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Land conservation in northern New England: Historic trends and alternative conservation futures

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ABSTRACT

Protected areas (PAs) are an important component of the global conservation strategy and understanding the past drivers of land protection can inform future conservation planning. Socioeconomic and policy drivers of protection vary through time and space, but a lack of spatio-temporal data limit the ability to conduct retrospective analyses of PAs. We developed a spatio-temporal database covering 90% of area in PAs in northern New England in the U.S. to quantify trends in the extent, rate of increase, ownership characteristics, and level of protection from 1800 to 2010. We found an accelerating rate of protection and an increase in the proportion of privately owned PAs. There was an increase in reliance on conservation easements for protection, and an increase in the proportion of PAs that allow resource extraction. We found three distinct time periods of PA growth, each characterized by new policies and a broadening set of conservation tools. The era 1999–2010 had the most rapid rate of land protection, representing more than 4-fold and 20-fold increases over the eras 1980–1999 and 1800–1979, respectively. We projected future PA growth based on past trajectories and found that current goals to protect 70% of New England's forests from development would require a 42% increase in the rate of protection over the 1999–2010 era. Our analysis of the historic and current trends in protection in northern New England underscores: (1) the significant influence of expanded policy and economic drivers guiding protection and (2) the importance of developing new conservation innovations for achieving future gains in protection.

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1. Introduction

For over a century, land protection has been a key global conservation strategy pursued by diverse public and private organizations. Conservation actors employed a wide array of conservation tools to protect a broad and dynamic set of ecological, economic, and social values. As a result, the current mosaic of protected areas (PAs)—those areas with legal, jurisdictional, or other mandates that protect them from conversion from natural land cover—reflects the cumulative effects of both strategic and opportunistic transactions driven by evolving conservation, economic, and policy mechanisms. In order to inform future conservation planning, we sought to understand the socioeconomic and policy factors that influenced the rate, type, and distribution of past protection (Tear et al., 2005; Davies et al., 2010; McDonald and Boucher, 2011).

To be successful, strategic plans must not only identify and pursue high-priority objectives based on ecosystem values and services, but must also link these conservation priorities to salient socioeconomic priorities (Cronan et al., 2010; Prendergast et al., 1999). In the U.S., organizations that engage in strategic planning are more effective at protecting land (Chang and Aldrich, 2010). Though conservation *planning* is an inherently long-range endeavor, conservation *action* is influenced by short-term constraints, such as immediate conservation priorities, internal and external socioeconomic pressures, and real estate market conditions, all of which vary through time and space (Halpern et al., 2013). Despite significant gains in assembling PA information at different scales, it remains difficult to conduct retrospective analyses of land protection – thereby limiting the ability to use past trends to inform future conservation goals and strategies.

There has been a lot of work done to understand the spatial patterns of PAs, but due to a lack of data, studies assessing the temporal trends in PA expansion are limited. The spatio-temporal studies

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that do exist tend to focus on either small geographic regions where data are readily available (McDonald et al., 2007; Cronan et al., 2010) or the global scale where data are coarse and incomplete (Chape et al., 2005; Jenkins and Joppa, 2009; McDonald and Boucher, 2011). Global analyses tend to smooth regional trends and may not detect socioeconomic drivers of PA growth at the sub-country scale (Zimmerer et al., 2004) or trends specific to biomes and ecoregions (Jenkins and Joppa, 2009). Zimmerer et al. (2004) found a 153% increase in the global coverage of PAs, from 3.48% in 1985 to 8.82% in 1997, but found that the rates of expansion, level of protection, and drivers of protection were geographically heterogeneous, indicating that global trends encapsulate diverse patterns and may not reflect specific regional drivers and trends.

Another limiting factor of some global analyses of PAs is the exclusion of some forms of protection that may be common in some regions but not others. Conservation easements, which are voluntary agreements between a landowner and a conservation organization to extinguish some management rights for the purpose of protecting conservation value, have emerged as the leading tool for protecting private land in the U.S. (Kiesecker et al., 2005; Lewis et al., 2002; Merenlender et al., 2004; Rissman et al., 2007; Wallace et al., 2008). They are appealing alternatives to fee simple acquisitions, in which a landowner purchases the property and all its implied management rights, in part because of their cost effectiveness and social acceptance as a market-based, voluntary conservation tool (Plantinga and Miller, 2001). Unfortunately, conservation easements and other forms of private PAs may be overlooked by global databases such as the World Database on Protected Areas (WDPA; e.g., Crouzeilles et al., 2013). Moreover, PA databases focus on active land protection and ignore lands protected through passive means, which are spatially heterogeneous and difficult to track, in part because they are typically enacted through local or regional policies. Passive protections, such as regulatory measures that protect specific natural features or restrict management actions, may be significant, especially in the case of wetland protection and buffers around waterbodies, as are common practices in the U.S.

In this paper, we present a spatio-temporal analysis of land protection in the northern New England (NNE) sub-region of the U.S.—including the states of Vermont, New Hampshire, and Maine. Our objectives were to: (1) create a landscape-scale, spatio-temporal dataset of land protection for NNE to document the region's conservation history; (2) quantify temporal and spatial patterns in the rate, ownership type, and level of protection in the region; (3) identify the policy and socioeconomic conditions characterizing different periods of PA growth and (4) assess future trajectories based on past conservation trends. By examining the sequence of historic conservation patterns in the region, we provide insights about which policies and economic drivers were characteristic of periods with accelerated land protection. We are also able to provide insights about how past conservation innovations may contribute to future PA growth potential.

2. Methods

2.1. Study area

The New England region of the U.S. has a long history of significant shifts in land cover (Foster, 2002). Through the 18th and 19th centuries, there was widespread clearing of forests for agriculture, followed by farm abandonment and subsequent forest regrowth. Simultaneously, there was a major expansion in regional population and urbanization. Today, development pressures radiate not only from major population centers such as Boston and New York City, but also from growing regional service centers such as Burlington, Vermont and Portland, Maine. As a result, the NNE sub-region faces a tension between rising demands for human use, and growing recognition of the need for conservation to provide ecosystem services (Stein et al., 2007). Over the last two centuries, New England has pioneered some notable land protection innovations, including the first land trust in the U.S. and the first large-scale working forest conservation easement (Foster, 2002; Levitt, 2005; Meyer et al., 2012).

NNE encompasses 133,054 km^2 or 71% of the New England region, and contains 77% of New England's 3.6 million-ha portfolio of land protected from development. NNE is predominantly privately owned, with relatively small amounts of land in federal or state ownership – 8% for Vermont, 16% for New Hampshire, and just 5% for Maine (Natural Resources Council of Maine, 2013). Nonetheless, there are several very large blocks of public land within NNE, including the White Mountain National Forest (WMNF), the Green Mountain National Forest (GMNF), and Baxter State Park. The region is heavily forested (Vermont 67%, New Hampshire 67%, and Maine 84% forest cover; Fry et al., 2011), and each state has significant commercial timberland holdings. Since the late 1990s, many large-scale working forest conservation easements have been secured, mostly through partnerships between environmental nongovernmental organizations (ENGOs) and large forest products and land management companies (Ginn, 2005; Fairfax et al., 2005). Beyond these large blocks, there are tens of thousands of smaller dispersed parcels of public and private lands that are protected from development under various mechanisms. The objectives of PAs in the region broadly include conservation of biodiversity, provisioning of ecosystem services, public open space, recreation, and natural resource extraction such as timber harvesting.

2.2. Composite conservation database

When we began our study, there were no comprehensive datasets of conserved lands in the NNE region that included information regarding PA date of establishment. We used multiple sources and approaches to augment existing geospatial datasets to create a comprehensive database that included parcel-level data for date of protection.

The Nature Conservancy's (TNC) Secured Areas Database (Anderson and Sheldon, 2011) provided our reference dataset. Although temporal information is generally lacking, this dataset represents the most current and spatially complete accounting of PAs in the study area, and includes extensive information about the type of ownership, management, and level of protection of each PA. Anderson and Sheldon (2011) describe the level of PA protection using the GAP rating system (Crist et al., 1998), where all PAs assigned to GAP categories 1–3 are permanently protected from development or conversion from natural land cover. Specifically, GAP 1 PAs have a mandate to maintain a natural state, GAP 2 PAs have a mandate to primarily maintain the natural state but allow some provisions to suppress natural disturbances, and GAP 3 PAs allow extractive uses. (For a crosswalk between GAP statuses and the IUCN categories used globally, see Anderson and Sheldon (2011)). Given that this dataset includes PAs assembled over two centuries, it is important to note that GAP status was, in many cases, assigned to each PA long after it was protected and generally reflects the most recent known level of protection. We recognize that there is a large range of voluntary and legal protections represented across the PAs in this study, including many that do not have sufficient level of protection to warrant an IUCN ranking (e.g., GAP 3 status). PA databases commonly include lands owned by municipal and educational entities, even if the land lacks formal protection. We note here that our database excludes passive

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