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Agreed but not preferred: expert views on taboo options for biodiversity conservation, given climate change

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Abstract. Recent research indicates increasing openness among conservation experts toward a set of previously controversial proposals for biodiversity protection. These include actions such as assisted migration, and the application of climate-change-informed triage principles for decision-making (e.g., forgoing attention to target species deemed no longer viable). Little is known however, about the levels of expert agreement across different conservation adaptation actions, or the preferences that may come to shape policy recommendations. In this paper, we report findings from a web-based survey of biodiversity experts that assessed: (1) perceived risks of climate change (and other drivers) to biodiversity, (2) relative importance of different conservation goals, (3) levels of agreement/disagreement with the potential necessity of unconventional-taboo actions and approaches including affective evaluations of these, (4) preferences regarding the most important adaptation action for biodiversity, and (5) perceived barriers and strategic considerations regarding implementing adaptation initiatives. We found widespread agreement with a set of previously contentious approaches and actions, including the need for frameworks for prioritization and decision-making that take expected losses and emerging novel ecosystems into consideration. Simultaneously, this survey found enduring preferences for conventional actions (such as protected areas) as the most important policy action, and negative affective responses toward more interventionist proposals. We argue that expert views are converging on agreement across a set of taboo components in ways that differ from earlier published positions, and that these views are tempered by preferences for existing conventional actions and discomfort toward interventionist options. We discuss these findings in the context of anticipating some of the likely contours of future conservation debates. Lastly, we underscore the critical need for interdisciplinary, comparative, place-based adaptation research.

Key words: assisted migration; biodiversity conservation; climate change adaptation; conservation triage; decision-making under uncertainty; expert survey; place-based research; protected areas.

Introduction

A long-recognized challenge facing biodiversity conservation scientists and resource managers is how to adapt conservation policy and practice to expectations of shifts in species ranges induced by climate change (Parmesan 2006), altered disturbance regimes (Littell et al. 2010), and ensuing novel ecosystems (Hobbs et al. 2009). Peters and Darling (1985) expressed concerns decades ago about the impacts of climate change on biodiversity and since then, key questions include: How will species and ecosystems respond to expected climate impacts? What management actions will continue to be effective? What novel actions and approaches might be considered? How might management goals, standards of success, and frameworks for prioritization change? And crucially, what types of governance arrangements facilitate successful adaptation in particular social-ecological contexts?

In conjunction with an increasingly comprehensive knowledge base of climate impacts (Parmesan 2006, Bellard et al. 2012), conservation researchers have proposed a suite of adaptation principles and actions (Hannah et al. 2002, Hannah 2009, Heller and Zavaleta 2009). Some of the most commonly advocated actions include increasing the spatial area of protected areas, linking protected areas through connectivity corridors, and minimizing non-climate stressors (Hannah et al. 2002, Heller and Zavaleta 2009, Anderson and Ferree 2010, Beier and Brost 2010, Poiani et al. 2011, Groves et al. 2012).

More controversial proposals include overtly interventionist actions (Hobbs et al. 2011). For instance, assisted migration (the deliberate translocation of species to nonhistorically occupied locales; McLachlan et al. 2007, Hoegh-Guldberg et al. 2008), planning and managing for novel ecosystems (Hobbs et al. 2009), the application of principles for triage-based decision-

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making (e.g., forgoing attention to target species or ecological assemblages deemed no longer viable; Baron et al. 2008, Bottrill et al. 2008, Lawler 2009), and the reassessment of conservation objectives more broadly (Hagerman et al. 2010*a*). While this latter list of actions and approaches remains contentious within conservation circles (Marris 2011), many biologists and ecologists argue that applications of these sorts will be necessary, given expected climate change impacts (e.g., see Baron et al. 2008, Lawler 2009, Hobbs et al. 2011) and doubts about the long-term ecological efficacy of conventional actions such as protected areas (Hobbs et al. 2010, Araujo et al. 2011).

Categorizing conservation adaptation actions: Ecological, institutional, and decision-making considerations

Conservation adaptation actions such as those we have noted are commonly distinguished in reference to broad ecological goals using the concepts of *resistance*, *resilience*, and *response* (Millar et al. 2007). Resistance actions are those that seek to maintain relatively unchanged conditions. Resilience actions seek to bolster the capacity of systems to absorb some degree of disturbance and foster the long-term persistence of existing conditions. Response actions, in contrast, include efforts to intentionally establish novel ecological assemblages that are anticipated to be better suited to changing conditions (Joyce et al. 2008, Heller and Zavaleta 2009, Glick et al. 2011).

Adaptation actions can further be distinguished by their *institutional conventionality*. Here, we define *conventional* actions as those that are advocated irrespective of climate change, embedded within existing institutional rules, norms, and processes for decision-making, and that have a history of implementation (protected areas for example). *Unconventional* (or taboo) actions are those that challenge institutional rules and norms. They tend to be relegated to the fringes of debate in conservation policy-making settings, and have a sparse or contentious history of implementation (assisted migration for example).

Cutting across these ecological and institutional distinctions, adaptation actions of all kinds share at least two policy-relevant features in common. First, decisions about conservation actions considering climate change will always be made under persistent scientific uncertainties. Any potential adaptation action is imprinted with uncertainties relating to its local efficacy and synergistic effects across scales. Scientific inquiry, practical experience, and ideally monitoring, will resolve some uncertainties over time, while new uncertainties will be revealed as the science advances and biophysical conditions and ecological responses continue to change (Morgan and Henrion 1990).

Second, given these prevailing uncertainties, experts (including conservation experts) will continue to be a key source of insight for informing decisions (Morgan et al. 2001, Burgman 2004). Research from the field of behavioral decision-making has shown that expert insights and evaluations of policy actions (such as conservation adaptation actions) are shaped not only by scientific assessments of ecological effectiveness and risk, but also by affective or emotion-based (Loewenstein et al. 2001, Slovic et al. 2004) and normative or value-based logics, also known as heuristics (Gilovich et al. 2002, Burgman 2004, Kahneman 2011). In considering expert-based policy recommendations for conservation adaptation, it is relevant to understand how this group perceives the risks of climate impacts to biodiversity, the types of goals they view as important, their preferences (and feelings toward) particular policy actions, and their views about information and decision-making in the broader social-political context. By experts, we mean individuals with specialized knowledge (i.e., scientists *and* practitioners), in this case relating to the implications of climate change on biodiversity conservation.

Expert assessments of conservation adaptation actions

A handful of studies have examined conservation scientist and manager views in relation to some of the adaptation proposals just outlined. Schliep et al. (2008) surveyed biosphere reserve managers about the risks of climate change to protected areas. Hagerman et al. (2010*b*) conducted a set of comprehensive interviews to illustrate active (if uncomfortable) engagement with some of the unconventional components of conservation redesign that we have described. Rudd (2011), in part, used verbatim responses from experts interviewed by Hagerman et al. (2010*b*) to survey conservation scientists on their opinions about policy elements necessary for successful conservation in the future. The latter two studies both report expert agreement with the necessity for climate-informed prioritization or triage, and increased management interventions more broadly. These findings contrast with earlier opinions wherein triage, for instance, is described as "ethically pernicious and politically defeatist" (Noss 1996).

The studies by Hagerman et al. (2010*b*) and Rudd (2011) assessed expert levels of agreement in the abstract. That is, assessments were not linked to particular conservation actions. The findings presented in this paper are part of a larger study designed (1) to quantify levels of expert agreement and preference across a set of specific adaptation actions and approaches (this paper), and (2) to examine the underlying choice logics of expressed judgments across *specific* actions (Hagerman and Satterfield 2013).

The dependent variables measured here derive from previous research, as well as the literature on risk and decision-making under uncertainty. We measured: (1) perceived risks of climate change (and other drivers) to biodiversity, (2) relative importance of different conservation goals, (3) levels of agreement/disagreement with the potential necessity of unconventional-taboo actions and approaches, including affective evaluations, (4) preferences regarding the most important adaptation action for biodiversity, and (5) perceived barriers and strategic considerations regarding implementing adaptation initiatives. Given previously reported indications of evolving views among conservation experts, our central hypothesis is that experts will report high levels of agreement with a set of historically taboo options, but when presented with specific options, preferences will default to, or remain aligned with, conventional approaches.

By quantifying expert perceptions of climate-related risks, levels of agreement with controversial approaches, and views about implementation, this paper contributes a more comprehensive understanding of the perspectives of this group of experts who play an important role in conservation decision-making under uncertainty. This analysis is not designed to advance the literature on risk and behavioral decision-making, but rather to add insight to the problem-defined field of conservation adaptation.

Methods

Survey design and analysis

Between December 2010 and January 2011, we conducted a web-based survey (eSurveyCreator.com) of expert views about biodiversity conservation, given climate impacts. Individual survey questions were derived from previous interview-based research (Hagerman et al. 2010*b*), which also served as pilot interviews for this study. We used Likert-style survey items (statements or questions that respondents evaluate from a provided closed-ended response scale). Our survey also measured the following independent variables: demographic characteristics (including gender, age, and political perspective) and professional characteristics (including affiliation and type of ecological expertise); see Appendix A. Statistical analysis was conducted using JMP version 10.0.2 (SAS Institute 2012). Chi-square analysis and one-way analysis of variance was used to characterize interactions between dependent and independent variables. The wording of the individual questions associated with these topics is presented alongside the results. The survey is available in Appendix B.

Sample frame and implementation

We obtained a globally representative sample of conservation experts in two steps. First, we identified a total set of "climate impacts and biodiversity" journal articles ($n = 1164$) within the ISI Web of Knowledge database (through 19 March 2010) using a set of search terms developed for this purpose. The search terms were created using a literature review across three fields: (1) Climate Change Impacts: Predictions, (2) Climate Change Impacts: Observed Biotic Responses, and (3) Conservation Planning and Management. We then created a Boolean search thread and conducted a pilot search to test that the terms captured climate change adaptation research without also including those that used climate as a rationale but not object of empirical inquiry. Individuals for inclusion in the survey were further narrowed to include primary authors (of at least one article), and secondary and tertiary authors (of more than one article) ($n = 573$). From this, $n = 488$ usable email addresses were identified.

In addition to the globally representative sample just described, we sought to draw from the conservation adaptation expertise that exists across the Pacific Northwest (PNW). To do so, we constructed a regional sample frame of experts involved in climate adaptation activities relating to species and ecosystem management in Washington State and British Columbia. To be eligible, individuals had to have been involved in a recent (within 5 years) government, nongovernmental organization (NGO), and/or university-sponsored adaptation planning workshop ($n = 116$). Combining global and regional populations ($488 + 116$), this process identified a total of 604 conservation experts. In total, 160 individuals participated in the survey for a response rate of 26.5%, which is consistent with parallel surveys of experts conducted on different topical domains (Lyytimaki and Hilden 2011, Quijas et al. 2012). Sample sizes for different questions varied because not all respondents answered all questions.

The full sample thus includes a systematically identified, globally representative sample of conservation experts (including those working for NGOs), enhanced by a regional sample of conservation experts affiliated with a range of resource management and NGO agencies. This strategy yields a globally representative sample that includes academic and NGO experience, and leverages the adaptation expertise that characterizes the PNW region (i.e., adaptation work by Eco-Adapt, Washington Department of Fish and Wildlife, the U.S. Forest Service, and The Nature Conservancy in this region).

Our sample is representative of a relatively narrow definition of academic and practitioner experts, and thus excludes local, traditional, and citizen experts, among others. In the discussion portion of this article, we evaluate the sampling approach taken here and identify opportunities for future research that would include a broader range of expertise.

The survey was pilot tested with graduate students, practicing biologists, and practitioners. Invitations to participate in the survey were sent by an e-mail that included a description of the study, information about anonymity and consent, and a link to the survey. Initial invitations were sent in early December 2010. Following a modified "Dillman schedule" (Dillman 2000), two reminder e-mails were sent before the survey closed in January 2011.

Demographic and professional characteristics of respondents

The distribution of responses between the global and regional sample did not vary across questions. Analyses

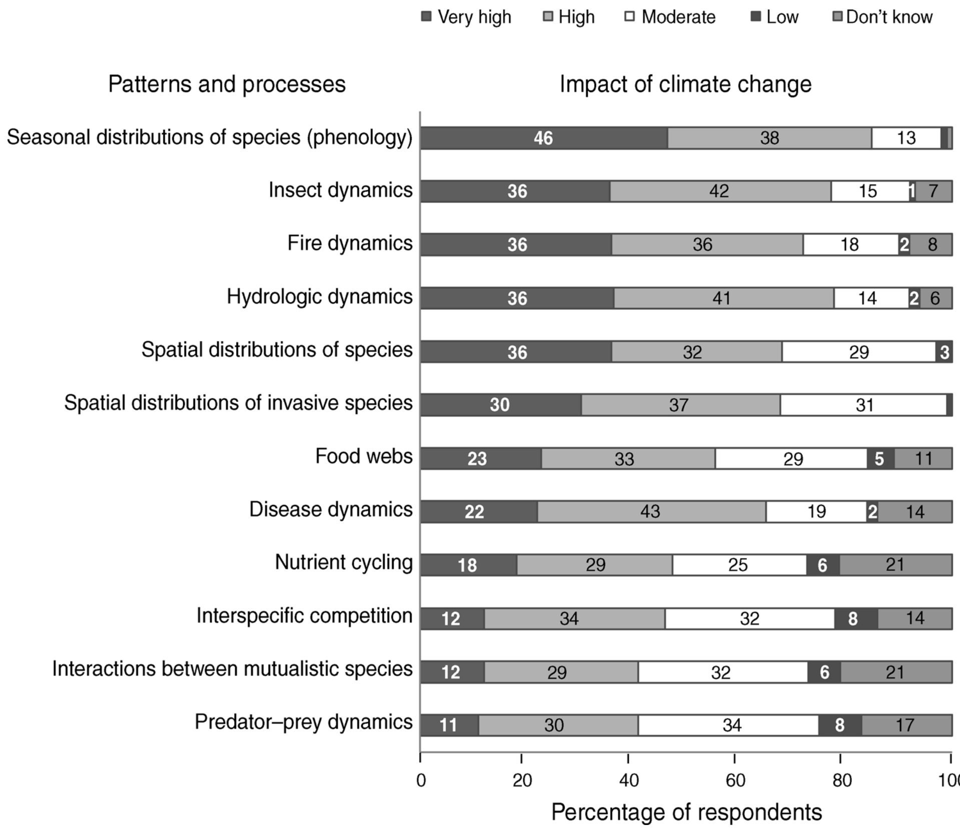

FIG. 1. Response to survey question: *Globally, over the next 30–40 years, what degree of impact (direct and indirect) do you expect climate change will have on the following ecological patterns and processes?* For each pattern or process, n varies from 100 to 135. Response categories in the horizontal bars go from "very high" on the far left to "don't know" on the far right. Numbers inside the bars are the percentage of respondents selecting a particular response. Responses of 2% or less do not have a number label.

presented here use the pooled sample. Similarly, we found no significant differences between individuals who identified their primary role as "researcher" ($n = 102$) and those who identified as "practitioner" ($n = 39$) (19 did not indicate their professional group) for gender, political perspective, or preferences for most important action.

The majority of respondents were 40 years of age or older (68%); 48% were female. The predominant political perspective across the sample was liberal (58%), with only 2% identifying as conservative (25% identified as moderate and 15% identified as other). Almost 50% had been involved in climate change adaptation for less than 10 years. Reflecting the sample population, the majority of participants (72%) identified their primary work role as researcher/scientist. Similarly, the majority of participants (68%) held doctorate degrees. Of those with doctorate degrees, the following broad disciplines were represented: ecology/conservation (39%); general biology (31%); environmental science/resource management (19%); marine/aquatic (10%). Overall, the majority of participants work in terrestrial ecosystems (67%), with 20% working in marine and coastal areas, 12% in freshwater, and 1% in urban. The primary location of climate-related work was as follows: North America (63%), EU/Asia (22%), Global South (14%). Additional details are available in Appendix C.

RESULTS

Climate and other drivers of ecological change

The survey began with questions about climate change in general, and climate change risks relative to other drivers. Virtually all respondents agreed that climate change will impact species and ecosystems within the next 30–40 years, and that these impacts will be expressed across a wide range of ecological patterns and functions (Fig. 1). At the same time, respondents ranked climate change behind a handful of other drivers (e.g., such as habitat loss and degradation) in terms of their current impact (Fig. 2). Moreover, many respondents indicated concern that the pursuit of adaptation initiatives detracts attention from addressing these more immediate drivers. The specific details will be described.

A full 97% ($n = 135$) of respondents "agreed" or "strongly agreed" with the statement that: "Climate is changing on a multi-decadal scale," and 99% ($n = 136$) either "agreed" or "strongly agreed" with statement that

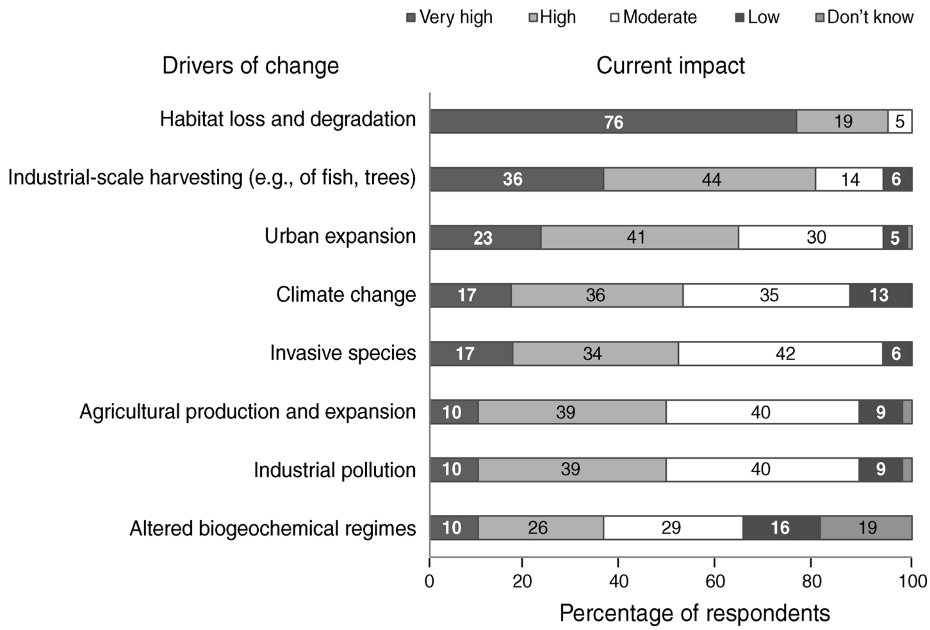

FIG. 2. Response to survey question: *For the following drivers of change, what is the current intensity of impact on species and ecosystems?* For each driver, *n* varies from 100 to 135. Response categories in the horizontal bars go from "very high" on the far left to "don't know" on the far right. Numbers inside the bars are the percentage of respondents selecting a particular response. Responses of 2% or less do not have a number label.

"Changes in climate will substantially impact species and ecosystems over the next 30–40 years." Respondents indicated that climate change is expected to have varying degrees of impact for different ecological patterns and processes (Fig. 1). From a given list of 12 ecological patterns and functions, the greatest expected impacts (with 67–84% of respondents selecting "very high" or "high" degree of impact) were associated with phenology, insect dynamics, fire dynamics, hydrological dynamics, and spatial distributions of species including invasive species. Of this subset of impacts, 0–8% of respondents selected "don't know" as their response. Impacts on food webs, disease dynamics, and interspecific interactions including mutualistic interactions received relatively lower impacts rankings (with 41–65% of respondents selecting "very high" or "high degree" of impact). This subset of impacts was associated with a greater percentage (11–21%) of "don't know" responses.

Respondents also assigned different perceived intensities to a set of eight potential drivers of ecological change, including climate change (Fig. 2). Climate change ranked as the fourth most currently intense driver, behind habitat loss and degradation, industrial scale-harvesting, and urban expansion. Approximately one-third of respondents (32%, $n = 133$) "strongly agreed" (5%) or "agreed" (27%) that "local and regional efforts to adapt to climate change impacts detract from the need to address more immediate drivers of ecological change (e.g., habitat loss)."

Conservation goals

While a minimum of 75% of respondents ranked the full list of a given set of nine conservation goals as "important" or "extremely important," explicit biophysical goals received relatively higher rankings than did goals equated with economic benefits or community well-being (Fig. 3). For instance, many more respondents rated maintaining ecological processes as an "extremely important" conservation goal compared to protecting culturally or economically significant species, or maintaining sustainable livelihoods of local communities. Preserving wilderness and protecting species at risk ranked second and third overall, respectively.

Views on specific components of taboo actions

This survey confirms the changing state of expert views regarding a set of previously taboo conservation actions and approaches (Hagerman et al. 2010*b*, Rudd 2011). Experts surveyed here overwhelmingly agreed with the limits to active management, and thus the need for revised prioritization schemes and metrics of conservation success in light of shifting species ranges and emerging non-analogue ecosystems (Fig. 4). Simultaneously, the survey found that respondents were roughly divided about how negatively they feel about interventionist actions. Moreover, a majority of respondents continue to prefer conventional actions as the most important actions, and indicate the importance of strategic considerations in expressing their views in a public forum.

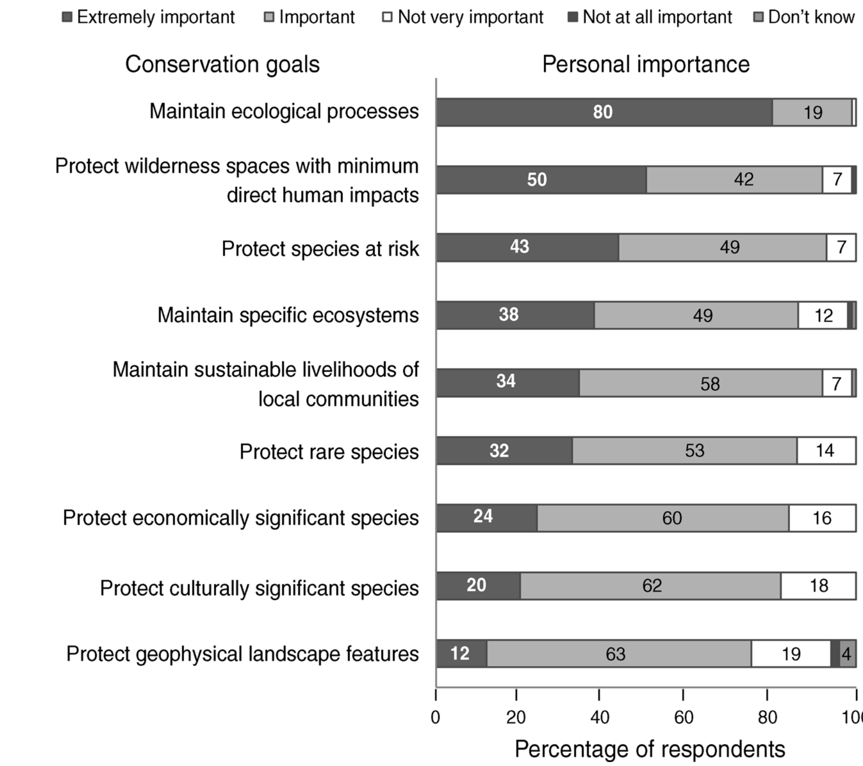

FIG. 3. Response to survey question: *Generally speaking, how important are the following conservation goals to you personally?* For each goal, n varies from 128 to 136. Response categories in the horizontal bars go from "extremely important" on the far left to "don't know" on the far right. Numbers inside the bars are the percentage of respondents selecting a particular response. Responses of 2% or less do not have a number label.

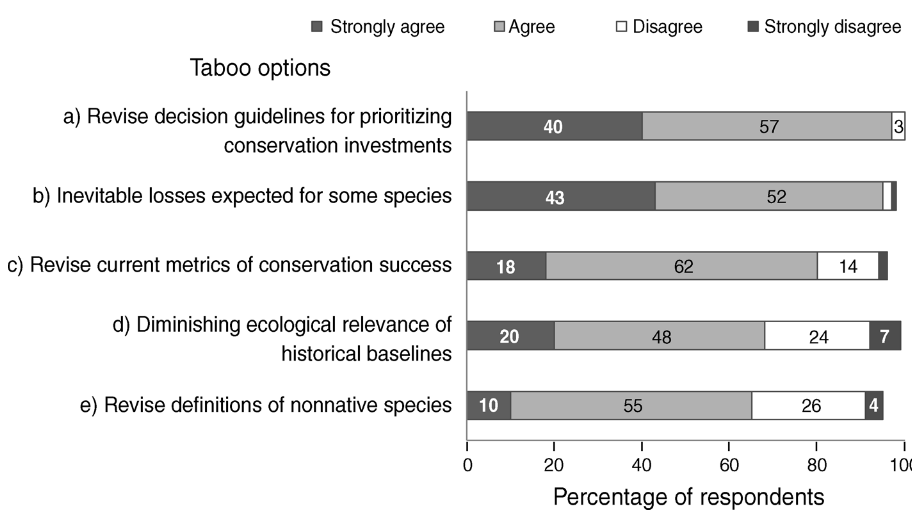

FIG. 4. Expert views across a set of previously contested taboo considerations for conservation. Exact wording for each survey question and number of responses (n) is as follows. (a) *Decision guidelines for prioritizing investments in species and ecosystems will need to be revised in consideration of climate change impacts* ($n = 129$). (b) *Given climate change and other drivers, even the best informed active management strategies will not be able to retain some species* ($n = 130$). (c) *Given climate and other drivers, current metrics of success (e.g., the persistence of specific species or ecosystem types in specific places) will need to be revised* ($n = 126$). (d) *Given climate and other drivers, the use of historical baselines as guidelines to conservation and restoration targets will become less ecologically relevant* ($n = 131$). (e) *Given climate and others drivers, definitions of nonnative species will need to be revised* ($n = 128$). Response totals may not add to 100 because a small number of respondents selected the "prefer not to say" response option. These responses are excluded. Response categories in the horizontal bars go from "strongly agree" on the far left to "strongly disagree" on the far right. Numbers inside the bars are the percentage of respondents selecting a particular response. Responses of 2% or less do not have a number label.

TABLE 1. Views about the most important conservation adaptation action ($n = 116$ respondents) in response to the survey question: *Of the following actions, which one do you think is the most important for conserving species and ecosystems in an era of climate change?*

Statements of actions	Percentage of respondents
Reduce non-climate stressors	36
Include biodiversity objectives in the management of off-reserve areas	24
Extend the spatial coverage of protected areas	22
Connect networks of protected areas through corridors	13
Passively allow historically nonnative species to become established in protected areas judged to have more suitable climatic conditions	3
Actively move nonnative species into protected areas judged to have more suitable climatic conditions	2

With respect to the sufficiency or not of existing conservation frameworks in light of climate impacts, 90% ($n = 128$) of respondents either "disagreed" (71%) or "strongly disagreed" (19%) with the statement that "Existing frameworks for adaptive management (managing ecological systems through a structured and iterative process of learning by doing) will be sufficient to protect and manage species and ecosystems given climate change." Levels of agreement across a set of potential elements of conservation redesign varied (Fig. 4). Respondents were nearly unanimous in their agreement or strong agreement that "guidelines for prioritizing investments in species and ecosystems will need to be revised considering climate change impacts" (97%, $n = 129$; Fig. 4a). Similarly, the majority of respondents "agreed" or "strongly agreed" with the statement that "Even the best informed active management strategies will not be able to retain some species" (95%, $n = 130$; Fig. 4b), and that "given climate change and other drivers, current metrics of success (e.g., the persistence of specific species or ecosystem types in specific places) will need to be revised" (80%, $n = 126$; Fig. 4c).

There was slightly more variation in response to questions about the relevance of historical baselines and definitions of native species. A slight majority of respondents (68%, $n = 131$) "agreed" or "strongly agreed" that "the use of historical baselines as guides to conservation and restoration targets will become less ecologically relevant" (Fig. 4d). Similarly, (65%, $n = 128$) "agreed" or "strongly agreed" that "given climate and other drivers, definitions of nonnative species will need to be revised" (Fig. 4e).

By contrast, when asked to choose the most important conservation action from a given option set of six conservation actions, including two unconventional actions, 90% of respondents judged one of the four conventional actions (reduce non-climate stressors, include biodiversity objectives in off-reserve areas, extend the spatial coverage of protected areas, and connect protected areas through connectivity corridors) as "the most important conservation action given climate impacts" (Table 1). Moreover, 56% reported "very negative" (12%) or "negative" (44%) "...feelings about strongly interventionist active management actions (e.g., species introductions) in conservation areas" ($n = 127$). Based on an analysis of mean scores, researcher experts were significantly more likely to indicate negative feelings about interventions relative to practitioner experts ($P = 0.0323$, $n = 127$). Additionally, across the full sample, female respondents were more likely to indicate negative feelings about interventions relative to male respondents ($P = 0.0335$, $n = 114$). No differences were detected across employer group, political perspective, age, or feelings toward interventions broadly. Lastly, respondents overwhelmingly (85%, $n = 124$) indicated that strategy plays a "very important" (46%), or "important" (39%) role "when publicly expressing their views about various adaptation actions."

Information and decision-making under uncertainty and implementation

We asked a subset of respondents who reported that some aspect of their job involves "management, planning, or land-use decision-making" ($n = 60$) about the types of information they use to inform their work; their views on decision-making under uncertainty; and the barriers they face in designing and implementing adaptation strategies and actions. The findings reveal a common contradiction at the nexus of science and decision-making. On the one hand, respondents indicate widespread agreement with the need for "decision-making under uncertainty." On the other hand, a lack of scientific information is indicated as a major barrier to adaptation. Further, this particular set of findings highlights the importance of attending to barriers that can be classed as "human dimensions."

The most commonly used sources of information (with >50% reported usage) from a provided set of 12 were vulnerability assessments (78%), case studies (78%), expert panels (68%), scenario planning (63%), and traditional and local knowledge (57%; Table 2). Comparatively less common were tools such as dynamic global vegetation models (30%) or climate-driven hydrologic projections (42%). The most commonly reported limitations to adaptation were "lack of information on synergistic impacts," "political and/or regulatory uncertainties," "conflicting objectives of agencies and stakeholders," "lack of climate impacts at relevant spatial scales," and "lack of institutional support" (Table 3). Although respondents cited lack of information relating to climate impacts as a limiting barrier to implementation, 84% of respondents simultaneously either "strongly agreed" (51%) or "agreed" (33%) that "adaptation decisions will need to be made

Table 2. Information used by the subset of respondents ($n = 60$) who report that some aspect of their job involves "management, planning, or land-use decision making."

Source of information	Percentage of respondents
Species vulnerability assessment	78
Case studies	78
Expert panels	68
Scenario planning	63
Traditional and local knowledge	57
Eco-regional assessments	50
Species-traits assessments	50
Bioclimate (niche) modes (species level)	48
Habitat suitability model	48
Bioclimate (niche) modes (ecosystem level)	47
Climate-driven hydrologic projections	42
Dynamic vegetation growth models	30

Note: Responses were to the survey question: *In practice, which (if any) of the following sources of information do you apply to decision-making in your work? Check all that apply.*

under conditions of persistent scientific uncertainties" ($n = 120$).

Discussion

The central finding of these results is the near-unanimous agreement of experts with a set of unconventional policy recommendations heretofore considered taboo to the extent that these include triage principles for decision-making, and managing for novel (not historical) ecosystems. Simultaneously, approximately half of the respondents indicate feeling negatively toward interventions such as assisted migration, and indicate a preference for conventional actions (e.g., reduce climate stressors or expand protected areas), as the most important conservation action, given climate change. This measured widespread agreement with climate-informed triage principles, and their suggestion of the need for unconventional actions, is a significant finding in its own right. At the same time, for many respondents, these views were tempered by a sense of discomfort associated with explicit interventions that were logically consistent with unconventional actions, and preferences for actions that are aligned with conventional approaches. Four topics arise for discussion in the context of understanding the implications of these findings for the evolution of biodiversity conservation in a warming world.

A convincing mandate for adaptation planning

Conservation experts were unequivocal in their assessment of the existence of climate change, and its anticipated wide-ranging impacts on ecological patterns and processes at times scales relevant for decision-making. The majority also agreed that current frameworks for adaptive management were insufficient for responding to climate change, indicating a convincing basis to pursue anticipatory adaptation. However, one-third of respondents worried that efforts to adapt to climate change detract from addressing more immediate drivers of change. This concern underscores the challenge of conservation broadly, given the need to address the impacts of historical (e.g., past harvesting practices) and current drivers (e.g., habitat loss and degradation) in the immediate term and within constrained budgets and shrinking human resources.

The unique formal and informal institutional rules and commitments of different land management agencies and conservation institutions will play an influential role in shaping their capacity to adapt to climate change, given perennially limited resources. Some conservation organizations, for instance, have leveraged climate-based concerns to secure additional resources for existing institutional commitments (e.g., to protected areas). This is exemplified by the approach of Conservation International (CI), which used a climate-based (specifically carbon) rationale to lobby for increased protected areas targets within the Convention on

Table 3. Views about limitations to implementing climate change adaptation among the subset of respondents ($n = 60$) who report that some aspect of their job involves "management, planning, or land-use decision making."

Response item	Responses indicating "extremely limiting" or "limiting" (%)	n
Lack of information about synergistic impacts	85	58
Political, regulatory, and legal uncertainties	76	56
Conflicting objectives of agencies and stakeholders	76	57
Lack of climate impacts information at relative scales	65	58
Lack of institutional support	63	57
Scientific uncertainties: ecological impacts of adaptation actions	62	58
Restrictive legislation/regulation	57	53
Lack of climate impacts information for my system of interest	57	56
Too busy with other work priorities	55	52
Difficulties deciding what to manage for	45	58
Restrictive agency mandate	45	52

Notes: Responses were to the survey statement: *Please indicate the degree to which the following items limit/do not limit your progress towards developing or implementing adaptation strategies for conserving and managing species and ecosystems.* The scale used was not at all limiting, not very limiting, limiting, extremely limiting, or no answer.

Biological Diversity (Hagerman et al. 2012), an effort that was arguably successful, given its consistency with prevailing institutional commitments (to protected areas) and norms (i.e., an aversion to intervention).

In contrast, current institutional rules and commitments of agencies such as the U.S. Forest Service (USFS) provide comparatively less opportunity to leverage climate-based concerns to explicitly motivate action. Despite a national mandate to respond to climate change on forest lands, and a wealth of information about adaptation in forested ecosystems, management-level activities within the USFS continue to be driven by the need to meet budget targets (i.e., board feet, miles of stream restored), regulatory obligations (i.e., to National Environmental Policy Act, Endangered Species Act, Clean Water Act), and immediate, non-climate issues (e.g., road access and management including culvert repair, and grazing).

These examples illustrate how responses to climate change are shaped by, and commonly reinforce, existing institutional rules and commitments. With time, and severity of impacts, however, these rules and commitments may come to be modified to include the acceptance of previously rejected pathways and actions.

Taboo thinking: expert agreement vs. preference

Our findings provide a detailed characterization of conservation experts' views that both reinforce and contradict the conclusions of related studies. Specifically, our findings are only partially consistent with Rudd's (2011) recent survey of experts. The latter study reported a "consensus" of views on some previously controversial conservation approaches and actions. Our survey detected similar agreement among experts regarding unconventional, taboo approaches to conservation (Fig. 4). Yet, it also found that when experts were asked to make explicit their commitment to the importance of various actions, preferences for conventional actions prevailed (Table 1). One might expect, therefore, that the focus of expert advocacy in conservation policy settings will continue to reinforce the promotion of existing (conventional) actions. This interpretation is consistent with at least two lines of evidence. The first comes from within this survey, where the vast majority of respondents indicate that strategy plays a very important role when publicly expressing their views about various adaptation actions. Previous research indicates that some conservation scientists are concerned that publicly expressing the need for interventionist actions or triage principles—however necessary they may be—is a slippery slope to apathy and reduced resources for conservation action (Hagerman et al. 2010*c*). The second piece of evidence derives from systematic observations made at recent international forums for conservation governance (e.g., The World Conservation Congress of the International Union for the Conservation of Nature and the Convention on Biological Diversity). There, as in other conservation forums, tensions surrounding expectations of success by conventional actions (such as protected areas) are occasionally voiced within technically focused sessions, but typically are quickly dismissed in favor of bolstering support for these same actions (Hagerman et al. 2012).

Still, the observed majority agreement with the set of taboo components sits in stark contrast to earlier published statements, and thus elucidates some of the shifting contours of the conservation policy landscape. Navigating these shifts in the service of protecting biodiversity to the greatest possible extent will require the integration of perspectives from disciplines that span the natural and social sciences.

Process goals amid static regulations and enduring values

This sample of conservation experts assessed the full list of potential conservation goals as important to varying degrees. However, it is noteworthy that relatively higher importance rankings were assigned to "maintaining ecological processes" ("ecosystem function" in Rudd 2011). This finding reflects the scientific literature on the key role of ecological processes for maintaining particular ecological patterns on the landscape as well as broader agency-wide directives to manage for ecological processes and function (e.g., British Columbia Ministry of Forests, Parks Canada, USFS).

Ecological processes aside, the conservation of iconic values such as those captured by the idea of wilderness or the possible charisma of endangered species (aka "species at risk") ranked second and third highest in importance. This combined importance of ecologically functional, and wilderness and species values reveals the multiple and sometimes competing objectives that motivate conservation activities. It also points to some of the fault lines that afflict efforts to manage for ecological processes within a regulatory landscape that is imprinted by enduring preservationist values and driven by objectives to maintain specific species and conditions.

Decision-making and the malleable role of scientific uncertainties

Lastly, the finding that scientific uncertainties (in this case those relating to regionally specific climate impacts and synergistic interactions) are viewed as barriers or limits to adaptation reflects an oft-observed paradox at the climate science/decision-making interface. That is, even though land and resource managers have always made decisions with scarce and/or uncertain knowledge, and widely agree with the need for decision-making under uncertainty, a lack of scientific information is typically cited as an influential barrier to action. This might be explained by the fact that, among a sample of scientifically trained practitioners, no matter how robust the science is, there will always be a desire for more data and less uncertainty, and thus a standing tendency to indicate scientific uncertainty as a barrier, irrespective of the actual influence (or not) of uncertainty on the evaluation, advocacy, and implementation of various actions.

More broadly, this finding may also reflect a commonly held (false) assumption that more or better information is one, if not *the*, crucial barrier to policy action. As demonstrated within the literature on behavioral decision-making, human behavior is more heavily influenced by historical relationships and experience, trust, social norms, affect, and belief, all of which can shape the interpretation of existing information (Kahan et al. 2009, Kahneman 2011). On this last point, it might be that scientific uncertainty is made to matter in decision-making not simply because of its perceived existence, but because it provides a legitimized way of asserting the objectives, beliefs, and values of those making decisions or promoting particular policy options.

That expressions of scientific uncertainty (as a barrier, or not) can to some extent be understood as standing in for particular normative positions and institutional commitments is consistent with our results. For instance, the experts surveyed here indicate that climate change will extensively impact dispersal, migration, biotic interactions, competition, mutualism, pathogens, and disease dynamics. While all of these processes are known to influence the distribution of species through space and time, they are not yet well represented in the models used to project future species and ecosystem distributions, given expected changes in climate. The myriad uncertainties that this creates in terms of model projections is widely recognized (Guisan and Thuiller 2005). However, it is also the case that these uncertainties tend to be glossed over in drawing implications for policy and management, namely recommendations for climate-informed, or "climate-smart" networks of protected areas (Williams et al. 2005, Vos et al. 2008, Hannah 2009, Rose and Burton 2011).

We argue that proposals for protected areas as an adaptation response to climate change have, in part, been insulated from meaningful policy discussions about the uncertainties associated with their effectiveness, because protected areas are nested within and sheltered by existing institutional norms. Other likely contributing factors include the view that the risks of unintended ecological consequences associated with protected areas are low in comparison with more interventionist actions such as species introductions (and thus there is relatively little need for implementation precaution in the face of uncertainty). Additionally, regardless of their efficacy, given climate change, many view protected areas as likely to deliver ancillary benefits to biodiversity in the short term (for instance by addressing immediate concerns such habitat loss and degradation).

Finally, three out of the five cited most important barriers or limits to implementing adaptation involve so-called "human dimensions" challenges. Political and regulatory uncertainties received high rankings, as did the challenge of navigating conflicting objectives of agencies and stakeholders. This finding reflects the very practical need to address the lack of empirical research on implementation dimensions of conservation adaptation. Outstanding questions to be addressed include the following. What institutional and resource characteristics contribute to successfully advancing adaptation initiatives in particular contexts? What decision processes and structures of governance can help to navigate inevitable clashes between adaptation and other objectives? How might regulatory frameworks and institutional arrangements be modified to better accommodate changing ecological conditions and potentially newly accepted management actions?

Conclusions and Future Research Directions

This study suggests several specific avenues for future research. Principally, the empirical material can be used as a reference from which to examine the potential evolution of expert views and preferences about conservation over time, as biophysical conditions change and previously unconventional-taboo options become potentially viable. This suggestion raises two design issues. The first relates to the need to assess views in specific decision contexts and locales (rather than in the abstract). The ability to do so is becoming increasingly possible as conceptual adaptation initiatives of the past 5–10 years are now being implemented. The recent study by Lemieux and Scott (2011) that examined scientist and manager views across suites of specific adaptation options as they applied to management options for Ontario parks is a good example of this much-needed move toward place-based research. To this end, we wholeheartedly agree with Lemieux et al. (2011) that, thus far, much of the conservation adaptation literature has been "too generic." Moreover, future place-based research needs to include a wide range of regional contexts so as to test the expected influence of different climatic exposure regimes on attitudes and preferences.

The second issue concerns the sample population. This study was specifically designed to build on past qualitative research with conservation and biodiversity experts. However, in many cases there was not enough heterogeneity in responses to the dependent variables (e.g., perceived risk, levels of agreement across policy actions) to test for the effects of the independent variables such as gender, age, and political perspective. Although we anticipated relatively high levels of agreement with the policy actions tested, we did not expect this degree of homogeneity, given earlier contention regarding responses such as triage. Understanding the views of experts is crucial for interpreting the basis of proposed policy alternatives as outlined in the *Introduction*. However, future (place-based) work would benefit from taking a broader definition of expertise to include local, traditional, and citizen knowledge. Accordingly, in addition to scientist and expert practitioners, this would include sampling the views of key constituents such as policy makers, indigenous communities, industry groups, and activists.

Lastly, with regard to future research directions, our findings clarify a need to systematically examine questions relating to climate-informed triage principles, and decision frameworks for thinking through the stewardship and management of novel ecosystems. Although many conservationists may understandably prefer not to devote their attention to what might be seen as an undesirable or even academically risky research program of "letting go" (Marris 2007), empirical analysis and transparent debate are needed to identify the most ecologically effective, politically feasible, and socially just management actions and approaches in particular social-ecological contexts.

The challenge of adapting biodiversity conservation policy and practice to a warming world is characterized by a tangle of persistent uncertainties relating to the impacts of, and responses to, climate change, novel conservation actions, and conflicting objectives. Navigating these challenges will require humility, a willingness to learn from efforts conducted in particular locales, and the combined perspectives of scholars, practitioners, and citizens, working at the various scientific, ethical, political, social, and legal fronts of conservation. The future of conservation may be unclear, but the need for interdisciplinary, comparative, place-based empirical inquiry for charting its navigation is certain.

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Supplemental Material

Appendix A

Descriptive statistics for the study sample (*Ecological Archives* A024-032-A1).

Appendix B

Survey instrument (partial) (*Ecological Archives* A024-032-A2).

Appendix C

Differences in the sample population (*Ecological Archives* A024-032-A3).