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Research Paper

Improving the utility of existing conservation plans using projected housing development

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HIGHLIGHTS

- We assess vulnerability of and threat to expert-based conservation priorities.
- One third of priority areas are threatened by current housing development.
- Multi-purpose priority areas are more threatened than conservation-only areas.
- Threat and vulnerability metrics can be used to schedule conservation actions.
- This method can add value to existing conservation plans across the US.

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ABSTRACT

Land management agencies frequently develop plans to identify future conservation needs and priorities. Creation and implementation of these plans is often required to maintain funding eligibility. Agency conservation plans are typically expert-based and identify large numbers of priority areas based primarily on biological data. As conservation dollars are limited, the challenge is to implement these plans in a manner that is effective, efficient, and considers future threats. Our goal was to improve the utility of existing, expert- and biologically-based plans using a flexible approach for incorporating spatial data on vulnerability to and threat from housing development. We examined two conservation plans for the state of Wisconsin in the United States and related them to current and projected future housing development, a key cause of habitat loss and degradation. Most (54–73%) priority areas were highly vulnerable to future threat, and 18% were already highly threatened by housing development. Existing conservation investments were highly threatened in 8–9% of priority areas, and 25–34% of priority areas were highly vulnerable and highly threatened, meriting immediate conservation attention. Conversely, low threat levels in 20–26% of priority areas may allow time for new, large-scale conservation initiatives to succeed. Our results highlight that vulnerability to and threat from existing and future housing development vary greatly among expert- and biologically-based priority areas. The framework presented here can thus improve the utility of existing plans by helping to target, schedule, and tailor actions to minimize biodiversity loss in highly threatened areas, maximize biodiversity gains, and protect existing conservation investments.

1. Introduction

Conservation plans are important tools for guiding conservation actions at local to global scales (Moilanen, Wilson, & Possingham, 2009), and ideally identify where, when, and how to act so that conservation goals are achieved, resources are used efficiently, and negative impacts to human communities are minimized (Sarkar et al., 2006). Land management agencies are major conservation actors (Theobald et al., 2000), and frequently develop conservation

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plans to guide their operations, including land protection and management. Agency plans are often developed to meet specific legal or funding requirements (e.g., Wildlife Action Plans in the United States, US Fish and Wildlife Service, 2006). However, priority areas identified in agency plans are also often incorporated into funding and approval processes for land protection, land management, and other conservation actions within and outside of agencies (e.g., Endangered Resources Grant Programs, Wisconsin Administrative Code NR 58, 2008). Thus agency plans may ultimately influence targeting of a much broader set of conservation resources.

Two important decisions in developing conservation plans are the data and the approach planners will use to identify spatial priorities. Government agency plans often are based primarily or exclusively on biological data (i.e., biologically-based, Lerner, Cochran, & Michalak, 2006). This is unfortunate, as many other factors influence both where action may be most needed (e.g., threatening processes and vulnerability to those processes, Wilson et al., 2005) and where agencies are most likely to be able to act (e.g., Knight & Cowling, 2007; Knight et al., 2011). Agency plans are also often expert-based (Cowling et al., 2003; Newburn, Reed, Berck, & Merenlender, 2005; Prendergast, Quinn, & Lawton, 1999), meaning that priorities are identified not by a spatial optimization algorithm, but by consulting with natural resource experts to identify, based on their knowledge, expertise, and familiarity with the available data, the most important locations for conservation action (e.g., Pohlman, Bartelt, Hanson, Scott, & Thompson, 2006). For example, spatial priority areas in most Wildlife Action Plans (created by each state and territory in the United States in 2005) are expert-based (Lerner et al., 2006).

A common characteristic of plans that are biologically-based (and also often expert-based) is that they identify large numbers or sizes of priority areas, covering much of the landscape (Cowling et al., 2003; Lerner et al., 2006). Such plans may be ineffective in helping conservation actors to achieve conservation goals in any one area (Bottrill, Mills, Pressey, Game, & Groves, 2012), and unlikely to identify high-urgency locations where high biodiversity value and high threat intersect (Margules & Pressey, 2000; Pressey, 1994; Pressey & Taffs, 2001).

One approach to address plans which identify many priorities covering large portions of the study region is to incorporate additional (non-biological) data into future plans. However, writing better future plans does not address the situation in which agencies currently find themselves: staff, partners, stakeholders and the public who helped develop existing plans, often over multiple years, have an expectation that current plans will be used. In addition, agencies may be legally required to implement current plans, often valid for up to 10 years, to maintain funding eligibility (e.g., Wildlife Action Plans in the United States, US Fish and Wildlife Service, 2006). What is needed is an alternative, easily-applied approach to increase the effectiveness of existing plans in guiding future conservation actions.

Here we propose using existing biologically- and expert-based plans together with data on vulnerability to and threat from projected future housing development to target, schedule, and tailor future conservation actions. Housing development is a major threat to wildlife and wildlife habitat in the United States (Wilcove, Rothstein, Dubow, Phillips, & Losos, 1998), but is rarely considered in conservation plans (Lerner et al., 2006; Newburn et al., 2005). We define a given area as vulnerable to housing development when there is a lack of protected areas, and as threatened by housing development when either current or projected future housing density is high, or when rapid housing growth is likely. Both vulnerability to and threat from housing development vary greatly in space (Radeloff et al., 2010). Housing development pressure is also usually correlated with land costs (Capozza & Helsley, 1989). Explicit consideration of the location and intensity of threats and land costs in conservation plans can dramatically increase conservation effectiveness and decrease conservation costs (Ando, Camm, Polasky, & Solow, 1998; Naidoo et al., 2006; Newburn et al., 2005). Here we quantify the vulnerability of and threat to individual conservation priority areas from housing development, and use that information to identify where action is most needed (i.e., targeting), when that action needs to occur (i.e., scheduling), and what kind of action may be most suitable (i.e., tailoring).

When applying vulnerability and threat data to existing, expert-based plans, it is important to first understand to what extent these data may have been considered indirectly in plan development. Although expert-based plans are typically also biologically-based, experts creating the plans are often aware of threats facing biodiversity in their region (Cowling et al., 2003; Lerner et al., 2006). They may not agree, however, on the severity, location, extent, or impact of threats (Underwood, Francis, & Gerber, 2011), as expert knowledge can be biased toward places and taxa that the experts know best (Cowling et al., 2003; Maddock & Samways, 2000). Experts may also disagree on the extent to which priority areas in the plan should attempt to minimize biodiversity loss or maximize biodiversity gain (Maguire & Albright, 2005), which may be problematic when plan goals and criteria for identifying priority areas are not specific and clear. A further complicating factor is that expert-based plans are rarely published in the peer-reviewed literature, and thus are rarely evaluated (e.g., Knight et al., 2008). As a result, the conservation value of expert-based plans is poorly understood compared to plans developed using spatial optimization algorithms, and is often discounted.

Our goal was to improve the utility of existing plans as strategic tools for targeting, scheduling, and tailoring conservation actions by incorporating spatial data on vulnerability to and threat from housing development. We had two objectives. First, we sought to quantify, map, and compare vulnerability and threat characteristics of priority areas in existing expert- and biologically-based plans. We examined two conservation plans for the state of Wisconsin in the United States as our case studies. One of the plans, Wisconsin's Wildlife Action Plan, had conservation as its sole goal (WDNR, 2008). The second, Wisconsin's Land Legacy Plan, had dual recreation and conservation goals (Pohlman et al., 2006). Our second objective was to demonstrate the utility of vulnerability and threat metrics for targeting, scheduling, and tailoring conservation actions within existing plans. We used nationwide, publicly available data on vulnerability to and threat from housing development to facilitate application of this approach to other locations. The timing of our study is opportune for Wildlife Action Plans in particular, as all plans must be revised by 2015. We hope that the information presented here, applied in other states, can provide tools for shaping the next round of Wildlife Action Plans to be strategic and effective instruments in targeting conservation investments across the United States.

2. Methods

2.1. Study area

Our study area was the state of Wisconsin, an area of ~145,000 km^2 in the north-central United States. The state is biologically diverse, with over two hundred rare species (WDNR, 2011). Wisconsin is divided into 16 ecological landscapes based on physical and biological characteristics such as topography, soils, and existing and pre-settlement vegetation (WDNR, 2012). A major ecological division occurs between the northern hardwood forests of northern Wisconsin ecological landscapes, and the prairies, savannas, barrens, and oak woodlands that historically dominated southern Wisconsin. Today, much of southern Wisconsin has been