urbanization, biodiversity, and conservation. *BioScience*, 52, 883-890. doi – 10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2

McKinney, M. L. (2006). Urbanization as a major cause of biotic homogenization. *Biological Conservation*, 127(3), 247-260.

McKinney, M. L. (2008). Effects of urbanization on species richness: A review of plants and animals. *Urban Ecosystems*, 11(2), 161-176.

Milder, J. C. (2007). A framework for understanding conservation development and its ecological implications. *BioScience*, 57(9), 757-768. doi – 10.1641/B570908

Milder, J. C., Lassoie, J. P., & Bedford, B. L. (2008). Conserving biodiversity and ecosystem function through limited development: An empirical evaluation. *Conservation Biology*, 22(1), 70-79. doi – 10.1111/j.1523-1739.2006.00491.x

Milder, J. C., & Clark, S. (2011). Conservation development practices, extent, and land-use effects in the United States. *Conservation Biology*, 25(4), 696-707. doi – 10.1111/j.1523-1739.2011.01688.x

Miller, J. R., Groom, M., Hess, G. R., Steelman, T., Stokes, D. L., Thompson, J., Bowman, T., Fricke, L., King, B., & Marquardt, R. (2009). Biodiversity conservation in local planning. *Conservation Biology*, 23(1), 53-63. doi – 10.1111/j.1523-1739.2008.01110.x

Miller, J. R., & Hobbs, R. J. (2002). Conservation where people live and work. *Conservation Biology*, 16(2), 330-337. doi – 10.1046/j.1523-1739.2002.00420.x

Mohamed, R. (2006). The economics of conservation subdivisions: Price premiums, improvement costs, and absorption. *Urban Affairs Review*, 41(3), 376-399. doi – 10.1177/1078087405282183

Nassauer, J. I. (2011). Care and stewardship: From home to planet. *Landscape and Urban Planning*, 100, 321-323. doi – 10.1016/j.landurbplan.2011.02.022

Nassauer, J. I. (2012). Landscape as medium and method for synthesis in urban ecological design. *Landscape and Urban Planning*, 106(3), 221-229.

NC State University. (2011). *Conservation Subdivision Handbook*. Retrieved December 31, 2013 from *www.ces.ncsu.edu/forestry/pdf/ag/ag742.pdf*

Nilon, C. H. (2011). Urban biodiversity and the importance of management and conservation. *Landscape and Ecological Engineering*, 7(1), 45-52.

Nilon, C. H., Long, C. N., & Zipperer, W. C. (1995). Effects of wildland development on forest bird communities. *Landscape and Urban Planning*, 32, 81-92.

Odell, E. A., & Knight, R. L. (2001). Songbird and medium sized mammal communities associated with exurban development in Pitkin Country Colorado. *Conservation Biology*, 15, 1-8. doi – 10.1046/j.1523-1739.2001.0150041143.x

Odell, E. A., Theobald, D. M., & Knight, R. L. (2003). Incorporating ecology into land use planning: a songbird's case for clustered housing developments. *Journal of the American Planning Association*, 69, 72-82. doi – 10.1080/01944360308976294

Olive, A., & Minichiello, A. (2013). Wild things in urban places: America's largest cities and multi-scales of governance for endangered species conservation. *Applied Geography*, 43, 56-66.

Ostrom, E. (2000). Collective action and the evolution of social norms. *Journal of Economic Perspectives*, 14(3), 137-158.

Parris, K. M. (2006). Urban amphibian assemblages as metacommunities. *Journal of Animal Ecology*, 75(3), 757-764.

Pejchar, L., Morgan, P. M., Caldwell, M. R., Palmer, C., & Daily, G. C. (2007). Evaluating the potential for conservation development: Biophysical, economic, and institutional perspectives. *Conservation Biology*, 21(1), 69-78. doi – 10.1111/j.1523-1739.2006.00572.x

Pellissier, V., Cohen, M., Boulay, A., & Clergeau, P. (2012). Birds are also sensitive to landscape composition and configuration within the city centre. *Landscape and Urban Planning*, 104(2), 181-188.

Peterson, M. N., Peterson, M. J., Peterson, T. R., & Liu, J. (2007). A household perspective for biodiversity conservation. *Journal of Wildlife Management*, 70, 1243-1248.

Pickett, S. T. A., Cadenasso, M. L., Grove, J. M., Boone, C. G., Groffman, P. M., Irwin, E., Kaushal, S. S., Marshall, V., McGrath, B. P., Nilon, C. H., Pouyat, R. V., Szlavecz, K., Troy, A., & Warren, P. (2011). Urban ecological systems: Scientific foundations and a decade of progress. *Journal of Environmental Management*, 92, 331-362.

Pickett, S. T. A., Boone, C. G., McGrath, B. P., Cadenasso, M. L., Childers, D. L., Ogden, L. A., McHale, M., & Grove, J. M. (2013). Ecological science and transformation to the sustainable city. *Cities,* 32, S10-S20.

Pimentel, D., McNair, S., Janecka, J., Wightman, J., Simmonds, C., O'Connell, C., Wong, E., Russel, L., Zern, J., Aquino, T., & Tsomondo, T. (2001). Economic and environmental threats of alien plant, animal and microbe invasions. *Agriculture, Ecosystems, and Environment,* 84(1), 1-20.

Plaut, P. O., & Boarnet, M. G. (2003). New urbanism and the value of neighborhood design. *Journal of Architectural and Planning Research*, 20(3), 254-265.

Reed, S. E., Hilty, J. A., & Theobald, D. M. (2014). Guidelines and incentives for conservation development in local land-use regulations. *Conservation Biology*, 28(1), 258-268*.* doi – 10.1111/cobi.12136

Rittenhouse, C. D., Pigeon, A. M., Albright, T. P., Culbert, P. D., Clayton, M. K., Flather, C. H., Masek, J. G., & Radeloff, V. C. (2012). Land-cover change and avian diversity in the conterminous United States. *Conservation Biology*, 26(5), 821-829.

Santorufo, L., Van Gestel, C. A. M., Rocco, A., & Maisto, G. (2012). Soil invertebrates as bioindicators of urban soil quality. *Environmental Pollution*, 161, 57-63.

Seto, K. C., Burak, G., Hutyra, L. R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences of the United States of America*, 109, 40, 16083-16088.

Smith, M. D., & Krannich, R. S. (2000). “Culture clash” revisited: Newcomer and longer-term residents’ attitudes toward land use, development, and environmental issues in rural communities in the Rocky Mountain West. *Rural Sociology*, 65(3), 396-421.

Smith, V. H. (2003). Eutrophication of freshwater and coastal marine ecosystems – A global problem. *Environmental Science and Pollution Research*, 10(2), 126-139.

Sohn, D. W., Moudon, A. V., & Lee, J. (2012). The economic value of walkable neighborhoods. *Urban Design International*, 17(2), 115-128.

Soule, M. E. (1991). Land use planning and wildlife maintenance. *Journal of the American Planning Association*, 57(3), 313-323.

Stokes, D. L., Hanson, M. F., Oaks, D. D., Straub, J. E., & Ponio, A. V. (2010). Local land-use planning to conserve biodiversity: Planners’ perspectives on what works. *Conservation Biology*, 24(2), 450-460. doi – 10.1111/j.1523-1739.2009.01356.x

Sushinsky, J. R., Rhodes, J. R., Possingham, H. P., Gill, T. K., & Fuller, R. A. (2012). How should we grow cities to minimize their biodiversity impacts? *Global Change Biology*, 19, 401-410.

Rossi, P. H., Freeman, H. E., & Lipsey, M. W. (2004). *Evaluation: A systematic approach* (7th ed.). Newberry Park, CA - Sage.

Theobald, D. M., Reed, S. E., Fields, K., & Soule, M. (2012). Connecting natural landscapes using a landscape permeability model to prioritize conservation activities in the United States. *Conservation Letters*, 5(2), 123-133.

Theobald, D. M., Spies, T., Kline, J., Maxwell, B., Hobbs, N. T., & Dale, V. H. (2005). Ecological support for rural land-use planning. *Ecological Applications*, 15, 1906-1914.

Trombulak, S. C., & Frissell, C. A. (2000). Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology*, 14(1), 18-30. doi – 10.1046/j.1523-1739.2000.99084.x

Underwood, J. G., Francis, J., & Gerber, L. R. (2011). Incorporating biodiversity conservation and recreational wildlife values into smart growth land use planning. *Landscape and Urban Planning*, 100(1-2), 136-143.

U.S. Census Bureau. (2011). Retrieved from http://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf

Verburg, P. H., van Eck, J. R.R., de Nijs, T. C. M., Dijst, M. J., & Schot, P. (2004). Determinants of land-use change patterns in the Netherlands. *Environment and Planning B: Planning and Design*, 31, 125-150.

Vitousek, P. M., Mooney, H. A., J. Lubchenko, J., & Melillo, J. M. (1997). Human domination of earth's ecosystems. *Science*, 277(5325), 494-499. doi – 10.1126/science.277.5325.494

Wald, D. M., & Hostetler, M. E. (2010). Conservation value of residential open space: Designation and management language of Florida's land development regulations. *Sustainability*, 2(6), 1536-1552.

Walker, B., Carpenter, S., Anderies, J., Abel, N., Cumming, G., Janssen, M., Lebel, L., Norberg, J., Peterson, G. D., & Pritchard, R. (2002). Resilience management in social-ecological systems: A working hypothesis for a participatory approach. *Conservation Ecology*, 6(1), 14.

Wallace, G. N., Theobald, D. M., Ernst, T., & King, K. (2008). Assessing ecological and social benefits of private land conservation in Colorado. *Conservation Biology*, 22, 284-296.

Williams, N. S. G., Schwartz, M. W., Vesk, P. A., McCarthy, M. A., Hahs, A. K., Clemants, S. E., Corlett, R. T., Duncan, R. P., Norton, B. A., Thompson, K., & McDowell, M. J. (2008). A conceptual framework for predicting the effects of urban environments on floras. *Journal of Ecology*, 97, 4-9.

Youngentob, K, and Hostetler, M. E. (2005). Is a new urban development model building greener communities? *Environment and Behavior*, 37, 731-759. doi – 10.1177/0013916505275311

BIOGRAPHICAL SKETCH

Daniel Feinberg was born and raised in Baltimore, MD, where he attended Friends School of Baltimore and became curious about urban ecological issues. In 2010, he gained research experience through the Semester in Environmental Science at the Marine Biological Laboratory in Woods Hole, MA, and in 2012, he earned a Bachelor of Arts degree in Biology from Hamilton College in Clinton, NY. In 2014, he earned a Master of Science degree in Wildlife Ecology and Conservation, with an emphasis on Human Dimensions, from the University of Florida. During his time in Gainesville he also volunteered at the Alachua County Humane Society and performed original music. His future interests include pursuing doctoral studies and promoting biodiversity in urban areas through research, education, and outreach.