

Adapting conservation easements to climate change

Adena R. Rissman¹, Jessica Owley², M. Rebecca Shaw³, & Barton (Buzz) Thompson⁴

¹ Forest and Wildlife Ecology, University of Wisconsin-Madison, Madison, WI, USA

² SUNY Buffalo Law School, Buffalo, NY, USA

³ Environmental Defense Fund, San Francisco, CA, USA

⁴ Law School and Woods Institute for the Environment, Stanford University, Palo Alto, CA, USA

Keywords

Administrative discretion; climate change adaptation; conservation easements; environmental policy and law; land trusts; private land conservation; protected areas.

Correspondence

Adena R. Rissman, Forest and Wildlife Ecology, University of Wisconsin-Madison, 1630 Linden Drive Madison, WI 53706, USA.

Tel: 608-263-4356.

E-mail: arrissman@wisc.edu

Received

24 October 2013

Accepted

18 March 2014

doi: 10.1111/conl.12099

Abstract

Perpetual conservation easements (CEs) are popular for restricting development and land use, but their fixed terms create challenges for adaptation to climate change. The increasing pace of environmental and social change demands adaptive conservation instruments. To examine the adaptive potential of CEs, we surveyed 269 CEs and interviewed 73 conservation organization employees. Although only 2% of CEs mentioned climate change, the majority of employees were concerned about climate change impacts. CEs share the fixed-boundary limits typical of protected areas with additional adaptation constraints due to permanent terms on private lands. CEs often have multiple, potentially conflicting purposes that protect against termination but complicate decisions about principled, conservation-oriented adaptation. Monitoring is critical for shaping adaptive responses, but only 35% of CEs allowed organizations to conduct ecological monitoring. In addition, CEs provided few requirements or incentives for active stewardship of private lands. We found four primary options for changing land use restrictions, each with advantages and risks: CE amendment, management plan revisions, approval of changes through discretionary consent, and updating laws or policies codified in the CE. Conservation organizations, funders, and the Internal Revenue Service should promote processes for principled adaptation in CE terms, provide more active stewardship of CE lands, and consider alternatives to the CE tool.

Introduction

Static conservation tools are likely to fail in the face of environmental and social change. Conservation easements (CEs) appeal to conservation organizations because of their perpetual restrictions on land use, but they introduce challenges for conservation-oriented adaptation to climate change (Merenlender *et al.* 2004; Korngold 2007; Owley 2011). Particular concern centers on how CEs structure or prevent change (McLaughlin 2005; Rissman *et al.* 2013). The need to plan for adaptation is growing with concerns over climate change and other environmental and social changes (Hobbs *et al.* 2009; West *et al.* 2009). It is time to rethink the role of CEs in the conservation toolbox.

A CE is a voluntary, typically permanent, partial interest in property created through agreement between

a landowner and a nonprofit land trust or government agency in which a landowner agrees to land-use restrictions, usually in exchange for a payment, tax reduction, or permit. CEs have emerged as a popular conservation tool for helping protect private land from development and overuse (Gustanski & Squires 2000). The tool is on the rise internationally (Korngold 2010). For example, nongovernmental organizations in Kenya are promoting the use of CEs to conserve land outside of protected areas (Watson *et al.* 2010) and England and Wales are considering the adoption of a CE-like statute (Law Commission 2013). CEs, based on permanent property rights to avoid protracted and uncertain political processes, present different challenges than public land policy and land-use planning and zoning (Fairfax *et al.* 2005; Morris 2008). The institutional context for CEs is characterized by strained financial capacity, decentralized governance,

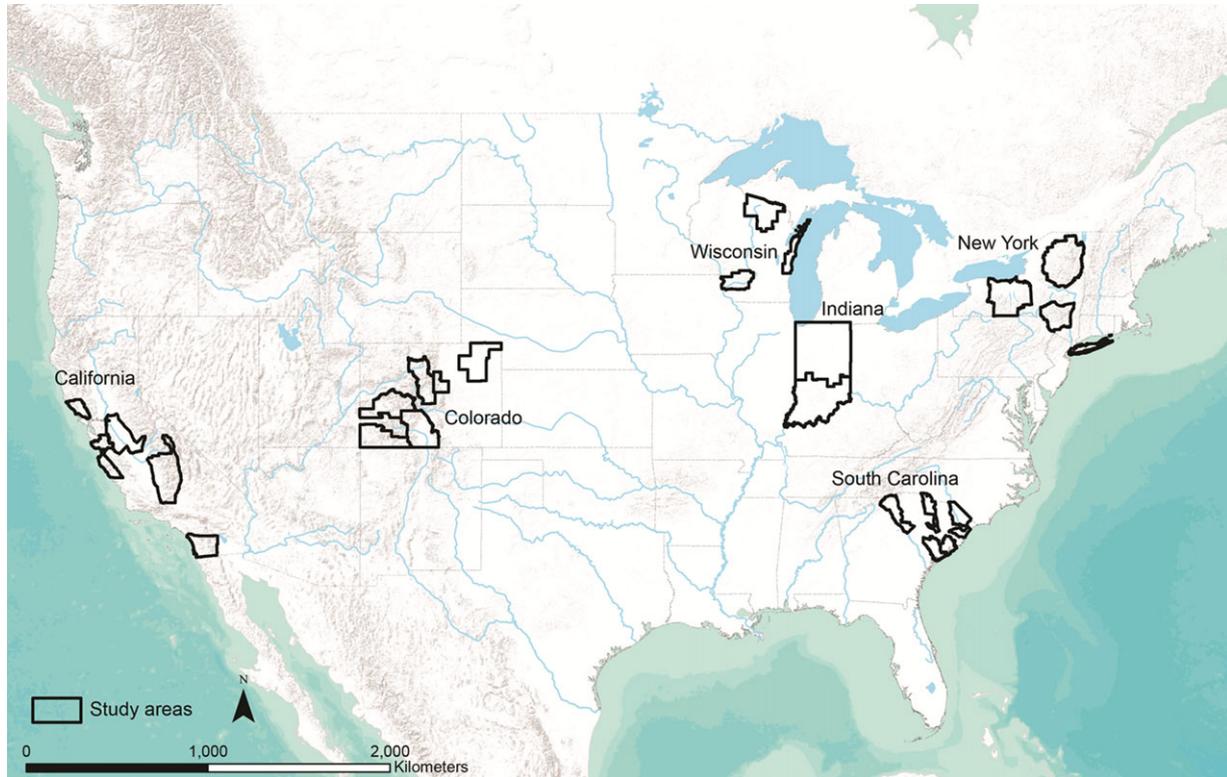


Figure 1 Conservation organizations and their conservation easements were selected from diverse landscapes within the United States.

and blending of regulatory, incentive, and market mechanisms (Hodge & Adams 2012).

Numerous climate-driven changes threaten the effectiveness of CEs and other protected areas (Hannah *et al.* 2002; Philip 2005). Climate change will impact species ranges, agricultural and forest productivity, flooding and fire regimes, and invasive species (Hannah *et al.* 2007; Gillson *et al.* 2013). Climate change will make species conservation more expensive (Shaw *et al.* 2012) and may also affect the compatibility of permitted uses such as residences or resource production with biodiversity, habitat, or recreation goals. National climate adaptation strategies provide high-level guidance to decision-makers (Bierbaum *et al.* 2013; Kareiva & Groffman 2013). However, climate-change adaptation has been slow to enter into local land management due to lack of information, incomplete policy guidance, and competing higher priority issues (Ellenwood *et al.* 2012).

We define climate adaptation as human actions in response to actual and expected climate-change impacts taken in an attempt to moderate harm or exploit beneficial opportunities. Principled adaptation is change that increases net conservation benefit (Craig 2010). The pathway for achieving principled climate adaptation on

lands with CEs is fraught with risks and questions, even where CEs specify desired conservation benefits. Do CEs allow holders and landowners to change land-use restrictions to better achieve CE purposes? Can holders and landowners change the purpose or location of CEs to match changing landscapes? If so, who gets to decide?

To tackle the challenging question of CE adaptation, we examined 269 CE documents from six states in the United States (Figure 1) and interviewed 73 staff members from conservation organizations. Our survey of CE documents examined purposes, land-use restrictions, and options for changing land use. Interviews revealed organizational responses to climate change and the changes conservation staff perceived as impacting their organization's CEs. Given findings of our survey and interviews, we conclude that CEs have important limitations, particularly for conservation under climate change. CE holders, funders, legislatures, and the Internal Revenue Service (IRS) should rethink current policies and practices regarding private land conservation. Our proposed changes involve: (1) drafting CEs for principled adaptation, (2) improving monitoring and stewardship, and (3) deciding when and where to deploy CEs.

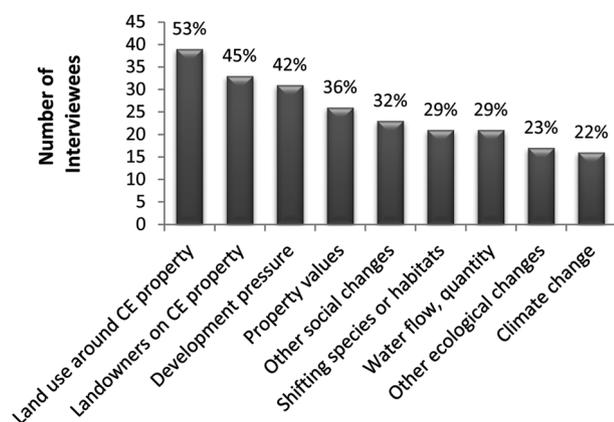


Figure 2 The number (and percent) of employees who perceived each social and ecological change as having affected their conservation easements ($n = 73$).

Organizations are concerned about climate change but most CEs do not address it

Most organizational staff (88%) were concerned about climate-change impacts in their region, whereas 3% were unconcerned and 9% didn't know. Half (56%) thought negative climate-change impacts on CEs' conservation purposes were somewhat to very likely. One-quarter (25%) thought negative impacts were somewhat to very unlikely, and 19% didn't know. Future efforts that present information about climate change to conservation organizations might elicit different perceptions of climate-change impacts. Conservation organization employees perceived many social and ecological changes as already affecting their CEs, with one-fifth reporting perceived effects of climate change (Figure 2). Although 70% of interviewees said their organization has prepared, or plans to prepare, for potential climate-change impacts, 25% said their organization was not planning to make changes in preparation for climate change. This may be because climate change ranked relatively low on the list of perceived existing threats to conserved lands. Most organizations we contacted are still thinking about how or whether to address climate adaptation and few efforts involved formal modeling and scenario planning.

Although a majority of staff were concerned about climate change, only six CE documents in our study (2%) mentioned climate change, and they did so in very different ways. Two included climate adaptation as a purpose, stating "the protection of the Property ... will help to ensure that wildlife populations ... remain healthy and viable in the face of future changes to the climate or ecology of the area." Two CEs recognized the potential for climate change to alter management plan requirements

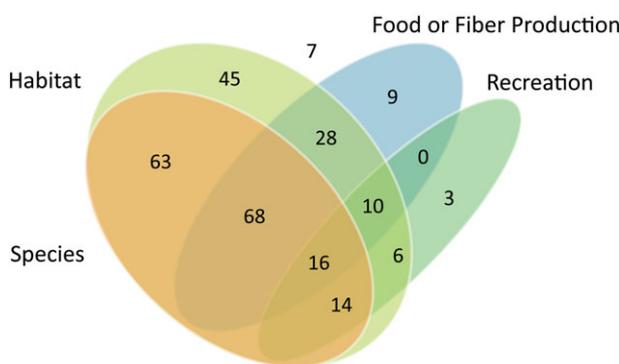


Figure 3 Most conservation easements had multiple purposes, as depicted in this multiway Venn diagram ($n = 269$).

for species; one recognized carbon sequestration on the property as a climate change mitigation measure while also noting the CE should adapt with climate-induced landscape changes; and one exempted the landowner and CE holder from liability due to climate-induced changes (see Online Supporting Information for climate-related CE terms).

In response to climate change, 18% of interviewees were reassessing CE terms. This included increased use of mechanisms like amendment policies and management plans. Three organizations were developing new CE terms to address fire planning. Some were interested in pursuing research on climate-change impacts (14%) and sequestering carbon as a mitigation strategy (8%).

Draft CEs with processes for principled adaptation

Organizations and funders should focus on writing CE terms that permit and encourage the landowner and CE holder to pursue principled, conservation-oriented adaptation to climate change (Ohm 2000). This requires clear purposes and land-use restrictions. It also requires well-developed decision processes for altering terms.

Conservation for what purpose?

The logic of permanent protection suggests that keeping CEs in place and preventing their termination is necessary to achieve conservation goals. To provide that assurance, as well as to align with landowner and funder goals, CEs often included many diverse, potentially conflicting purposes (Figure 3). If at least one purpose can still be achieved, a CE cannot be terminated on the basis that its purpose is impossible or impractical to fulfill. CEs in our sample had a median of seven purposes and a maximum of 16 purposes including open space (74%),

scenic values (70%), protection of a particular species or rare or threatened species (60%), and food and fiber production through grazing, forestry, or agriculture (49%). More recent CEs included more purposes (Owley *et al.*, unpublished data). Interviews suggested that CE holders increasingly require multiple, broad purposes in case one purpose becomes impossible to achieve, though only two organizations noted these changes as specific reactions to climate change. Only 19% of CEs specified a dominant purpose.

Parties should clarify CE purposes and provide for how purposes should be interpreted in the context of conflict or environmental change (Glick *et al.* 2011). CEs with multiple purposes could designate primary and secondary purposes. If the CE includes multiple coequal purposes that come into conflict, such as wildlife habitat and agriculture, it leaves both parties and the public interest vulnerable to an uncertain process of negotiation and dispute resolution in resolving which purpose ought to take precedence.

The logic of conservation as restricting land use

Saving land for cows not condos, and keeping forest as forest, are consensus-building ideas among communities seeking to protect ecosystems and natural resource economies (Brunson & Huntsinger 2008). Thus, conservation of private lands focuses primarily on restricting development and subdivision. Land-use restrictions are the core of CEs and need to be well-tailored to conservation purposes. In negotiating CEs, conservation organizations must determine which land uses are threats to the conservation purposes and whether to compromise with private landowners on restrictions. Most CEs in our sample allowed limited development of private residences or agricultural buildings but prohibited subdivision of the property (Figure 4).

Options and processes for principled adaptation

The challenge of drafting specific, perpetual restrictions is that a good fit for current conditions may mean problems under future conditions (Rissman 2010). A variety of circumstances could prompt one or both parties to desire a change in restricted land uses or in the management of a property (Thompson 2004). We found four primary options used for altering land-use restrictions for existing CEs, which do not necessarily facilitate principled adaptation: (1) modification through CE amendment, (2) management plan revision, (3) approval of changes through discretionary consent, and (4) changes through updating

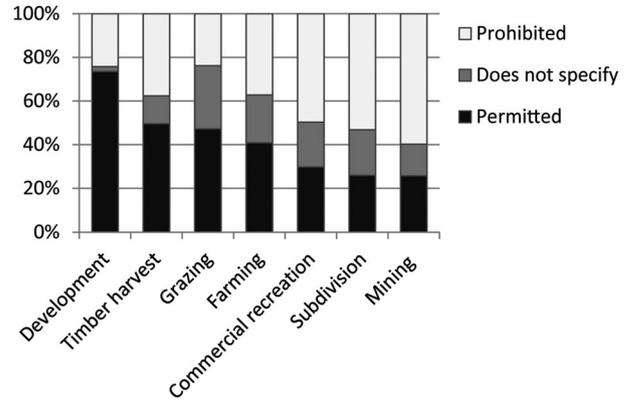


Figure 4 Percent of conservation easements that permit and prohibit specific land uses. Conservation easements that do not specify may permit the activity by default, unless it is interpreted by the holder and landowner as prohibited by a general clause.

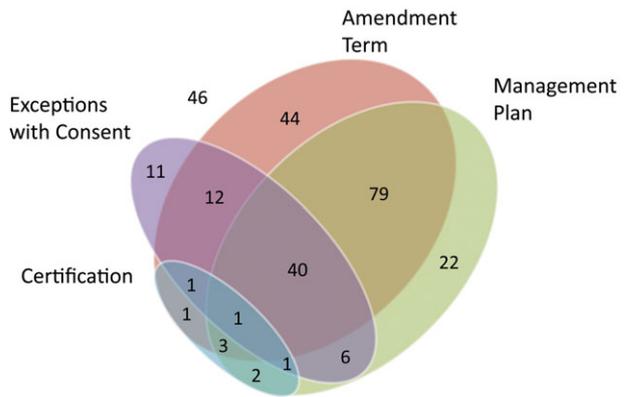


Figure 5 A multiway Venn diagram depicting combinations of options for changing land use on CE properties (*n* = 269).

laws and policies codified in the CE such as forest certification (Figure 5).

These options for change were more likely to exist in CEs that permitted timber harvest, grazing, or farming (Figure 6). Organizations found that some uses initially prohibited by CEs later became valuable to protect conservation purposes, such as herbicides for invasive species removal, requiring the organizations to reinterpret or selectively enforce terms. CEs in our study that included species protection as a conservation purpose or value were more likely to have a management plan (64% of species CEs, 47% of nonspecies CEs, $\chi^2 = 7.41$, $P = 0.006$) and an amendment term (73% of species CEs, 59% of nonspecies CEs, $\chi^2 = 5.28$, $P = 0.022$). Species protection CEs were no more likely to provide the CE holder rights to conduct active land management, require the landowner to obtain certification, or include language that allows the conservation organization to make

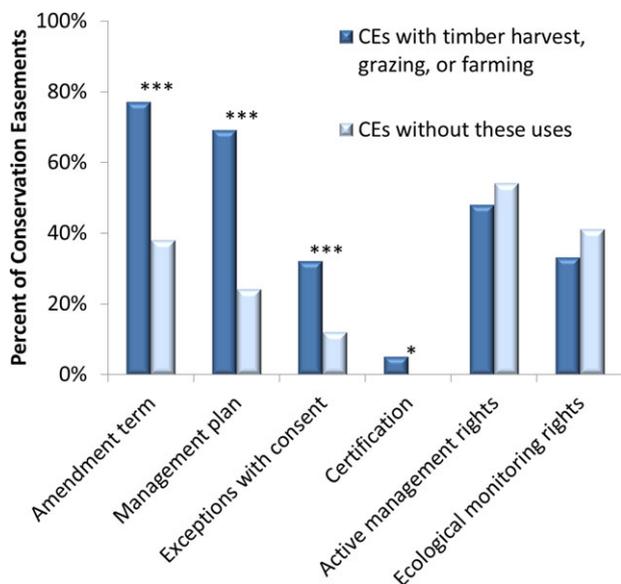


Figure 6 Mechanisms for change were more likely to be found in CEs with timber harvesting, grazing, or farming, whereas CE holder rights for ecological monitoring and active management were not significantly different for properties with these land uses (***) $P \leq 0.001$, * $P = 0.08$).

exceptions to land use restrictions. Each of these options for change has advantages and risks.

Most staff (71%) thought their organization's CEs provided enough flexibility to adapt to changing environmental and climatic conditions, whereas 14% said the CEs did not provide enough flexibility, and 15% didn't know. These responses include varied interpretations of flexibility. Some perceived adaptation as keeping the CE land-use restrictions in place regardless of how the property changed. They thought purposes of relatively natural habitat or open space were sufficiently broad to be achieved under any future conditions, even if particular species were lost. Others were committed to specific biodiversity or economic production goals and thought they had the CE terms and organizational capacity to achieve those by modifying land management.

We recommend CE holders negotiate for CE terms that provide adequate organizational authority to manage for climate risks and changed conditions and authorize conservation-purpose-enhancing amendments. In many states, the safest course for making amendments would be to obtain court approval after notice to the state attorney general. Standards for amendment could be set by the IRS for donated CEs, funders for purchased CEs, and permitting authorities for exacted or mitigation CEs. Donated CEs can provide for extinguishment and still be deductible, if they are extinguished in court because the purposes are impossible or impractical and the proceeds are reinvested for conservation (Treas. Reg. 170A-

14(g)(6)(i)). We recommend the IRS develop a policy on CE amendment and extinguishment that sets clear guidelines including enhancement of conservation benefits and a transparent public participation process (Jay 2012; McLaughlin 2012). Although CE amendment should be infrequent and scrutinized to prevent abuse, not allowing amendment creates an incentive to draft less comprehensive CEs, and is unrealistic given environmental and social change. External review and approval of changes can help ensure conservation-oriented adaptation and protect the conservation purposes advanced by donations, public and private financial investments, or permit requirements. Public and foundation funders, the IRS, or the Land Trust Accreditation Commission could develop more comprehensive standards for what terms should be included in CEs and how those terms could be modified.

Management plans may provide a useful means of providing options for climate change adaptation, but they need to be carefully bounded within organizational decision processes to ensure that their terms enhance conservation purposes. Management plans have allowed CE holders and landowners to defer difficult decisions until the agreement has closed and the landowner has been compensated. Updating management plans can also be resource intensive, particularly if disputes arise. Organizations should develop more robust decision-making processes for discretionary consent, management plans, and amendment decisions with higher levels of expert advice, transparency, and public accountability than are currently typical. A novel institutional arrangement is in place on the prominent Tejon Ranch in southern California, where environmental groups agreed not to block development plans in exchange for protection of 97,120 of the 109,270 hectare property through CEs and other instruments. The ranch management plan is written by the Tejon Ranch Conservancy and approved by its board, which consists of four representatives selected by the landowner, four by environmental groups, and four jointly-appointed experts. Organizations developing administrative procedures should consider who in the organization will decide (staff, managers, boards of directors); whether they will involve experts, an expert review panel, mediators, or arbitrators; and which other parties should be consulted (e.g., funders, permit authorities, IRS, state attorneys general).

Transparency and public accountability are problematic for CEs already (King & Fairfax 2006) and become even more problematic in processes that permit change in land uses. Accountability is challenging with private land trusts because these organizations are not bound by the same open records and public notice requirements as public agencies. The IRS has taken an active oversight role for fiscal abuses of donated CEs, but the IRS

has limited power to ensure accountability for climate adaptation because it lacks a conservation mission and land management expertise, is primarily focused on financial value, and cannot challenge a donor's charitable deduction after the 3-year statute of limitations has ended (although fraud does extend this time limit). Government agencies face challenges as well and have lost track of and failed to monitor their CEs (Office of the Legislative Auditor 2013). Third-party enforcement of CEs through citizen suits are almost nonexistent (Brown 2005), although federal funders and attorneys general sometimes include specific third-party enforcement rights (Jay 2005). Voluntary land trust accreditation requires organizations to develop CE amendment policies that result in a "positive or not less than neutral" conservation outcome (Land Trust Alliance 2004).

The landowner–CE holder relationship is also complicated. The CE holder's property rights are primarily exercised as the right to enforce restrictions, which positions the CE holder as an enforcer of land-use restrictions on private land. Landowners are often donors, constituents, land trust members, and permittees. Landowner power generates bipartisan support for public funding for CEs; Congress has extended tax deductions for CEs even through budget crises. However, landowner power is a double-edged sword when it comes to enforcing restrictions on private land. CE holders are concerned that a CE amendment or revision process would allow landowners to negotiate for additional private land-use rights. Goal conflict between landowners and CE holders can complicate adaptation strategies. Given contested perceptions of climate change, organizations that must negotiate climate-adaptation actions with landowners will face additional challenges.

Provide more active stewardship of conservation lands

Ecological monitoring is a major missing link in CEs, despite being necessary for active adaptive management for climate and landscape change (Lawler *et al.* 2008). Although 96% of CEs specifically granted the CE holder the right to conduct *compliance* monitoring for CE violations (a right already guaranteed by most state statutes and IRS regulations), only 35% of the CEs granted the right to conduct *ecological* monitoring or scientific research (something not already required by law). Even among the CEs that mentioned a species or natural community for protection, only 37% (69 of 189) granted the organization the right to conduct ecological monitoring (compared to only 29% of nonspecies CEs, a significant difference at $\chi^2 = 3.83$, $P = 0.050$).

Monitoring is critical for learning about change on CE properties and for improving management, key components of climate adaptation. CEs with a purpose of protecting relatively natural habitat, particular species, or particular natural communities like wetlands should allow the CE holder to conduct biophysical monitoring (Kiesecker *et al.* 2007). Ecological monitoring could be encouraged or required by conservation organizations, funders, or IRS regulations; indicators to be monitored could be established in the CE. We found that ecological monitoring rights actually became less common over time, being included in 45% of CEs before 2000 but only 30% of CEs after 2000 (Owley *et al.*, unpublished manuscript). The structural reasons that CEs have become popular, including a presumption of lower acquisition costs and modest staffing needs, present challenges for organizational capacity to conduct monitoring and adaptation efforts.

To help ensure that CEs will achieve conservation purposes in the face of climate change, conservation organizations should develop detailed baseline information when acquiring CEs, provide for adequate stewardship funds, develop policies to guide ongoing management decisions, and engage landowners as stewards. Active management such as removing invasive species, prescribed burning, or managing watercourses is often required to sustain ecosystems. Informally, organizations can use education and social norms to influence landowner decisions (Rissman & Sayre 2012). Another challenge for principled adaptation is that financial incentives are provided entirely up front but achieving conservation purposes often involves ongoing management costs. Funding for ongoing monitoring, operations, and management may be less exciting than new acquisitions, but it is needed.

CEs evoke a deeper question: are humans threats, stewards, or coproducers of landscapes? CEs facilitate conservation on private land. Their multiple purposes suggest some compatibility between residences, ranching or timber harvesting, wildlife habitat, and recreation. However, CEs function by restricting private land use rather than fostering active stewardship. The CE logic works well for eliminating threats like development but is not enough to ensure a process of conservation-oriented management (Fischer *et al.* 2012).

Choose perpetual CEs deliberately, not by default

Conservation organizations should consider tools that provide greater organizational power to ensure conservation outcomes, such as fee simple acquisition. Of course,

landowners may be unwilling to donate or sell fee simple title and organizations may be reliant on donations. But where it is an option, fee simple should be considered for its higher level of organizational discretion over land management. Fee simple is more likely to allow public recreation, which provides the benefit of recreation access but a potential conflict for some species (Reed & Merenlender 2008).

In choosing which lands to protect, some conservation staff indicated they were beginning to identify lands important for climate-change adaptation strategies, including hot spots, refuges, corridors, niches, habitat stepping stones, elevation gradients, and buffers. Ten percent of interviewees felt that continuing their current work or expanding the number and size of protected lands was the best response to climate change. In open-ended questions, only 21% of interviewees mentioned climate adaptation as a consideration for which lands to protect. We encourage organizations to develop and adhere to acquisition priorities that incorporate climate-adaptation strategies through approaches such as qualitative scenario planning (Peterson *et al.* 2003), targeting heterogeneous geographies (Hodgson *et al.* 2009; Anderson & Ferree 2010), or climate modeling (Hannah *et al.* 2007).

Organizations may also consider new approaches to combining perpetual duration with flexibility in spatial location (Lemieux *et al.* 2011). Static property boundaries limit strategies for spatially dynamic approaches such as moveable conservation areas (Pressey *et al.* 2007). Tradable CEs could allow organizations to move CEs to more appropriate locations if biodiversity or other purposes become impossible to achieve on a property due to climate change (Weeks 2011), something the IRS has declared impermissible for donated CEs that qualified for a charitable deduction (Internal Revenue Service 2012). Term-terminable CEs would allow a CE to be terminated if the organization and landowner mutually agree that the conservation purposes could be better served elsewhere (McLaughlin 2004). Decisions about trades should involve conservation benefits, costs, and the probability of avoided loss. Options could be purchased on desired lands. Rolling CEs have spatial boundaries tied to landscape features, already common for riparian boundaries, and possible although challenging for climatic features. Endowment easements place purchase funds in an endowment and pay landowners from the interest; if the agreement ended, the funds could be transferred to a new property (Rissman *et al.* 2014).

Land conservation involves a portfolio of acquisition, incentive-based, market-based, and regulatory tools. Improved integration of these tools could help address the sources and consequences of development and parceliza-

tion, and thereby reduce vulnerability to climate change. Our research reinforces the need to pair long-term protection of places, by preventing development and other land uses, with conservation-oriented decision processes to help species, ecosystems, and resource-dependent humans in a changing climate.

Conclusions

CEs have serious limitations for conservation in a changing climate. Climate change is likely to result in sea-level rise; increasing droughts, storms, and disturbance events; reduction in snow and ice; shifting species ranges and resource productivity; as well as secondary effects of climate adaptation and mitigation efforts (West *et al.* 2009; Stocker *et al.* 2013). CE holders, private and government funders, state and federal legislatures, and the IRS should rethink current policies and practices regarding CEs. Our proposed changes involve: (1) CE language and adaptive decision-making processes, (2) monitoring and stewardship, and (3) a deliberate spatial and temporal mix of CEs and other conservation tools. Although we found four primary options for changing land management already embedded in CEs, each has advantages and risks for principled adaptation.

CEs are increasing internationally, with little research on their implications in countries with diverse sociopolitical contexts and legal frameworks. Increasingly, nonprofit organizations and governments are looking to CEs and similar tools to protect special places without fee simple purchase (Telesetsky 2001). The rapid pace of global climate, land use, and sociopolitical change poses important questions about these conservation strategies, including CE design and administration.

Conservation organizations should reconsider CE drafting, with clear purposes, processes for principled adaptation, and ongoing monitoring and stewardship in light of climate change. Only 35% of CEs in our study allowed for ecological monitoring; we recommend that all CEs with a purpose of protecting relatively natural habitat, particular species, or particular natural communities allow the CE holder to conduct some biophysical monitoring. Broader changes are needed in accreditation, public funding, and charitable deductions. We recommend the IRS develop guidance on CE amendment and termination to set standards that allow principled adaptation while preventing abuses. Funders should also direct grantees to address climate adaptation and ongoing ecological monitoring and stewardship. Attention to transparent processes for conservation-oriented change will contribute to principled adaptation of CEs in a changing climate.

Acknowledgments

Many thanks to the faculty, postdoctoral researcher, and student teams who helped conduct this research and improve this manuscript, including M. Bihari, C. Carlarne, F. Cheever, J. Eagle, R. Fischman, C. Locke, W. W. Weeks, and four anonymous reviewers. Thank you to C. Chang, G. Grube, and G. Shea for GIS assistance. Funding was provided by the Resources Legacy Fund, the University of Wisconsin-Madison, and the Baldy Center for Law and Social Policy.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

The following supplementary material is available for this article:

- A. Methodology.
- B. Conservation easement terms that mentioned climate change.
- C. Novel decisions for anticipatory climate adaptation.

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1 Supporting Information A. Methodology

2 We analyzed 269 CEs held by 63 organizations, selected from 28 regions within six states. The
3 six states were chosen because of their diverse landscapes and because faculty in those states
4 agreed to participate in data collection. Regions within the states were selected to include a
5 diversity of landscapes including coast, forest, rangeland, and wetland regions. To include a wide
6 range of conservation organizations and CEs, we selected three primary CE holders from each
7 region, including at least one state or federal government agency and one nonprofit land trust.
8 We asked each organization to provide four CEs from the selected region: the oldest and newest
9 CEs, a middle CE from the median year between the oldest and newest CE, and the largest CE
10 (by area). If the largest CE was also the oldest, middle, or newest CE, the second largest CE was
11 selected. We selected these CEs to maximize the variation in CE terms within each organization,
12 to include new and large properties that may be most likely to have climate adaptation terms, and
13 to prevent organizations from selecting preferred CEs for the study. This selection process was
14 designed to enhance variability in the sample but did not generate a random selection of states,
15 organizations, or CEs.

16 Data collection was coordinated through a distributed graduate seminar among six universities in
17 Spring 2011 (Owley & Rissman 2011). Students coded CEs terms and interview responses into
18 online surveys with Qualtrics software. Each conservation easement document was categorized
19 according to its purposes, land-use rights and responsibilities, monitoring rights, and mechanisms
20 for adaptation (Rissman et al. 2013). Inter-coder reliability was improved through practice
21 piloting of conservation easement documents. A chi-square test compared whether options for
22 change over time and CE holder rights for active management and ecological monitoring were
23 more common in CEs that permit working land uses (forestry, farming, or grazing) than those

24 without working land uses. A second chi-square test compared options for change between CEs
25 with and without specific species or rare, threatened, or endangered species as conservation
26 purposes.

27 Students conducted 73 structured interviews with employees of 62 organizations, including 58
28 nonprofit and 15 government conservation easement holders. We interviewed one employee per
29 organization per region, so organizations selected in two regions in a state had more than one
30 interview. Interviews averaged 56 minutes and ranged from 27 to 150 minutes. Most interviews
31 (49) were conducted in person while 22 were conducted by phone and 2 were conducted via
32 email by interviewee request. Interviewees had an average of 10 years of experience working in
33 the organization and 75% had over 4 years of experience.

Types of Organizations	Number of Organizations or State Offices	Number of Conservation Easements	Number of Interviews
Land Trusts	44	160	44
The Nature Conservancy (TNC)	6	49	14
State Agencies	9	40	10
Federal Agencies	4	20	5
Total	63	269	73

34

35 Our policy recommendations were developed through extensive engagement with conservation
36 practitioners. We gathered feedback from land trusts and government agency conservation
37 easement holders through an initial two-day workshop of 25 research and practice leaders at
38 Stanford University in 2009. We conducted two interactive panels and distributed a white paper
39 to discuss preliminary results at the Land Trust Alliance Rally in 2011 and 2012. Rissman
40 conducted a 2012 webinar to disseminate results and learn about practitioner experiences with 82
41 land trust and government participants. We also conducted two workshops with federal funders

42 and foundation funders of CEs in 2013. During the 2012 webinar, we learned about the
43 Southwest Michigan Land Conservancy's experience with anticipatory climate adaptation
44 featured in Supporting Information C.

45

46 Supporting Information B. Conservation easement terms that mentioned climate change
47 Only six CEs in our sample (2%) had an explicit provision about climate change adaptation,
48 which we defined as any guidance or rules related to land use or interpretation of the CE due to
49 anticipated or actual climate change. This is not necessarily principled adaptation to increase
50 conservation benefits. For most CEs, actions taken to adapt to climate change would fall under
51 the purview of other CE terms restricting or permitting land uses.

52 Two coastal California CEs from the Elkhorn Slough Foundation included climate adaptation as
53 a purpose, stating: "The protection of the Property enhances wildlife movement and migration
54 between other nearby protected areas, parks, and watershed areas, and will help to ensure that
55 wildlife populations on the Property and adjacent public and private lands remain healthy and
56 viable in the face of future changes to the climate or ecology of the area."

57 Two species and habitat protection CEs recognized explicitly that the habitats they were
58 conserving might change in species composition due to climate change. On the north coast of
59 California, the Sonoma Land Trust recognized climate-change impacts on ecosystems, and
60 linked this to changing CE management plan requirements for target DBH (diameter at breast
61 height) of trees on the property:

62 Adapting to Climate Change. The parties recognize that, over time, climate
63 change may significantly alter the ecosystems, their structures and composition. It
64 is the intent of this Easement to adapt to the changes to the ecosystems and its
65 associated species over time. For example, it is recognized that there may be a
66 time when the climate in this region may no longer support the Bishop pine forest
67 or tile coastal redwood and Douglas- fir forest, or their species composition and

68 character may change over time in response to changed climatic conditions...
69 [Excerpt from the section on Reserved, Restricted, or Prohibited Uses: General
70 Requirements for All Uses.]

71 The Minimum Numeric DBH Targets shall be based on historical references for
72 the forest condition as it existed prior to 1900, but over time consideration shall
73 be given to changes in the environment as a result of climate change and other
74 naturally occurring conditions, and the Minimum Numeric DBH Targets may be
75 modified to adapt to such changes. [Excerpt from the Forest Management Plan
76 description.]

77 Similarly, a CE from The Nature Conservancy in Wisconsin, where boreal forest species on the
78 southern edge of their range are expected to shift northwards, included a purpose to:

79 Maintain or create forests composed of naturally occurring species, adapted to the
80 Superior Mixed Forest and Great Lakes Regions of North America, as they may
81 evolve over time with climate alteration or other natural changes in speciation and
82 adaptation.

83 Response to hazards or disasters is typically mentioned in a clause that reduces landowner and
84 CE holder liability to these “acts of God.” In one instance, climate change was explicitly
85 included among these: "nothing contained in this conservation easement shall be construed to
86 entitle [the CE holder] to bring any action against the landowner for any injury to or change in
87 the property resulting from causes beyond the landowner's control including . . . climate
88 change."

89

90 Supporting Information C. Novel decisions for anticipatory climate adaptation

91 Adaptation to anticipated climate change impacts launched the Southwest Michigan Land
92 Conservancy into uncharted territory. The Conservancy holds a CE on a high-quality, rare
93 conifer swamp south of most other occurrences of this wetland community, categorized as highly
94 vulnerable to climate change. The landowner was actively working to restore the wetland and
95 requested permission to introduce nonnative wetland conifers that he believed would be less
96 vulnerable to climate change. The Conservancy agreed with the landowners' overall objective to
97 maintain the conifer community, but was concerned about the introduction of nonnative species.
98 Facing this disagreement with the landowner, the land protection specialist and stewardship
99 director undertook a novel deliberative process to respond diligently, respectfully, and
100 knowledgably to this request. They referred to the CE terms, which gave them discretion to
101 approve a restoration plan. They assembled a panel of legal, scientific, and conservation experts,
102 invited the landowners to present a webinar to the panel, and documented the comments of the
103 panelists. The panel expressed significant concerns about the effect of nonnative trees on wetland
104 values. Conservancy staff determined that planting nonnative trees was inconsistent with
105 protecting the conservation values, and not compatible with CE language on ecological
106 restoration. They also determined that there was no evidence that the benefits would outweigh
107 the potential risk to the rare natural community. The land trust board voted to disapprove the
108 planting of those species. The board suggested that planting native species with more southerly
109 distributions and monitoring through a university partnership would be an acceptable alternative.
110 This was a time-consuming and emotional process in negotiating land management, but staff
111 were ultimately proud of the deliberative process developed. The Conservancy is a relatively

112 high-capacity, accredited land trust with six paid staff members. We learned about this case
113 during a workshop when we presented preliminary results to land trusts; we then conducted a
114 follow-up interview with staff. We are able to share this lesson because the organization has been
115 transparent about its approach and even circulated a brief on their process. We encourage other
116 organizations to follow this example of transparency.