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Evaluating the influence of conservation plans on land protection actions in Wisconsin, USA

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ABSTRACT

Conservation plans are a common management tool, but are rarely evaluated for their influence on conservation actions. We assessed four statewide conservation plans and 371 local land protection projects developed by a state land management agency in the United States. We asked whether completion of statewide plans and approval of local projects were associated with changes in the amount, location, and landcover composition of subsequently protected lands. We found a weak relationship between statewide plans and land protection actions. Completion of two of four plans was associated with an increase in land protection statewide or within plan boundaries. However, 58% of lands protected within 20 years of plan completion were outside plan boundaries. Further, the proportion of statewide land protection activity focused inside plan boundaries was lower or not different after plan completion for three of four plans. Conversely, for >90% of local land protection projects, most land protection occurred after formal project approval compared to before, with much of that activity occurring almost immediately. Forests and wetlands were protected more often than planned, while pasture and crop lands were protected less often than planned. We suggest that conservation plans are most likely to influence land protection actions when dependable, multi-year funding for land protection is present, when public, institutional, and political support for implementation are strong; and when agencies commit to an implementation strategy that links broad-scale plans to specific, local land protection projects and is actionable within the framework of existing administrative rules governing agency land protection.

1. Introduction

Conservation plans are a common management tool, but there has been little comprehensive evaluation of their effectiveness in influencing subsequent conservation actions (Bottrill and Pressey, 2012). Plans are developed by universities and local, state, national, and international agencies and conservation organizations to voluntarily identify conservation priorities, fulfill legal obligations, or be eligible for funding programs (e.g., Wildlife Action Plans in the United States (US), US Fish and Wildlife Service, 2006). Accordingly, some plans are tied explicitly to funding for implementation, while many others are not. Additionally, some plans are comprehensive (i.e., biodiversity conservation is the goal), while others focus on specific regions, habitat types, taxonomic groups, or species. Despite such differences in conservation plans, nearly all plans are intended to guide subsequent conservation actions, often focusing on land protection, and require significant commitments of staff and resources (Bottrill and Pressey, 2012; Bottrill et al., 2012). Conservation is a key driver of land protection efforts. However, the missions of agencies and organizations implementing conservation plans, and thus the drivers behind their land protection efforts, often include other goals as well (e.g., resource extraction, provision of recreational opportunities, preservation of scenic and historic sites, Pressey, 1994). Thus, an important question is whether comprehensive conservation plans are effective in influencing subsequent land protection activities.

The effectiveness of conservation plans in influencing subsequent conservation actions can be evaluated in numerous ways. One approach is to survey people who developed or were responsible for implementing plans. Qualitative surveys suggest that potential benefits of plans are broad, including influences to natural, financial, social, human, and institutional capital (Bottrill and Pressey, 2012; Bottrill et al., 2012). However, many published plans (67%) are not implemented, and few implemented actions (13%) are considered highly effective (Knight et al., 2008). Examples of successful plan implementation exist, in which lands or waters identified as priorities were subsequently protected (an institutional capital outcome) and conservation awareness and

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support for action among stakeholders increased (a human capital outcome, Fernandes et al., 2005; Gleason et al., 2010). In other cases plan implementation was successful by some human and social capital metrics (e.g., raising conservation awareness, stakeholder participation in project workshops), but achieved only mixed success or failed by institutional capital metrics (e.g., mainstreaming of plan products into agency land-use planning decisions, incorporating plan priorities into agency initiatives, Knight et al., 2011a). In general, the most commonly reported benefits of conservation plans are human, institutional, and social capital outcomes; positive natural and financial outcomes are reported less frequently (Bottrill and Pressey, 2012; Bottrill et al., 2012). We build on these qualitative assessments of plan implementation by quantitatively evaluating an institutional and a natural capital outcome from multiple conservation plans: the allocation of institutional resources to priority areas in plans and the representation of biodiversity assets within newly protected areas. We based our evaluation on land records commonly collected by agencies and organizations that protect land, to facilitate application of this approach in other locations.

In our evaluation, we considered three goals of conservation plans and how well they are realized in subsequent conservation actions: (1) the amount of land protected, (2) the location of protected lands, and (3) the vegetation type of protected lands. Comprehensive planning efforts often span multiple years and involve numerous meetings with stakeholders and the public (Bottrill and Pressey, 2012; Groves et al., 2002). As a result, the planning effort may raise conservation awareness (Bottrill and Pressey, 2012; Bottrill et al., 2011), potentially increasing public support for conservation action (Fernandes et al., 2005; Knight et al., 2011a) resulting in an increase in the amount of land protected. Conservation planning may also influence where land is protected by focusing land protection efforts inside plan boundaries (Margules and Pressey, 2000). Finally, conservation planning may influence which landcover types are protected. Systematic conservation planning includes an assessment of how well existing protected areas meet conservation goals (Groves et al., 2002; Margules and Pressey, 2000). Landcover is often used as a surrogate for biodiversity (e.g., Knight et al., 2011b), and thus plans typically identify gaps in landcover representation within the existing protected area network. A plan which finds, for example, that grasslands are currently under-represented, might prioritize grassland conservation and stimulate protection of grasslands both inside and outside of plan boundaries.

We focused our evaluation on plans developed by land management agencies and their subsequent land protection activities. Land management agencies in the US have protected much of the existing protected area network (Conservation Biology Institute, 2012) and frequently develop conservation plans to guide their operations, including land protection. Agency plans, however, are rarely published in the peer-reviewed literature and thus are rarely evaluated (e.g., Knight et al., 2008).

Key components of effective processes for implementing conservation plans include stakeholder involvement, empowering individuals and institutions to act, securing high-level support for action, evaluating and monitoring outcomes to ensure accountability and inform future actions, and mainstreaming planning products into the policies and practices of land planning and management agencies (Knight et al., 2006, 2011a; Martin et al., 2012; Pierce et al., 2005). When considering plan implementation specifically in terms of land protection, important considerations include funding, support, and legal authority for protection; land ownership patterns; and likely land availability (Fernandes et al., 2005; Gleason et al., 2010; Knight et al., 2011b).

Implementation of conservation plans via land protection actions in an agency context may involve multiple steps (Fig. 1). Important considerations include the impetus for plan development, the degree to which plan goals align with the agency's mission, support and funding for planning and implementation, public and stakeholder involvement, and laws, administrative rules, and policies governing land protection actions (Fig. 1). Public involvement in conservation planning and land protection actions is a major emphasis of publicly funded agencies, is often mandated by law (e.g., US National Environmental Policy Act of 1969), and often contributes to the multi-year timeframes needed for plan development and approval.

Existing laws, administrative rules, and policies governing land protection at national, state, and local scales may mediate the potential impact of any individual plan on subsequent land protection patterns. For example, federal laws may prioritize protection of individual parcels that both provide recreational opportunities and contribute to conservation of endangered species (e.g., Title 16 U.S. Code §460 k-1). State administrative rules may prioritize acquisitions within existing land protection projects over new projects (e.g., Wis. Admin. Code NR §1.40(2)(a), Appendix A). Federal policies (e.g., the National Wildlife Refuge System Draft Strategic Growth Policy, US Fish and Wildlife Service, 2014) may define nationwide acquisition priorities for federal agencies. Such laws, administrative rules, and policies may also promulgate past patterns of land protection despite plans which may identify other priorities. For example, if past land protection reflected a pattern of residual reservation, in which lands of low economic value received the greatest protection (Joppa and Pfaff, 2009; Pressey, 1994; Scott et al., 2001), these patterns are more likely to continue if laws, administrative rules, or policies facilitate protection of landcover types of low economic value (e.g., if land price per unit area is a criteria for evaluating land acquisitions). While laws, administrative rules and formally approved policies are subject to change, substantive changes tend to be infrequent, occurring much less often than the development of new conservation plans.

A difficulty in evaluating the influence of conservation plans on subsequent conservation actions is that plans are usually implemented incrementally (Bottrill and Pressey, 2012; Pressey et al., 2013). Further, conservation actions such as land protection, land management, and habitat restoration take time to implement and to become apparent on the landscape. We addressed this challenge by choosing a study site with a long history of conservation planning and more than a century of land protection records.

Our overarching question was whether priorities identified in comprehensive conservation plans developed by land management agencies were reflected in their subsequent land protection activities. We examined four statewide conservation plans for Wisconsin, US, hundreds of individual (local) land protection projects within the state, and over a century of agency land protection records. We had three objectives. First, we asked whether planning efforts were associated with changes in land protection activity (a) across the state, (b) within statewide plan boundaries, and (c) within individual (local) land protection projects. Second, we asked if the proportion of land protection focused inside plan boundaries changed after plan completion. Finally, we asked whether the landcover composition inside plan boundaries was reflected in the landcover composition of subsequently protected lands. We discuss implications of our findings for implementing conservation plans via land protection actions in a land management agency context and suggest strategies for facilitating plan implementation that may apply in other contexts and locations as well.

2. Material and methods

Wisconsin (~145,000 km^2) is located at the confluence of the Northern Forests, Eastern Temperate Forests, and Great Plains in

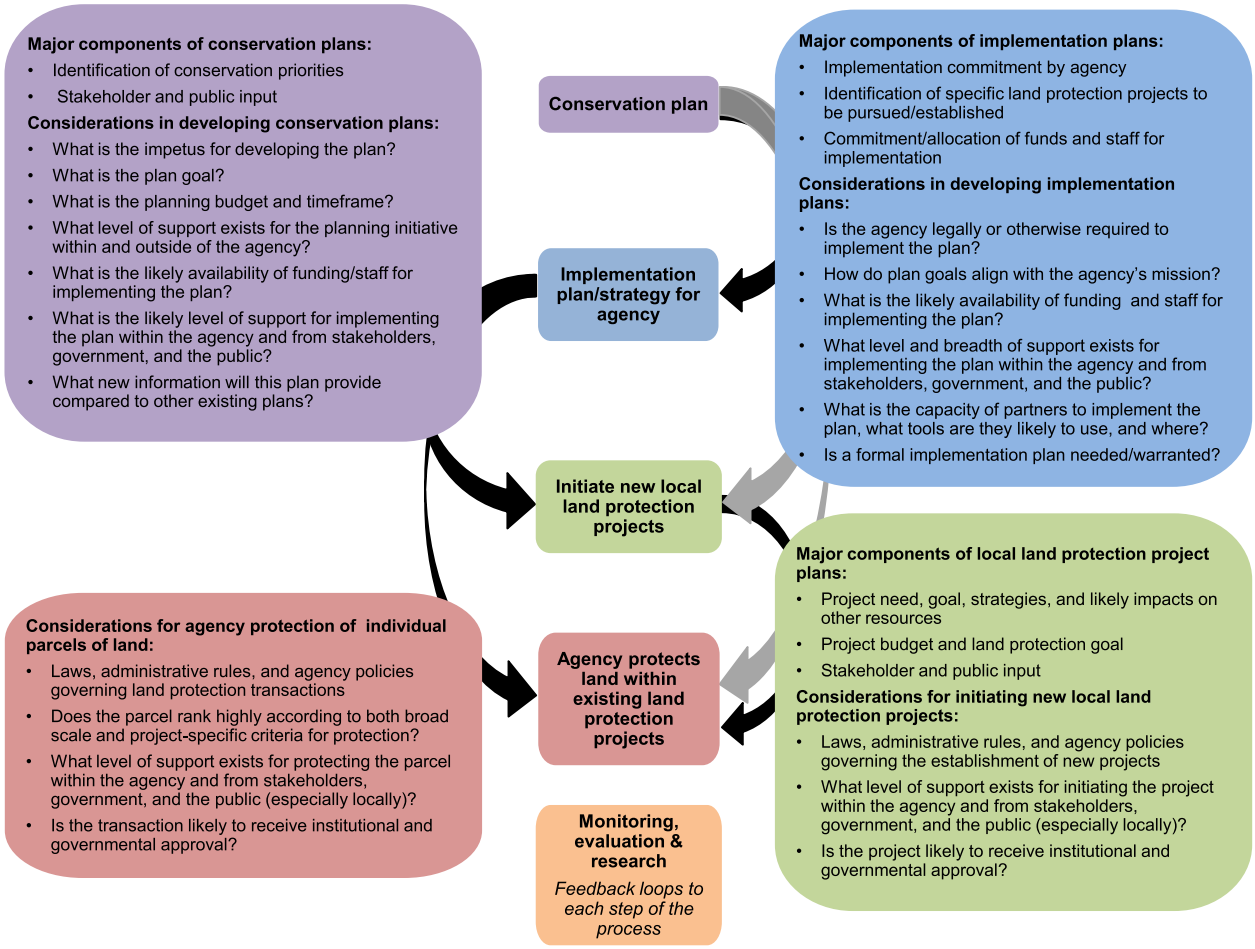

Fig. 1. Major steps and pathways by which land management agencies may implement conservation plans through land protection actions. Major components and considerations for each step of the process are color coded to match the corresponding step. Ideal/major pathways for action are indicated with black arrows; alternate pathways for action are indicated with grey arrows. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

the north-central US (Commission for Environmental Cooperation, 1997). Northern hardwood forests dominate northern Wisconsin, while southern Wisconsin has largely been converted to agriculture (Rhemtulla et al., 2007). Wisconsin is biologically diverse, with over 150 wildlife species of conservation concern (Wisconsin Department of Natural Resources, 2005). Major biodiversity threats include habitat loss, invasive species, and pollution (Wisconsin Department of Natural Resources, 2005).

2.1. Data

We examined four comprehensive statewide plans completed in 1939, 1964, 2004, and 2008 (Table 1, Appendix B). All were expert-based, had conservation only or dual conservation and recreation goals, and were led by or developed in close collaboration with the Wisconsin Department of Natural Resources. Priority area criteria were primarily biological (e.g., high-quality natural areas, important populations of rare species), but also included recreation, water quality, scenic, scientific, geologic, and historic value (Appendix B). Plans included an average of 211 priority areas (range 155–255) covering 22% of the state (range 12–30%).

We defined total protected lands as all lands protected for conservation or recreation purposes via acquisition or easement or within tribal reservations (Conservation Biology Institute, 2012; National Conservation Easement Database, 2013; Wisconsin Department of Natural Resources, 2013a, 2014a). Total protected lands encompassed 27,769 km^2, and included county, state, and national forests.

Wisconsin Department of Natural Resources land protection data included lands protected by the agency or with state funds between 1876 and 2013 (17,437 records). Each land protection record included the date, size, protection type, and cost. We combined protection types (primarily fee simple (87%) and easement (12%)) for analysis, as suggested by agency personnel.

Individual local land protection projects (e.g., proposed state parks) are initiated through a formal planning and approval process governed by agency policy (i.e., Manual Code 2105.2, Wisconsin Department of Natural Resources, 2003), and have a formal boundary within which multiple parcels are generally acquired over time. Each land protection record between 1938 and 2011 included the associated land protection project, the year the project was approved, and the total area within the project boundary. We considered only projects with a boundary larger than 0.17 km^2 (average 19.6 km^2, range 0.17–930.7 km^2), as smaller projects were primarily for buildings or public access.

We used remotely-sensed landcover data with a spatial resolution of 30 m (Fry et al., 2011). We considered gross domestic product for the US or Wisconsin (in real US dollars, Bureau of Economic Analysis, 2013a; Bureau of Economic Analysis, 2013b) as an indicator of the general state of the economy. We considered funds from the two major state programs funding land protection for conservation and recreation purposes in Wisconsin (Theobald and

Table 1
Descriptions of each comprehensive statewide conservation plan examined, including the year completed, plan goal, plan impetus, primary planning agency, number of priority areas, and total area included within plan boundary (km^2). Please see Appendix A for additional information on each plan.

Year completed	Plan goal	Plan impetus	Primary planning agency	Number of priority areas in plan	Total area inside plan boundary (percent of state)	Source
1939	Provide an adequate and flexible system for the protection, development and use of forests, fish and game, lakes, streams, plant life, flowers, and other outdoor resources in the State of Wisconsin	Legislative mandate by the state to develop a recreational plan for the state and 'designate the lands most appropriate for state parks, which with a system of valley parkways, will comprise a complete plan of recreational and educational areas, thus incorporating and conserving our most picturesque and historical natural landscapes'	Wisconsin Conservation Commission (now the Wisconsin Department of Natural Resources)	155	17,121 km^2 (11.8%)	Wisconsin State Planning Board and Conservation Commission (1939)
1964	Identify and protect irreplaceable scenic, scientific, and historic resources for future generations	Nationwide park planning effort stemming from 'an unprecedented surge of interest and concern across the country in meeting the outdoor recreation needs of the Nation'	National Park Service, in cooperation with federal, state and local parks and land management agencies	204	30,842 km^2 (21.2%)	National Park Service (1964)
2004	Identify the most important places to meet Wisconsin's conservation and recreation needs over the next 50 years	Recommendation by a panel convened by the state's governor to assess progress made under Wisconsin's major conservation funding program and determine if the program should be continued	Wisconsin Department of Natural Resources	230	44,228 km^2 (30.4%)	Pohlman et al. (2006)
2008	The federally-mandated goal for all state Wildlife Action Plans nationwide was to address the needs of declining wildlife species before they reach the point of possible listing as endangered or threatened. Wisconsin's Wildlife Action Plan 'stresses the importance of protecting habitat as a means of protecting whole suites of species rather than focusing conservation efforts on individual species'	Plan completion was required by the federal government if states wished to be eligible for funding from the State and Tribal Wildlife Grants Program	Wisconsin Department of Natural Resources	255	37,033 km^2 (25.5%)	Wisconsin Department of Natural Resources (2005, 2008)

Robbins, 1970, 1973, 1977, 1985; Wisconsin Legislative Reference Bureau, 2011; A. Runyard, *pers. comm.*), which comprise >90% of state funding for land protection in Wisconsin (Wisconsin Department of Natural Resources, 2014a). We used funds from the federal Land and Water Conservation Fund that were granted to states for land protection (US Department of the Interior, 2010, 2011, 2012; Vincent, 2010) as an indicator of federal conservation funding. We adjusted land cost and state and federal conservation funding prior to 2013 to 2013 dollars using the annual Consumer Price Index for Urban Wage Earners and Clerical Workers (US Bureau of Labor Statistics, 2013; US Bureau of the Census, 1975).

2.2. Analyses

We analyzed whether plan completion was associated with the amount of land protected statewide, within statewide conservation plan boundaries, and within individual (local) land protection projects. We considered three response variables: (1) value of land protected (cost to acquire, in US dollars), (2) area of land protected (km^2), and (3) number of land protection transactions.

For the first two spatial scales, we used multiple linear regression and considered only lands protected from 1900 to 2012 for which spatial data were available (15,740 records). We log- or square root-transformed response variables to improve normality, and log-transformed gross domestic product when needed to improve linearity based on visual analysis of the plotted variables. We checked regression residuals for temporal autocorrelation using the autocorrelation function (acf). If we detected a significant pattern of autocorrelation, we fit a model that appropriately accounted for the observed lack of independence.

Statewide, we regressed response variables against plan completion dates, gross domestic product, and state and federal funding for land protection. We modeled plan effect as zero before plan completion and one thereafter.

Within statewide conservation plan boundaries, we regressed response variables against whether each statewide plan was in place, gross domestic product, and state and federal funding for land protection. We considered only data for the twenty years before and after completion of each plan, as expanding housing development and changing land use in Wisconsin (Radeloff et al., 2005) suggest that plans older than 20 years were unlikely to be considered current guides for land protection. We analyzed only 10 years of pre-plan data for the 1939 plan, as gross domestic product was only available from 1929. Only 9 and 5 years of post-plan data were available for the 2004 and 2008 plans, respectively. For analyses of land protected statewide and within 1939 and 1964 plan boundaries, we used US gross domestic product, as Wisconsin gross domestic product was only available back to 1963, and both were highly correlated thereafter (Pearson correlation, $r = 0.996$).

At the individual project scale, we used chi-squared tests to compare the proportion of land protection projects for which the majority of land protection activity occurred before versus after formal project approval. We limited analysis to projects approved between 1948 and 2002 to ensure at least ten years of pre- and post-project approval data for all projects.

We used *t*-tests, assuming unequal variance, to compare the proportion of land protection activity (value of lands protected,

area of land protected, and number of land protection transactions) occurring within statewide plan boundaries in the 20 years before versus (up to) 20 years after plan completion.

Finally we compared the landcover composition of (1) all lands, and (2) unprotected lands only inside the two recent plans with the composition of lands protected since completion of each plan. We also calculated the composition of (1) all protected lands statewide (to assess past land protection efforts), and (2) all unprotected lands statewide (to assess the availability of individual landcover types). We conducted all statistical analyses in R (R Core Team, 2013).

3. Results

3.1. Do plans influence how much land is protected?

Statewide, the total annual value of land protected increased substantially beginning about 1960, a decade in which federal and state funding programs for land protection began (Fig. 2). Total annual area of land protected and number of land protection transactions increased substantially beginning about two decades earlier, coinciding with the 1939 conservation plan (Fig. 2). Two of three metrics of statewide land protection activity increased significantly upon completion of two of the four statewide plans (Appendix C). The value and area of land protected statewide increased significantly upon completion of the 1939 plan ($p < 0.001$ for both metrics). The area of land protected ($p = 0.002$) and number of land protection transactions ($p = 0.04$) statewide also increased significantly upon completion of the 2008 plan.

Within statewide conservation plan boundaries, land protection activity started in the early 1900s and continued through 2012 for each plan (Fig. 3). We detected a significant change in land protection activity within plan boundaries upon plan completion for only one of the four plans, and for only a single metric: more land protection transactions occurred after completion of the 2008 plan ($p = 0.002$, Appendix D).

At the local scale of individual land protection projects, significantly more projects had greater land protection activity occurring after formal project approval compared to before (for 94.5%, 90.9%, and 93.8% of projects, the majority of the value of land protected, area of land protected, and number of land protection transactions, respectively, occurred after formal project approval, $p < 0.001$ for all metrics, Appendix E). Further, about half of all land protection activity on projects (50.1% of the value of land protected, 59.3% of the area protected, and 50.1% of land protection transactions) was concentrated within the first five years following project approval (Fig. 4).

3.2. Do plans influence where land is protected?

Land protection in the 20 years after plan completion included many parcels well outside of plan boundaries for all plans (Fig. 5). The proportion of land protection activity focused within plan boundaries varied dramatically for all plans prior to about

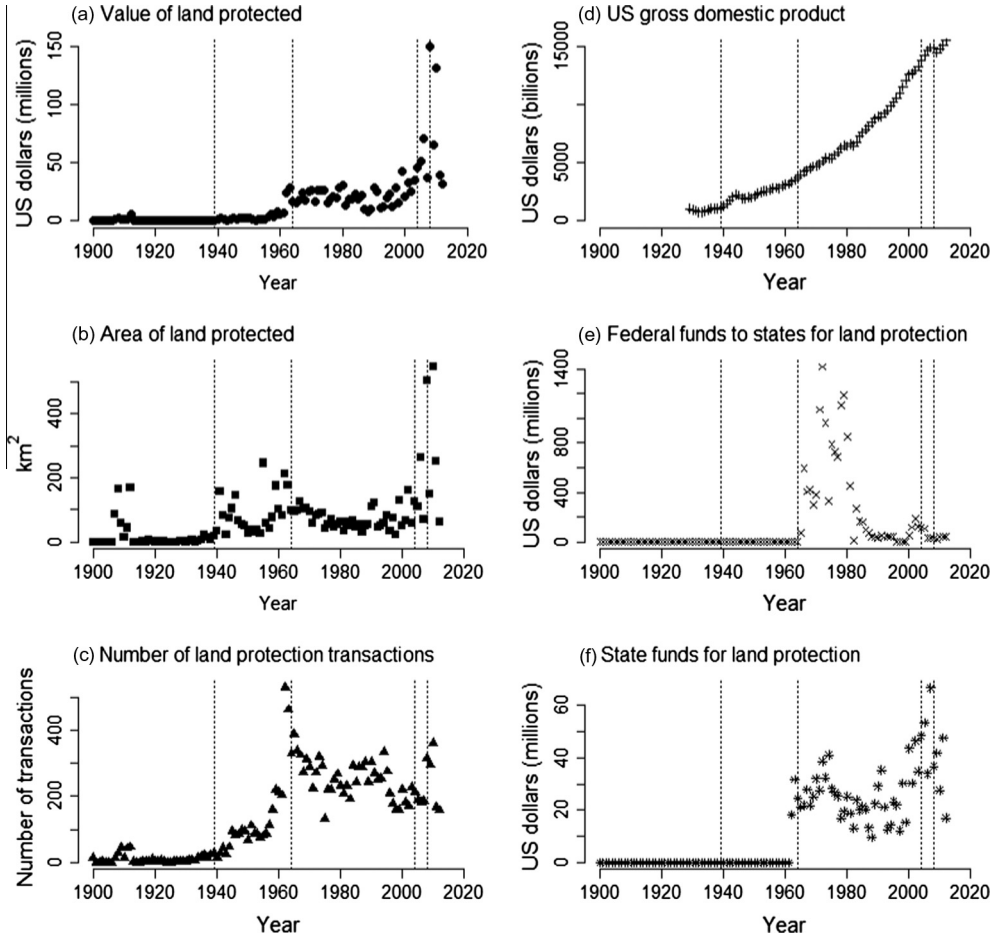

Fig. 2. Total annual statewide (a) value of land protected, (b) area of land protected, and (c) number of land protection transactions; and (d) US gross domestic product, (e) federal funding granted to states for land protection, and (f) state funds for land protection for each year between 1900 and 2012. Dotted lines indicate years in which conservation plans were completed.

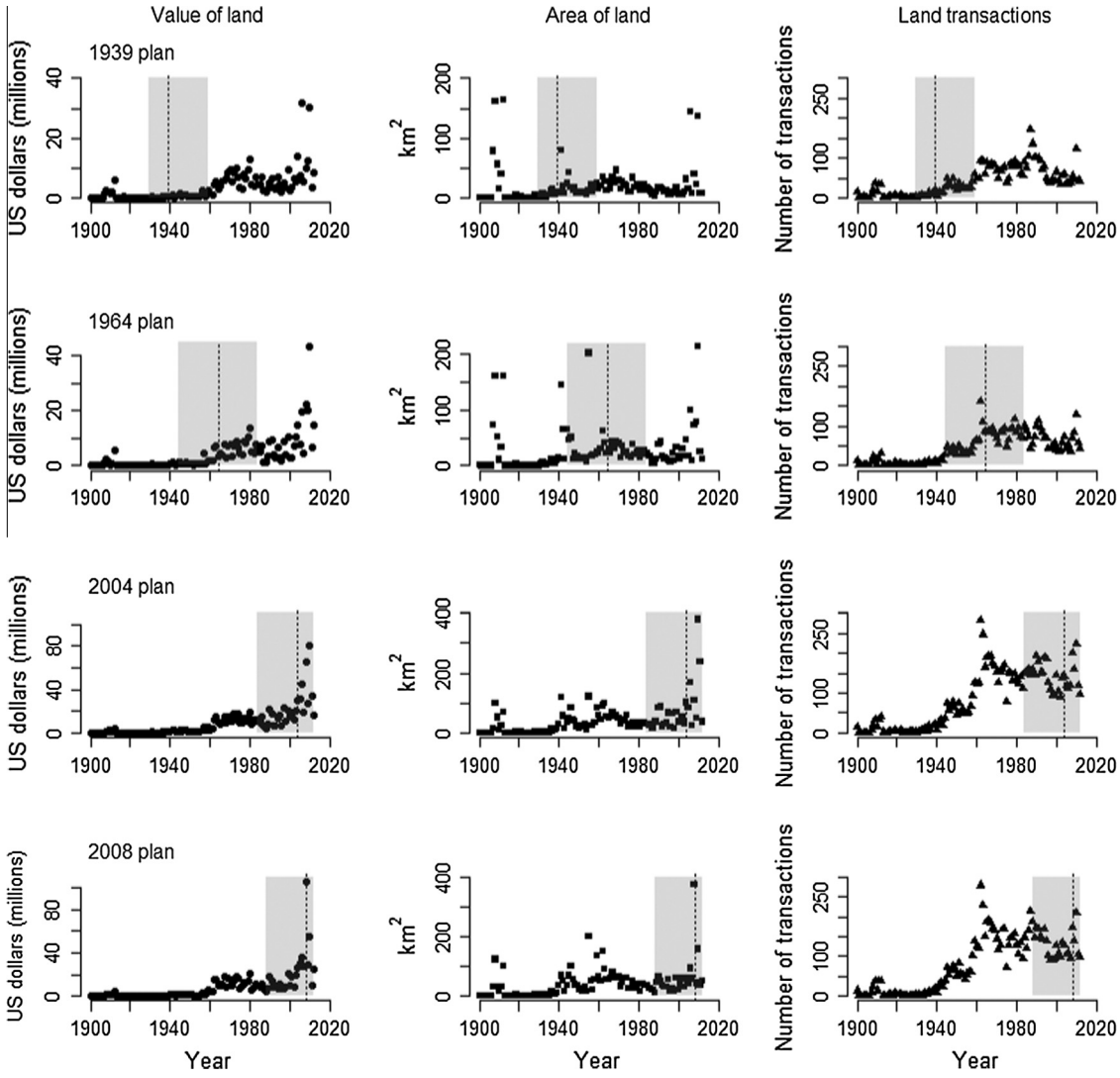

Fig. 3. Total annual value of land protected (left column), area of land protected (middle column), and number of land protection transactions (right column) within plan boundaries only for each plan between 1900 and 2012. Dotted lines indicate the year in which each plan was completed. Grey shading indicates years analyzed statistically. Note that the scale of the *y* axis for the 2004 and 2008 plans differs from that of the 1939 and 1964 plans for value and area of land protected.

1940 (Fig. 6), likely due to a lower overall level of land protection activity (Fig. 2). Only a single plan/response variable combination (of 12 tested) showed a significant increase in the proportion of land protection activity occurring within plan boundaries after plan completion (proportion of land protection transactions inside the 2008 plan: before: 0.59, after: 0.63, $p = 0.04$, Appendix F). There was also no clear pattern of increasing concentration of land protection activity within plan boundaries over longer time periods following plan completion (Fig. 6). In contrast, the proportion of total land protection activity occurring within plan boundaries decreased after plan completion for two of the three response variables for the 1939 plan (proportion of total area of land protected: before: 0.70, after: 0.27, $p < 0.001$; proportion of land protection transactions: before: 0.65, after: 0.38, $p = 0.003$), and for one of the three response variables for the 1964 plan (proportion of land protection transactions: before: 0.39, after: 0.32, $p = 0.02$, Appendix F).

3.3. Do plans influence what kind of land is protected?

Land protection following the 2004 and 2008 plans was higher than planned for forests and wetlands, and lower than planned for pasture/hay and crop lands (Table 2). Deciduous forests dominated the 2013 protected area network (43% of existing protected area) and were the dominant landcover type in both plans (29% and 36% of the 2004 and 2008 plans, respectively). In subsequent years, the Wisconsin Department of Natural Resources continued to protect deciduous forests more than any other landcover type and in higher proportions than identified in plans (44% and 45% of all lands protected since 2004 and 2008, respectively). Wetlands were the second most common landcover type in the 2013 protected area network (28% of existing protected area), and the second or third highest landcover priority in plans (19% and 20% of the 2004 and 2008 plans, respectively). In subsequent years, the agency continued to protect wetlands as the second most common landcover type, and in higher proportions than identified in plans (28% and 29% of lands protected since 2004 and 2008, respectively). In contrast, pasture/hay (important habitat for grassland-dependent wildlife, Renfrew and Ribic, 2008) and cultivated crop lands (important as matrix habitat and restoration sites, Sample et al., 1997) together comprised only 4.6% of the 2013 protected area network. Together these two categories represented 32% and 21% of lands in the 2004 and 2008 plans, respectively, and an even higher percentage of the unprotected lands (42% and 34% of

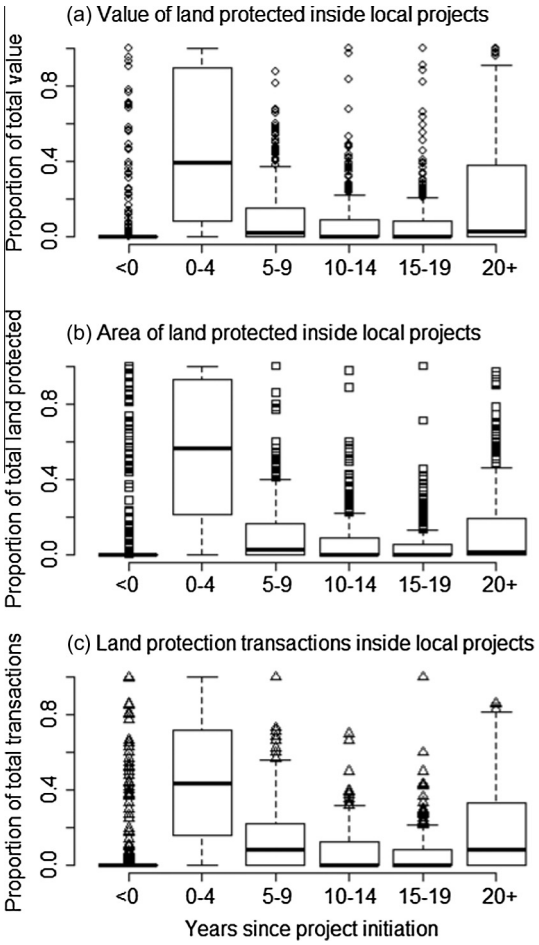

Fig. 4. Temporal distribution of land protection activity inside individual projects (n = 371 projects). We present three metrics of land protection activity: (a) value of land protected, (b) area of land protected, and (c) number of land protection transactions. Each project is represented once in each bin, corresponding to the proportion of all land protection activity on that project which occurred during that time period. Note that the first and last bins include a time period of more than 5 years.

unprotected lands in the 2004 and 2008 plans, respectively), yet only comprised 10% of subsequently protected lands. Availability of pasture/hay and crop lands was not limiting (15,324 and 37,172 km^2 unprotected in 2013, respectively).

4. Discussion

Development of conservation plans is time and resource intensive (Bottrill and Pressey, 2012; Groves et al., 2002), raising the importance of evaluating the influence of plans on conservation actions. Evaluation can assess whether planning met its goals, improve accountability, and provide key information needed to improve and adapt future planning initiatives (Bottrill and Pressey, 2012; Grantham et al., 2010). We evaluated the influence of plans on subsequent land protection actions in the context of a state land management agency. We found that while comprehensive statewide conservation plans were associated with increased land protection activity across the state and within plan boundaries in some cases, they generally did not focus land protection efforts within plan boundaries (58% of lands protected within 20 years of plan completion were outside of plan boundaries). Furthermore, the landcover composition of priority areas in statewide plans was only weakly reflected in subsequent land protection activity. Conversely, at the local scale of individual land protection projects, more than 90% of all projects had greater land protection activity occurring after formal project approval compared to before, and half of all activity was concentrated within the first five years following project approval. Funding and institutional, public, and political support for implementation; alignment of plan goals with the agency's mission; and laws, administrative rules, and policies governing land protection actions may mediate the influence of plans on agency land protection actions in Wisconsin and elsewhere. We suggest that conservation plans are most likely to influence land protection actions when dependable, multi-year funding for land protection is present, when public, institutional, and political support for implementation are strong, and when agencies commit to an implementation strategy that both links broad-scale plans to specific, local land protection projects and is actionable within the framework of existing laws, administrative rules, and policies governing agency land protection actions.

4.1. Do plans influence how much land is protected?

While conservation plans are commonly perceived to influence institutional investments (Bottrill et al., 2012), we found a weak relationship overall between plans and subsequent land protection actions at broad scales. A quantitative evaluation of multiple species recovery plans also failed to find clear impacts of plans on conservation outcomes (Bottrill et al., 2011). We attempted to account for changes in the overall economy and in conservation funding in our models, and both gross domestic product and state funding for conservation were often associated with changes in land protection activity (Appendices C, D). Coincidental changes in planning and funding for conservation illustrate their often interconnected nature, but make it difficult to identify effects of a given conservation plan (Ferraro and Pattanayak, 2006). For example, completion of the 1964 plan coincided with a rapidly growing economy (Fig. 2d), passage of major federal legislation earmarking federal funds for land protection (i.e., Wilderness Act of 1964 and Land and Water Conservation Fund Act of 1965, Rodgers, 1993–1994; Fig. 2e), and creation of a state program for land protection in Wisconsin (Voigt 1962; Fig. 2f). While completion of the 1964 plan was not associated with an increase in any metric of land protection activity, both gross domestic product and state funding for land protection were significantly positively associated with land protection activity both statewide and within the boundaries of the 1964 plan (Appendices C, D).

Our results contrast with two marine planning initiatives, in which planning resulted in rapid and significant increases in protected areas (e.g., the proportion of north central California state waters protected increased from 3.2% to 20% upon implementation of the Marine Life Protection Act Initiative (Gleason et al., 2010); the proportion of the Great Barrier Reef in no-take areas increased from 4.5% to 33% upon plan implementation (Fernandes et al., 2005)). A lack of private landowners and authority for rapid and broad-scale land protection by federal or state authorities in marine environments may have facilitated rapid and successful plan implementation in the marine sites (Fernandes et al., 2005; Gleason et al., 2010). A legal mandate for plan implementation may also have contributed to the success of the California plan, although two previous planning efforts initiated under the same mandate failed (Gleason et al., 2010). Development of several of the plans examined here was required by the state or federal government (Table 1), but implementation was required in only one case (the 2008 plan) and only for activities funded by the associated federal grants program (in Wisconsin, funds from this program were not used for land protection, T. Bergeson, *pers. comm.*).

In contrast to our findings for statewide plans, the approval of local land protection projects was associated with significantly

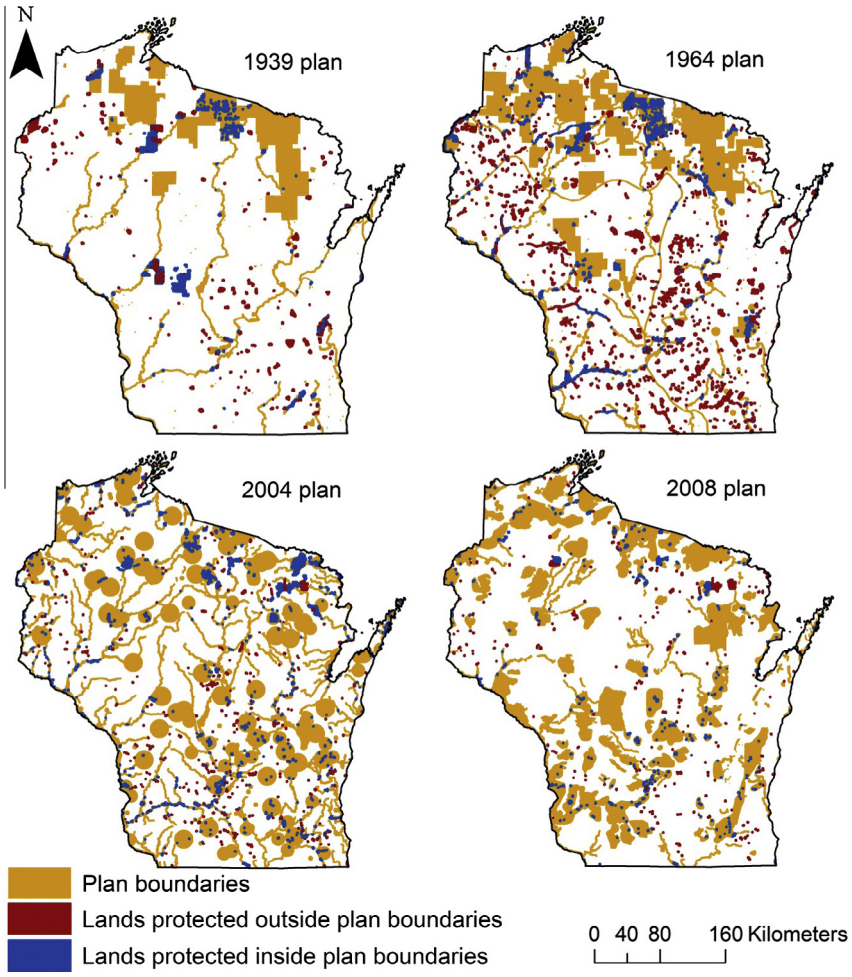

Fig. 5. Plan boundaries and the location of lands protected inside and outside of plan boundaries within twenty years after plan completion for each plan. The size of small protected areas has been exaggerated slightly to more clearly show their spatial distribution.

higher land protection activity inside project boundaries. Administrative rules and policies governing land protection within the agency likely contributed to this finding in two ways. First, administrative rules require that the agency's first priority for land protection be protection of lands inside existing local projects (Wis. Admin. Code NR §1.40, Appendix A). Land acquisition can and does occur outside of project boundaries, but it occurs much less frequently and requires additional levels of approval (Wis. Admin. Code NR §1.41, Appendix A). Second, land protection activity is authorized, and often begins, immediately upon local project approval (land protection activity began within the first five years of project approval for 97% of projects). In contrast, the process from statewide plan to establishment of a new project includes multiple steps and approval processes (Fig. 1), and can take many years (Wisconsin Department of Natural Resources, 2003; Wisconsin Department of Natural Resources, 2013b). Similar planning processes that include both a strong regional component and a strong local site-based component also exist in other agencies (e.g., US Fish and Wildlife Service National Wildlife Refuge System, D. Granholm, *pers. comm.*) and organizations (e.g., The Nature Conservancy, Bottrill et al., 2012). Associated policies (or, in the case of agencies, laws and administrative rules as well) guiding these planning processes and subsequent land protection transactions may mediate the extent and timing of the influence of broad scale plans on subsequent land protection actions.

4.2. Do plans influence where land is protected?

An average of 58% of lands protected within 20 years of plan completion were outside of plan boundaries, possibly reflecting limited lands for sale within plan boundaries, flexibility in potential conservation sites across the landscape (Pressey et al., 1993), and the breadth of the agency's mission. Landowner willingness-to-sell can substantially constrain conservation opportunities (Knight et al., 2011b), and land protection in our study area requires that landowners are willing to sell. Thus agencies may wisely pursue opportunities to protect land outside plan boundaries that would provide similar conservation or recreation benefits. Lands protected to meet other aspects of the agency's mission or vision (e.g., 'supporting the economy', Wisconsin Department of Natural Resources, 2013c) or in accordance with other resource or program-specific plans (e.g., Wisconsin's Forest Legacy Areas, Wisconsin Department of Natural Resources, 2012) may have also contributed to the large proportion of lands protected outside the boundaries of comprehensive statewide conservation plans. Land protection efforts of a large land trust (The Nature Conservancy) were concentrated more strongly inside plan boundaries (74% of acquisitions were inside ecoregional plan boundaries, Fisher and Dills, 2012), possibly reflecting its more focused mission (i.e., 'to conserve the lands and waters on which all life depends').

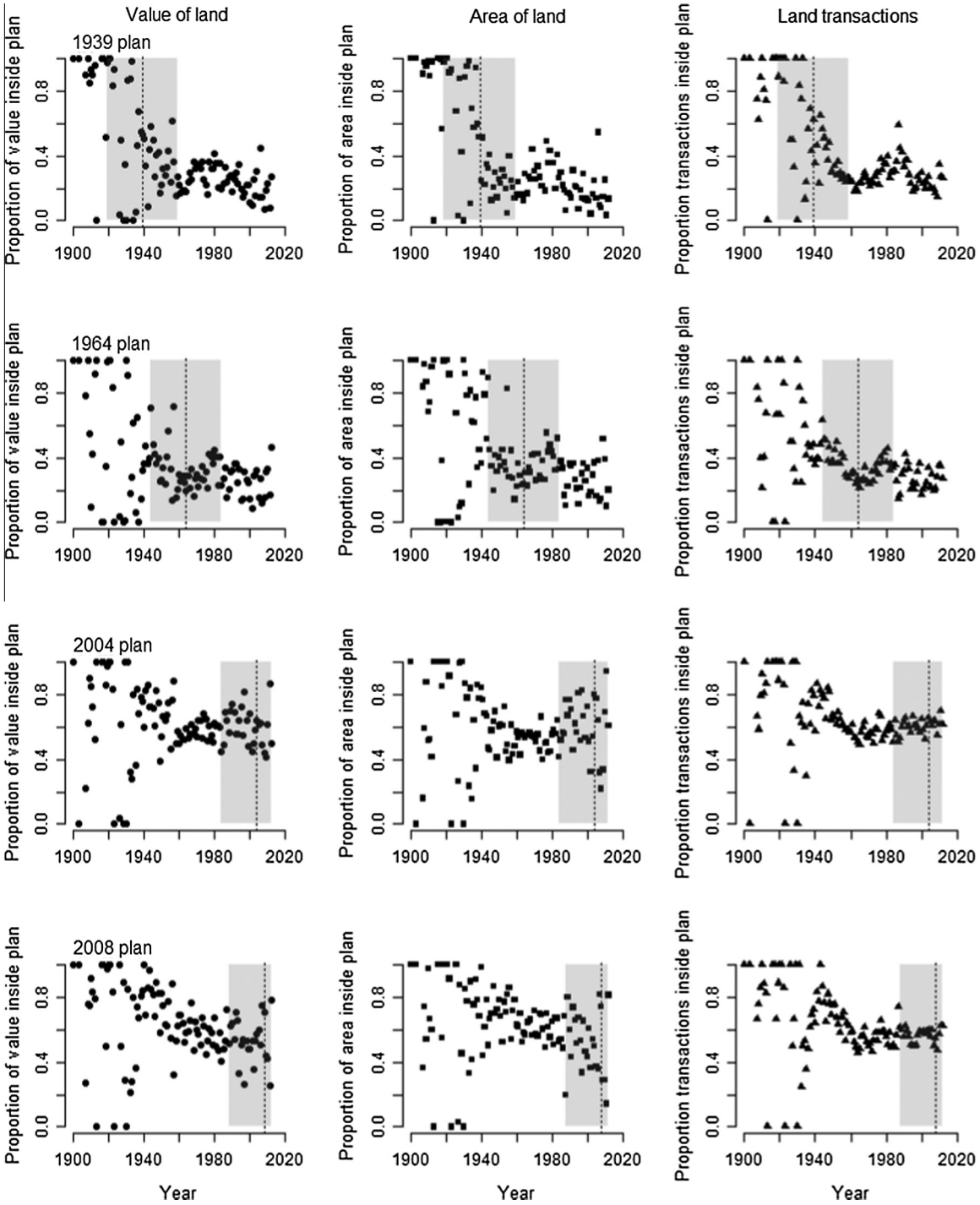

Fig. 6. Spatial focusing of land protection activity within plan boundaries for each of four plans (completed in 1939, 1964, 2004, and 2008) before and after plan completion. We present three metrics of land protection activity for each plan: the proportion of the total statewide value of land protected (left column), area of land protected (middle column), and number of land protection transactions (right column) that occurred within plan boundaries in each year for each plan. Dotted lines indicate the year in which each plan was completed. Grey shading indicates years analyzed statistically.

The proportion of total land protection activity focused within statewide plan boundaries was lower or not significantly different after plan completion for three of the four plans. Fisher and Dills (2012) also found no evidence that US land protection efforts by The Nature Conservancy were influenced by broad-scale conservation plans. We suggest five possible causes for our findings. First, administrative rules governing agency land acquisition prioritize land protection within existing local land protection projects over new projects (Wis. Admin. Code NR §1.40). Second, local land protection projects, once approved, are rarely terminated prior to reaching the authorized acreage goal (Wisconsin Department of Natural Resources, 2014a). Third, degazettement of existing protected areas may improve conservation outcomes (Fuller et al., 2010), albeit with potential negative long-term conservation implications (Mascia and Pailler, 2011). However, only recently has the Wisconsin Department of Natural Resources begun this practice, as required by the 2013–2015 state budget bill (Wis. Stat. §23.145). Further, criteria for the sale of existing protected areas are focused

Table 2
Land cover composition of all lands inside boundaries of the two recent plans, unprotected lands only within each plan boundary, all lands protected in the years since completion of each plan, the entire existing statewide network of protected lands, and all currently unprotected lands in the state. The composition of all lands within plan boundaries represents the best estimate of overall land cover protection goals for each plan. The composition of unprotected lands with the boundary of each plan represents the best estimate of the desired composition of lands remaining to be protected. The final two columns describe the composition of the current protected areas network in the state and the composition of lands that may be available for future land protection. Units are square kilometers; percentages are of the total in each column.

	2004 plan			2008 plan				
	All lands within plan boundary	Unprotected lands only within plan boundary	Lands protected since 2004	All lands within plan boundary	Unprotected lands only within plan boundary	Lands protected since 2008	All currently protected lands in Wisconsin	All currently unprotected lands in Wisconsin
Deciduous	12,690 (28.7%)	7557 (24.1%)	454 (43.9%)	13,453 (36.3%)	7528 (33.3%)	203 (45.4%)	12,053 (43.4%)	31,639 (26.9%)
Evergreen	1156 (2.6%)	551 (1.8%)	20 (1.9%)	1342 (3.6%)	477 (2.1%)	11 (2.4%)	1383 (5.0%)	1954 (1.7%)
Mixed	1808 (4.1%)	932 (3.0%)	66 (6.4%)	1701 (4.6%)	634 (2.8%)	24 (5.3%)	2099 (7.6%)	3128 (2.7%)
Shrub, grassland, and herbaceous	1201 (2.7%)	682 (2.2%)	29 (2.8%)	1364 (3.7%)	658 (2.9%)	14 (3.2%)	1119 (4.0%)	2666 (2.3%)
Pasture/hay	3726 (8.4%)	3626 (11.5%)	19 (1.8%)	2357 (6.4%)	2278 (10.1%)	10 (2.3%)	244 (0.9%)	15,324 (13.0%)
Cultivated crops	8793 (19.9%)	8354 (26.6%)	82 (7.9%)	5576 (15.1%)	5174 (22.9%)	35 (7.8%)	1026 (3.7%)	37,172 (31.6%)
Wetlands	8465 (19.1%)	4511 (14.4%)	293 (28.3%)	7519 (20.3%)	3298 (14.6%)	128 (28.6%)	7898 (28.4%)	12,012 (10.2%)
Barren	31 (0.1%)	25 (0.1%)	0	24 (0.1%)	18 (0.1%)	0	9 (0.0%)	88 (0.1%)
Green space	1725 (3.9%)	1395 (4.4%)	22 (2.1%)	1324 (3.6%)	946 (4.2%)	11 (2.4%)	700 (2.5%)	5294 (4.5%)
Developed	1389 (3.1%)	1344 (4.3%)	2 (0.2%)	504 (1.4%)	462 (2.0%)	1 (0.2%)	101 (0.4%)	4334 (3.7%)
Open water	3261 (7.4%)	2442 (7.8%)	47 (4.6%)	1884 (5.1%)	1155 (5.1%)	10 (2.2%)	1150 (4.1%)	3928 (3.3%)
Total	44,244	31,420	1033	37,048	22,629	448	27,781	117,538

on property access issues and whether or not parcels are inside an approved local land protection project boundary, rather than on statewide plans (Wisconsin Department of Natural Resources, 2014b). Fourth, there is substantial overlap in plan boundaries over time (>36% overlap with the preceding plan for all plans). The 2008 plan explicitly included priority areas in other plans as a prioritization criterion, and 90% of priority areas in the 2008 plan were partially or entirely encompassed by previous plans. All four factors might decrease the potential influence of recent plans on land protection patterns, particularly since many local land protection projects were initiated by the agency in the 1940s, 1950s, and 1960s. Finally, conservation plans, although intended primarily to guide future actions, may serve in part as reports of past accomplishments for two reasons: (1) agency plans are often expert-based (Lerner et al., 2006) and thus may be biased toward places experts know best (Cowling et al., 2003; Maddock and Samways, 2000; Prendergast et al., 1999), and (2) plans may include existing protected areas because they are well known to the public and represent continued priorities for land management (Pohlman et al., 2006).

4.3. Do plans influence what kind of land is protected?

After the 2004 and 2008 plans were completed, the agency protected some land cover types (e.g., deciduous forests and wetlands) in greater proportion than indicated in plans and others (e.g., pasture/hay and crop lands) in lesser proportion than indicated in plans. Both trends mirror past efforts (deciduous forests and wetlands comprise 72% of Wisconsin's protected areas, pasture and crop lands only 5%) and may partially reflect a pattern of residual reservation (Pressey, 1994) facilitated by cost, funding, and regulatory considerations and differing conservation strategies. Forested lands are generally cheaper to acquire than agricultural lands in Wisconsin (US Department of Agriculture National Agricultural Statistics Service, 2013a, 2013b), and federal Forest Legacy Program funding is specifically for protection of working forests (US Forest Service, 2012). Development of wetlands is largely prohibited by state law (Wis. Stat. §281.36), likely increasing availability and lowering costs. In this and other regions, pasture and hay fields are important habitat for grassland-dependent wildlife (Renfrew and Ribic, 2008). Cultivated crop lands are important both as a matrix surrounding core grassland habitat and as restoration opportunities for prairies and grasslands (Sample et al., 1997). Restoration is costly (Gardner, 2010), however, and local ordinances may discourage or prohibit loss of agricultural lands (Ohm, 1999). In addition, grassland conservation and restoration strategies in Wisconsin often focus primarily on providing technical assistance to landowners and facilitating enrollment in federal landowner assistance programs (e.g., US Department of Agriculture Conservation Reserve Program), which do not involve land acquisition by the state agency and thus would not have been captured in our evaluation.

4.4. Limitations

Our ability to link plans and subsequent actions was limited in several ways. First, we examined only four conservation plans. While the four plans spanned a long period of time (75 years) and were accompanied by detailed land protection records, they were all developed for a single US state. Second, we had limited post-plan data for the two recent plans, although other plans have been evaluated using similar timeframes (Bottrill et al., 2012; Knight et al., 2008). Third, 1939 and 1964 plan boundaries were only available in coarse paper maps, and the 2004 plan lacked explicit boundaries. Approximating boundaries as circles introduces error (Visconti et al., 2013). We were conservative in that we chose large circles to capture all potential plan effects, but some circles, particularly in the working landscapes of southern Wisconsin, encompassed non-target land cover types (e.g., crop lands) in addition to targeted habitats. Finally, we considered only natural and institutional outcomes related to land protection as metrics of plan influence. Many other metrics for evaluating plans exist (Bottrill and Pressey, 2012). While we did not have comprehensive data to evaluate additional outcomes, we note two examples. First, Wisconsin incorporated the 2008 plan into a state grant program (Wis. Admin. Code NR §58), subsequently focusing more than $900,000 in federal funding for land management and research within plan boundaries from 2011 to 2013 (T. Bergeson, *pers. comm.*). Second, agency staff indicated that the 2008 plan helped build support for biodiversity conservation across programs within

the agency, and was also used by outside organizations to help lobby for future funding for conservation at the federal level (T. Bergeson, *pers. comm.*).

4.5. Conservation implications

Our finding that completion of conservation plans does not coincide with clear and consistent changes in the amount, location, or landcover type of subsequently protected lands at broad scales highlights that conservation decisions are often driven by opportunity, economics, politics, public support, existing policies, and other factors (Bottrill et al., 2012; Knight and Cowling, 2007; Knight et al., 2011a, 2011b). We do not suggest that conservation plans are not valuable. Plans provide key justification for protection action when plan priorities and land protection opportunities align (Knight et al., 2011b), and may help facilitate more strategic action during periods when political, economic, and social conditions are favorable (Radeloff et al., 2013). However, we suggest that conservation plans are most likely to be a strong force in guiding land protection actions when dependable, multi-year funding for land protection is present, when public, institutional, and political support for implementation are strong, and when agencies develop and commit to an implementation strategy. A significant challenge to effective implementation is its protracted nature under most circumstances, requiring strong support and funding over multiple years and sometimes decades (Knight et al., 2011a; Pressey et al., 2013). Public and stakeholder involvement in planning at all stages and scales (e.g., nationwide planning initiatives, statewide conservation and implementation plans, local project plans), including a strong rollout of plans to stakeholders and the public, can foster accountability and help generate and maintain the public, institutional, and political support and funding needed for effective plan implementation (Martin et al., 2012).

Implementation strategies should link broad-scale plans to local land protection initiatives (Pressey et al., 2013), and be actionable within the framework of existing laws, administrative rules and policies governing the agency's land protection actions. Ideally implementation plans include a commitment to monitoring conservation outcomes (Knight et al., 2006), although unfortunately there is little incentive or support for agencies to make such a commitment (Ferraro and Pattanayak, 2006). Implementation plans should also identify plan goals which may be difficult to achieve under current laws, administrative rules, and policies, setting the stage for future legal and policy changes needed for more effective long-term implementation.

An important mechanism of plan influence here was the identification of new priority areas in landscapes currently underrepresented in the protected area network. Designating these sites as implementation priorities in the implementation strategy would link broad scale plans more directly to the establishment of new, local land protection projects. The need to link broad-scale and local planning initiatives extends beyond agency settings to conservation organizations as well (e.g., The Nature Conservancy, Bottrill et al., 2012). Linking the two planning scales through an implementation strategy would help focus staff and stakeholder efforts on building the institutional, political, and public support needed for local projects to succeed. Such implementation strategies were developed for the 2004 plan studied here. Two consecutive five-year implementation plans were approved by the agency oversight board (Wisconsin Department of Natural Resources, 2004, 2010). The 2004 implementation plan identified 14 specific land protection projects in which to initiate or concentrate land protection efforts. Two of the seven newly proposed land protection projects were subsequently approved, and land protection occurred in 12 of the 14 priority projects. A decrease in state funding beginning in the late 2000s (Fig. 2f), the large area within the plan boundary (30% of the state), and the influence of other resource-specific plans and funding sources (e.g., the Federal Forest Legacy Program) may have contributed to the lack of clear plan effects observed here.

Explicit identification of plan goals is critical for understanding plan influence. Goals should not be limited to on-the-ground actions, which may be modest. Rather, plan goals should encompass other desired social, institutional, financial, and human outcomes (Bottrill and Pressey, 2012; Bottrill et al., 2012). For example, the 2004 plan was developed to assess progress made under Wisconsin's major conservation funding program and to determine if the program should be continued. The plan has since been used to justify continuing the program at stable funding levels, an outcome potentially more important than any specific land protection action.

Up-front assessments of likely plan outcomes, and the spatial scale at which outcomes are likely to occur, can help focus planning processes, plan products, and stakeholder involvement strategies. If on-the-ground actions resulting from plans may be limited, for example if plans are being developed primarily to meet requirements for a modest federal funding program (as was the case with the 2008 plan), then a streamlined process relying on available data and targeting stakeholders likely to be eligible for funding under the program may be appropriate. If on-the-ground action is most likely to be associated with the establishment of new local land protection projects, then extensive public outreach and involvement where new projects are proposed can generate the local support needed for those projects to succeed (Knight et al., 2008, 2011a). If plan goals and likely impacts involve broadly influencing public or political support for conservation, key public and political leaders should be involved in plan development, and plan products should be tailored and rolled out to these audiences (Pierce et al. 2005).

Finally, while plans should clearly not be driven by opportunity (Margules and Pressey, 2000), the practical reality is that land protection often is (Knight and Cowling, 2007; Knight et al., 2011b; Pressey, 1994). However, many conservation plans, particularly those developed by agencies at the state level, still rely primarily or exclusively on biological data (Lerner et al., 2006). Incorporating into conservation plans the factors (including laws and policies governing land protection actions) potentially constraining conservation action can help identify locations where biological priorities and practical opportunities for action are most likely to intersect (Cowling and Pressey, 2003; Knight and Cowling, 2007; Knight et al., 2011a; Pressey and Bottrill, 2008).

5. Conclusions

Comprehensive, quantitative evaluations of multiple conservation outcomes across multiple conservation plans are currently lacking in the published literature (Bottrill and Pressey, 2012). We have taken a step toward addressing this information gap by quantifying the influence of numerous conservation plans developed by a state land management agency on their subsequent land protection actions. Our approach considered multiple institutional and natural capital metrics of plan influence by quantifying associations between plan completion and changes in the amount, location, and land cover type of protected lands. We considered plan influence at two spatial scales: comprehensive statewide conservation plans and local land protection projects. We used land protection records that land management agencies and conservation organizations commonly collect as the basis of our evaluation, to facilitate application of this approach to other locations.

We found that comprehensive statewide conservation plans did not have clear or consistent impacts on the amount, location, or

landcover type of subsequently protected lands. Our results for Wisconsin are consistent with findings for nationwide land protection efforts in the US by the world's largest land trust (Fisher and Dills, 2012), and may reflect the reality of the effectiveness of broad-scale plans in guiding land protection activity in other contexts and locations as well. Our findings suggest that while comprehensive conservation plans do play important roles in conservation, their influence on subsequent land protection efforts may be limited by funding and institutional, political, and public support for implementation, and mediated by laws, administrative rules, and policies governing land protection actions.

In contrast to our findings for statewide plans, we found that the formal approval of local land protection projects was associated with significant activity, much of which occurred almost immediately. In our study area, the project initiation process is strongly linked to agency administrative rules governing land acquisition. Thus we suggest that conservation plans will be most effective when agencies develop and commit to implementation strategies that link broad-scale and local planning initiatives, clearly identifying newly-proposed local land protection projects, and are actionable within the framework of existing laws, administrative rules, and policies governing agency land protection actions. Clearer definition of plan goals and consideration of known influences on plan implementation are also needed to more effectively and efficiently focus conservation planning efforts.

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Appendix A. Supplementary material

Current administrative rules governing land protection by the state land management agency in Wisconsin (Appendix A), goals, priority area criteria, and priority area descriptions for conservation plans (Appendix B); factors associated with changes in land protection activity statewide (Appendix C) and within statewide plans (Appendix D); and land protection activity within local projects (Appendix E) and statewide plans (Appendix F) before and after project approval/plan completion are available online. The authors are solely responsible for the content of these materials. Queries (other than absence of the material) should be directed to the corresponding author. Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.biocon.2014.07.014.

References

Bottrill, M.C., Mills, M., Pressey, R.L., Game, E.T., Groves, C., 2012. Evaluating perceived benefits of ecoregional assessments. Conserv. Biol. 26, 851–861.
Bottrill, M.C., Pressey, R.L., 2012. The effectiveness and evaluation of conservation planning. Conserv. Lett. 5, 407.
Bottrill, M.C., Walsh, J.C., Watson, J.E.M., Joseph, L.N., Ortega-Argueta, A., Possingham, H.P., 2011. Does recovery planning improve the status of threatened species? Biol. Conserv. 144, 1595–1601.
Commission for Environmental Cooperation, 1997. Ecological regions of North America: toward a common perspective. Communications and Public Outreach Department of the CEC Secretariat, Montreal, Quebec, Canada.
Conservation Biology Institute, 2012. Protected Areas, USA. Corvallis, Oregon. <http://consbio.org/products/projects/pad-us-cbi-edition>. (accessed November 2012).
Cowling, R.M., Pressey, R.L., 2003. Introduction to systematic conservation planning in the Cape Floristic Region. Biol. Conserv. 112, 1–13.
Cowling, R.M., Pressey, R.L., Sims-Castley, R., le Roux, A., Baard, E., Burgers, C.J., Palmer, G., 2003. The expert or the algorithm? – comparison of priority conservation areas in the Cape Floristic Region identified by park managers and reserve selection software. Biol. Conserv. 112, 147.
Fernandes, L., Day, J., Lewis, A., Slegers, S., Kerrigan, B., Breen, D., Cameron, D., Jago, B., Hall, J., Lowe, D., Innes, J., Tanzer, J., Chadwick, V., Thompson, L., Gorman, K., Simmons, M., Barnett, B., Sampson, K., De'ath, G., Mapstone, B., Marsh, H., Possingham, H., Ball, I., Ward, T., Dobbs, K., Aumend, J., Slater, D., Stapleton, K., 2005. Establishing representative no-take areas in the Great Barrier Reef: Large-scale implementation of theory on marine protected areas. Conserv. Biol. 19, 1733.
Ferraro, P.J., Pattanayak, S.K., 2006. Money for nothing? a call for empirical evaluation of biodiversity conservation investments. PLoS Biol. 4, 482–488.
Fisher, J.R.B., Dills, B., 2012. Do private conservation activities match science-based conservation priorities? PLoS ONE 7, e46429.
Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., Wickham, J., 2011. Completion of the 2006 national land cover database for the Conterminous United States. Photogram. Eng. Remote Sens. 77, 858–864.
Fuller, R.A., McDonald-Madden, E., Wilson, K.A., Carwardine, J., Grantham, H.S., Watson, J.E.M., Klein, C.J., Green, D.C., Possingham, H.P., 2010. Replacing underperforming protected areas achieves better conservation outcomes. Nature 466, 365.
Gardner, H.W., 2010. Tallgrass Prairie Restoration in the Midwestern and Eastern United States. Springer, Dordrecht.
Gleason, M., McCreary, S., Miller-Henson, M., Ugoretz, J., Fox, E., Merrifield, M., McClintock, W., Serpa, P., Hoffman, K., 2010. Science-based and stakeholder-driven marine protected area network planning: a successful case study from north central California. Ocean Coast. Manage 53, 52–68.
Grantham, H.S., Bode, M., McDonald-Madden, E., Game, E.T., Knight, A.T., Possingham, H.P., 2010. Effective conservation planning requires learning and adaptation. Front. Ecol. Environ. 8, 431–437.
Groves, C.R., Jensen, D.B., Valutis, L.L., Redford, K.H., Shaffer, M.L., Scott, J.M., Baumgartner, J.V., Higgins, J.V., Beck, M.W., Anderson, M.G., 2002. Planning for biodiversity conservation: Putting conservation science into practice. Bioscience 52, 499.
Joppa, L.N., Pfaff, A., 2009. High and far: biases in the location of protected areas. PLoS ONE 4, e8273.
Knight, A.T., Cowling, R.M., 2007. Embracing opportunism in the selection of priority conservation areas. Conserv. Biol. 21, 1124.
Knight, A.T., Cowling, R.M., Boshoff, A.F., Wilson, S.L., Pierce, S.M., 2011a. Walking in STEP: lessons for linking spatial prioritisations to implementation strategies. Biol. Conserv. 144, 202–211.
Knight, A.T., Cowling, R.M., Campbell, B.M., 2006. An operational model for implementing conservation action. Conserv. Biol. 20, 408–419.
Knight, A.T., Cowling, R.M., Rouget, M., Balmford, A., Lombard, A.T., Campbell, B.M., 2008. Knowing but not doing: selecting priority conservation areas and the research-implementation gap. Conserv. Biol. 22, 610.
Knight, A.T., Grantham, H.S., Smith, R.J., McGregor, G.K., Possingham, H.P., Cowling, R.M., 2011b. Land managers' willingness-to-sell defines conservation opportunity for protected area expansion. Biol. Conserv. 144, 2623–2630.
Lerner, J., Cochran, B., Michalak, J., 2006. Conservation across the landscape: a review of the state wildlife action plans. Defenders of Wildlife, Washington D.C..
Maddock, A.H., Samways, M.J., 2000. Planning for biodiversity conservation based on the knowledge of biologists. Biodivers. Conserv. 9, 1153.
Margules, C.R., Pressey, R.L., 2000. Systematic conservation planning. Nature 405, 243.
Martin, T.G., Nally, S., Burbidge, A.A., Arnall, S., Garnett, S.T., Hayward, M.W., Lumsden, L.F., Menkhorst, P., McDonald-Madden, E., Possingham, H.P., 2012. Acting fast helps avoid extinction. Conserv. Lett. 5, 274–280.
Mascia, M.B., Pailler, S., 2011. Protected area downgrading, downsizing, and degazettement (PADDD) and its conservation implications. Conserv. Lett. 4, 9–20.
National Conservation Easement Database, 2013. West Linn, Oregon. <http://www.conservationeasement.us>. (accessed July 2013).
National Park Service, 1964. Parks for America: A survey of park and related resources in the fifty states, and a preliminary plan. US Department of the Interior, Washington, D.C..
Ohm, B.W., 1999. Guide to Community Planning in Wisconsin. Department of Urban and Regional Planning, University of Wisconsin-Madison/Extension, Madison, Wisconsin.
Pierce, S.M., Cowling, R.M., Knight, A.T., Lombard, A.T., Rouget, M., Wolf, T., 2005. Systematic conservation planning products for land-use planning: interpretation for implementation. Biol. Conserv. 125, 441.
Pohlman, J.D., Bartelt, G.A., Hanson, A.C., III, Scott, P.H., Thompson, C.D. (Eds.), 2006. Wisconsin Land Legacy Report: An inventory of places to meet Wisconsin's future conservation and recreation needs. Wisconsin Department of Natural Resources, Madison, Wisconsin.

Prendergast, J.R., Quinn, R.M., Lawton, J.H., 1999. The gaps between theory and practice in selecting nature reserves. Conserv. Biol. 13, 484.
Pressey, R.L., 1994. Ad Hoc reservations – forward or backward steps in developing representative reserve systems. Conserv. Biol. 8, 662.
Pressey, R.L., Bottrill, M.C., 2008. Opportunism, threats, and the evolution of systematic conservation planning. Conserv. Biol. 22.
Pressey, R.L., Humphries, C.J., Margules, C.R., Vanewright, R.I., Williams, P.H., 1993. Beyond opportunism – key principles for systematic reserve selection. Trends Ecol. Evol. 8, 124.
Pressey, R.L., Mills, M., Weeks, R., Day, J.C., 2013. The plan of the day: managing the dynamic transition from regional conservation designs to local conservation actions. Biol. Conserv. 166, 155–169.
R Core Team, 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
Radeloff, V.C., Beaudry, F., Brooks, T.M., Butsic, V., Dubinin, M., Kuemmerle, T., Pidgeon, A.M., 2013. Hot moments for biodiversity conservation. Conserv. Lett. 6, 58–65.
Radeloff, V.C., Hammer, R.B., Stewart, S.I., 2005. Rural and suburban sprawl in the US Midwest from 1940 to 2000 and its relation to forest fragmentation. Conserv. Biol. 19, 793.
Renfrew, R.B., Ribic, C.A., 2008. Multi-scale models of grassland passerine abundance in a fragmented system in Wisconsin. Landscape Ecol. 23, 181–193.
Rhemtulla, J.M., Mladenoff, D.J., Clayton, M.K., 2007. Regional land-cover conversion in the US upper Midwest: magnitude of change and limited recovery (1850–1935–1993). Landscape Ecol. 22, 57.
Rodgers, W.H.J., 1993–1994. Seven statutory wonders of US environmental law: Origins and morphology. Loyola of Los Angeles Law Review 27, 1009–1021.
Sample, D.W., Mossman, M.J., 1997. Managing habitat for grassland birds: a guide for Wisconsin. Wisconsin Department of Natural Resources, Bureau of Integrated Science Services, Madison, Wisconsin.
Scott, J.M., Davis, F.W., McGhie, R.G., Wright, R.G., Groves, C., Estes, J., 2001. Nature reserves: Do they capture the full range of America's biological diversity? Ecol. Appl. 11, 999.
Theobald, H.R., Robbins, P.V. (Eds.), 1970. The State of Wisconsin Blue Book 1970. Wisconsin Legislative Reference Bureau, Madison, Wisconsin.
Theobald, H.R., Robbins, P.V. (Eds.), 1973. The State of Wisconsin Blue Book 1973. Wisconsin Legislative Reference Bureau, Madison, Wisconsin.
Theobald, H.R., Robbins, P.V. (Eds.), 1977. The State of Wisconsin 1977 Blue Book. Wisconsin Legislative Reference Bureau, Madison, Wisconsin.
Theobald, H.R., Robbins, P.V. (Eds.), 1985. The State of Wisconsin 1985–1986 Blue Book. Wisconsin Legislative Reference Bureau, Madison, Wisconsin.
US Bureau of Economic Analysis, 2013a. National gross domestic product, 1929–2012. <http://www.bea.gov/national/index.htm>. (accessed June 2013).
US Bureau of Economic Analysis, 2013b. Wisconsin gross domestic product, 1963–2012. <http://www.bea.gov/iTable/index_regional.cfm>. (accessed June 2013).
US Bureau of Labor Statistics, 2013. Consumer price index-urban wage earners and clerical workers, 1913–2013. <http://www.bls.gov/cpi> (accessed July 2013).
US Bureau of the Census, 1975. Historical statistics of the United States, colonial times to 1970, bicentennial edition. US Department of Commerce, Washington D.C.
US Department of Agriculture National Agricultural Statistics Service, 2013a. Wisconsin forest land sales – 2012. Madison, Wisconsin.
US Department of Agriculture National Agricultural Statistics Service. 2013b. Wisconsin total agricultural land sales – 2012, Madison, Wisconsin.
US Department of the Interior, 2010. Fiscal year 2011: The Interior budget in brief, Appendix F: Land and Water Conservation Fund. Washington, D.C.
US Department of the Interior, 2011. Fiscal year 2012: the interior budget in brief, Appendix F: Land and Water Conservation Fund. Washington, D.C.
US Department of the Interior, 2012. Fiscal year 2013: The Interior budget in brief, Appendix E: Land and Water Conservation Fund. Washington, D.C.
US Fish and Wildlife Service, 2006. Guidelines for the State Wildlife Grant program. <http://teaming.com/sites/default/files/SWG%20Guidelines.pdf> (accessed November 2013).
US Fish and Wildlife Service, 2014. National Wildlife Refuge System Draft Strategic Growth Policy. <http://www.fws.gov/refuges/planning/StrategicGrowth.html>. (accessed May 2014).
US Forest Service, 2012. Forest legacy program. <http://www.fs.fed.us/spf/coop/programs/loa/aboutflp.shtml>. (accessed October 2013).
Vincent, C.H., 2010. Land and water conservation fund: overview, funding history, and issues. Congressional Research Service, Washington D.C.
Visconti, P., Di Marco, M., Alvarez-Romero, J.G., Januchowski-Hartley, S.R., Pressey, R.L., Weeks, R., Rondinini, C., 2013. Effects of errors and gaps in spatial data sets on assessment of conservation progress. Conserv. Biol. 27, 1000–1010.
Voigt, L.P., 1962. ORAP [Outdoor Recreation Areas Program] gets underway. Wisconsin Conserv. Bull. 27 (3), 3–6.
Wisconsin Department of Natural Resources, 2003. Manual Code 2105.2: Feasibility study and Wisconsin Environmental Policy Act analysis for establishing or modifying project boundaries, Madison, Wisconsin.
Wisconsin Department of Natural Resources, 2004. Implementation Strategy for the Wisconsin Land Legacy Report, Madison, Wisconsin.
Wisconsin Department of Natural Resources, 2005. Wisconsin's Strategy for Wildlife Species of Greatest Conservation Need, A State Wildlife Action Plan. Madison, Wisconsin.
Wisconsin Department of Natural Resources, 2008. Wisconsin's Wildlife Action Plan (2005–2015) Implementation: Priority Conservation Actions and Conservation Opportunity Areas. Madison, Wisconsin.
Wisconsin Department of Natural Resources, 2010. The DNR Land Acquisition Strategy for the Stewardship Program, with action items for 2010 to 2015. Madison, Wisconsin.
Wisconsin Department of Natural Resources, 2012. Wisconsin's Forest Legacy Areas. <http://dnr.wi.gov/topic/ForestPlanning/legacyAreas.html>. (accessed May 2014).
Wisconsin Department of Natural Resources, 2013a. Managed lands database. <ftp://ftp.wi.gov/DNR/public/Lands>. (accessed May 2013).
Wisconsin Department of Natural Resources, 2013b. Feasibility Studies. <http://dnr.wi.gov/topic/lands/masterplanning/Feasibility.html>. (accessed November 2013).
Wisconsin Department of Natural Resources, 2013c. 2013–2014 DNR Action Plan. Wisconsin Department of Natural Resources, Madison, Wisconsin.
Wisconsin Department of Natural Resources, 2014a. Wisconsin Department of Natural Resources land records database. Available from Bureau of Facilities and Lands, Wisconsin Department of Natural Resources, 101 S. Webster St., Madison, WI, 53707.
Wisconsin Department of Natural Resources, 2014b. Real Estate Program land sales. <http://dnr.wi.gov/topic/lands/RealEstate/landsale.html>. (accessed May 2014).
Wisconsin Legislative Reference Bureau, 2011. State of Wisconsin 2011–2012 blue book. Wisconsin Department of Administration, Madison, Wisconsin.
Wisconsin State Planning Board and Conservation Commission, 1939. A Park, Parkway and Recreational Area Plan. Madison, Wisconsin.