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# Social comfort zones for transformative conservation decisions in a changing climate

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**Article impact statement**
Comfort with climate interventions for forest biodiversity is high and new information reverses uncertainty and discomfort.

## Abstract

Novel management interventions intended to mitigate the impacts of climate change on biodiversity are increasingly being considered by scientists and practitioners. However, resistance to more transformative interventions remains common across both specialist and lay communities and is generally assumed to be strongly entrenched. We used a decision-pathways survey of the public in Canada and the United States ($n = 1490$) to test two propositions relating to climate-motivated interventions for conservation: most public groups are uncomfortable with interventionist options for conserving biodiversity and given the strong values basis for preferences regarding biodiversity and natural systems more broadly, people are unlikely to change their minds. Our pathways design tested and retested levels of comfort with interventions for forest ecosystems at three different points in the survey. Comfort was reexamined given different nudges (including new information from trusted experts) and in reference to a particular species (bristlecone pine [*Pinus longaeva*]). In contrast with expectations of public unease, baseline levels of public comfort with climate interventions in forests was moderately high (46% comfortable) and increased further when respondents were given new information and the opportunity to change their choice after consideration of a particular species. People who were initially comfortable with interventions tended to remain so (79%), whereas 42% of those who were initially uncomfortable and 40% of those who were uncertain shifted to comfortable by the end of the survey. In short and across questions, comfort levels with interventions were high, and where discomfort or uncertainty existed, such positions did not appear to be strongly held. We argue that a new decision logic, one based on anthropogenic responsibility, is beginning to replace a default reluctance to intervene with nature.

**KEYWORDS**
climate change, deliberation, forest biodiversity, pathway survey

Zonas de Comodidad Social ante las Decisiones de Conservación Transformadoras en un Clima Cambiante

**Resumen:** Los científicos y los practicantes de la conservación cada vez consideran más a las intervenciones novedosas de manejo con la intención de mitigar los impactos del cambio climático sobre la biodiversidad. Sin embargo, la resistencia a las intervenciones más transformadoras es común en especialistas y no profesionales y generalmente se asume que está fuertemente arraigada. Usamos una encuesta sobre toma de decisiones del público en Canadá y en los Estados Unidos ($n = 1490$) para evaluar dos

propuestas relacionadas a intervenciones de conservación motivadas por el clima: la mayoría de los grupos de público están incómodos con las opciones intervencionistas para conservar la biodiversidad y dada la sólida base de valores para las preferencias con respecto a la biodiversidad y a los sistemas naturales en general, es poco probable que las personas cambien de opinión. Nuestro diseño de encuesta analizó y reanalizó los niveles de comodidad con respecto a las intervenciones para los ecosistemas boscosos en tres puntos distintos dentro del estudio. La comodidad fue reexaminada con diferentes impulsos (incluyendo información nueva proveniente de expertos confiables) y en referencia a una especie particular (*Pinus longaeva*). Contrario a las expectativas de malestar del público, los niveles de línea base de la comodidad del público frente a las intervenciones climáticas en los bosques fueron moderadamente altos (46% de comodidad) e incrementaron cuando a los respondientes se les proporcionó información nueva y la oportunidad de cambiar su elección después de considerar a una especie particular. Las personas que al inicio estaban cómodas con las intervenciones tendieron a permanecer así (79%), mientras que el 42% de aquellos que estuvieron incómodos inicialmente y el 40% de aquellos que estuvieron inseguros cambiaron a estar cómodos para el final del estudio. En resumen, los niveles de comodidad frente a las intervenciones fueron elevados, y cuando existieron malestar o incertidumbre, dichas posiciones no parecieron mantenerse con fuerza. Argumentamos que una lógica de decisión basada en la responsabilidad antropogénica está comenzando a reemplazar una renuencia predeterminada a intervenir en la naturaleza.

**PALABRAS CLAVE**
biodiversidad del bosque, cambio climático, deliberación, encuesta de decisiones

## INTRODUCTION

A new sense of climate urgency has emerged in reference to natural resource sectors (Stern, 2015), with associated calls for more protected areas (Dinerstein et al., 2019), greater sharing of agrobiodiverse landscapes with wildlife corridors, hedgerows, or pollinator habitat (Benayas et al., 2020; Lecq et al., 2017), and changing consumption patterns to reduce the conversion of wildlands and forests (Kupers, 2020). These concerns and calls for action have only been heightened by the staggering Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services statistic that up to 1 million species now face extinction, many within decades (Diaz et al., 2019). Increasingly, many solutions emphasize extensive ecosystems interventions. This is true in the case of efforts to radically scale up afforestation for carbon sinks (Abiodun et al., 2013) through to transformative plans to stem biodiversity losses via new conservation agendas (McElwee et al., 2020). More recent strategies for stemming sixth extinction biodiversity loss include aiding threatened species by manipulating genomic sequences (Breed et al., 2019) and using assisted migration to move species to new habitat as current ecosystems are transformed by climate effects (García-hernández & Toledo-aceves, 2020).

However, resistance to genetic transformations or assisted migration runs deep within both expert and lay communities. Most conservation scientists remain uneasy with the spectre of unintended consequences of "engineered ecosystems" containing intentionally introduced species or genome-edited organisms (Phelps et al., 2020). Public groups express similar resistance toward genomic interventions to support wildlife conservation (Kohl et al., 2019), and geoengineered solutions for climate (Corner et al., 2012). Reasons for public opposition are often attributed to the transgression of strongly held values regarding nature (Siipi & Ahteensuu, 2016), such as is the case of the use of genomics in coral reef restoration (Morrison et al., 2020).

The evidence for why lay and expert groups hold entrenched positions against climate interventions are generally two-fold. First, an affectively valenced (e.g., emotionally charged) discomfort can arise when strongly interventionist management options are presented (Gifford et al., 2011), even when some support or at least uncertainty was initially present. Second, novel interventions are and have been evaluated as morally difficult (Hagerman & Satterfield, 2014) or as violating protected values (Baron & Spranca, 1997; Ginges et al., 2007). Such filtering "protected values" are often concerned with threatened species or highly valued ecosystems, and said to be infinitely valuable and inviolable despite any compensating benefit (Baron & Leshner, 2000). The logic of protected values is equally prevalent among conservation scientists who see such interventions as a slippery slope, as dangerously transgressing historical baselines, or involving outcomes that are poorly understood (Hagerman & Satterfield, 2013). Trading protected values off for economic or other outcomes is thus considered non-negotiable (Hanselmann & Tanner, 2008; Sacchi et al., 2014; Visschers & Siegrist, 2014), even where arguments for multiple benefits can be identified (Baron & Spranca, 1997; Daw et al., 2015). Thus, the already strong value positions associated with biodiversity or avoidance of manipulating nature closes the door on many difficult but necessary conversations.

There has been much controversy surrounding emerging management actions, including the continued suppression of species designated invasive despite climate-driven changes (Shackelford et al., 2013); rejection of assisted migration of

species to and from changing landscapes (Aubin et al., 2011; Palmer, 2019); and discomfort with the use of genomics to enhance survival of compromised keystone species and systems (Corlett, 2017). Many such actions are especially controversial when proposed for public lands and where consultation and reconciliation of diverse values and objectives is required (Gregory et al., 2013), and trust in managing authorities may be low (Stern et al., 2015). Thus, by and large, two assumptions about climate-motivated interventions for conservation prevail: most public groups are uncomfortable with interventionist options for conserving biodiversity and given the strong values basis for preferences regarding biodiversity and natural systems more broadly, people are unlikely to change their minds. Ultimately, greater effort to investigate when, where, and under what conditions protected values are durable and when comfort thresholds are fixed, is key if scholars and policy makers are to engage robustly in conversations about novel and transformative interventions.

To date, most efforts to discern the reasons for support or rejection of climate solutions use surveys based on descriptive or associative analysis (correlations or multiple regressions). However, methods for eliciting the conditions of rejection or acceptability of climate-motivated novel interventions are still nascent. Discerning the conditions under which positions vary and apply to decision-making, and why, is necessary to address this emerging and potentially difficult decision context. We sought to explore one example of a difficult decision: intervening in forest ecosystems in response to the impacts of climate change. This work, and broader survey, is part of a multifaceted project that also investigated views about interventions in relation to the specific case of bristlecone pine (Gregory et al., 2021). We used an interactive and deliberative method known as a decision pathway survey (Gregory et al., 2015). Decision pathway surveys offer a unique approach suited to policy makers because they reveal only levels of support across larger and representative sample frames and the reasoning processes of individuals as they make or resist trade-offs inherent to policy decisions (Gregory et al., 1997; Gregory et al., 2015). The design was adapted to explore deep-seated, though potentially malleable, positions of comfort, discomfort, or uncertainty associated with climate-adaptation interventions.

Perspectives on intervention as related to levels of comfort were examined in general before and after consideration of threats posed to high-alpine bristlecone pine forests. We assessed how durable support for and against intervention were in relation to assurances from trusted experts and as a function of deliberative thought throughout the entirety of the survey. This design reflects key debates for and against interventions in nature as identified in the literature and summarized above. Results reveal the in-principle distribution of comfort through discomfort with novel climate interventions; rationales attached to these positions; fixedness of positions (e.g., from in-principle comfort to discomfort or the reverse) before and after discussion of intervention options; and demographic and attitudinal positions associated with the durability of principled positions. In doing so, we investigated the following questions: How comfortable, in principle, are publics about transformative interventions for forest biodiversity, are people open to some revisiting of their first in-principle positions, be that to strengthen, weaken, or reverse original positions, and are those positions strongly held and under what central conditions?

## METHODS

### Survey design

We employed a decision-pathways approach to investigate these questions. Pathway surveys involve an iterative style of questioning that seeks to mimic small group discussions, but enable larger sample sizes. Based on decision theory, most policy preferences elicited in survey-style contexts are said to be constructed in response to predispositions held, but also in response to question framing or nudges (John et al., 2013) and the quality of information provided (Pelletier & Sharp, 2008). Specifically, behavioral decision theory posits that survey methods for eliciting choices (e.g., a preference for policy A or price B) will likely elicit systematically contradictory responses. By this, we mean that preferences do not always abide by assumptions of invariance consistent with rational choice (Lichtenstein & Slovic, 2006). In response, prescriptive decision theory suggests that decision elicitation contexts should recognize that one's initial response might be vague or underspecified in reference to the values one holds, the consequences inferred or the trade-offs involved. Pathway surveys, alternately, accept as a given need for a more iterative style of questioning (Gregory et al., 2015). Thus, these theorists recommend that decision problems be structured such that they clarify the decision context, elicit the reasoning behind trade-offs, offer increasingly specified information as the conversation deepens, and allow the decision itself to be decomposed into its component parts (e.g., values about nature, learning, and consideration of adaptation given uncertainty, etc.). The goal is to approach decisions as a multistage process—slowing down the steps by moving slowly from opening (value) positions to developing policy alternatives and addressing the implications of trade-offs made, as well as further or iteratively revisiting initial decisions (Gregory et al. 2012). Although this remains a nascent option for survey work, our goal was to express ideas about how decisions should be structured as fully as possible.

Using the prescribed steps referenced above by, we placed at the center of the design a value (principle) question about openness in principle with intervening in forest ecosystems. This question took three forms: "Are you in principle comfortable, uncomfortable or uncertain about intervening in forest ecosystems?" Based on one's initial in-principle choice, respondents were directed toward four options explaining the reason for their choice (including a free response option). These reasonings reflect debates in the conservation literature regarding historical (ecological) baselines, manipulating nature, knowledge certainty and uncertainty, and the problem of a perceived slippery slope.

The in-principle question was asked three times: after the opening decision context; after providing reasoning behind that principle and guidance to further information provided by

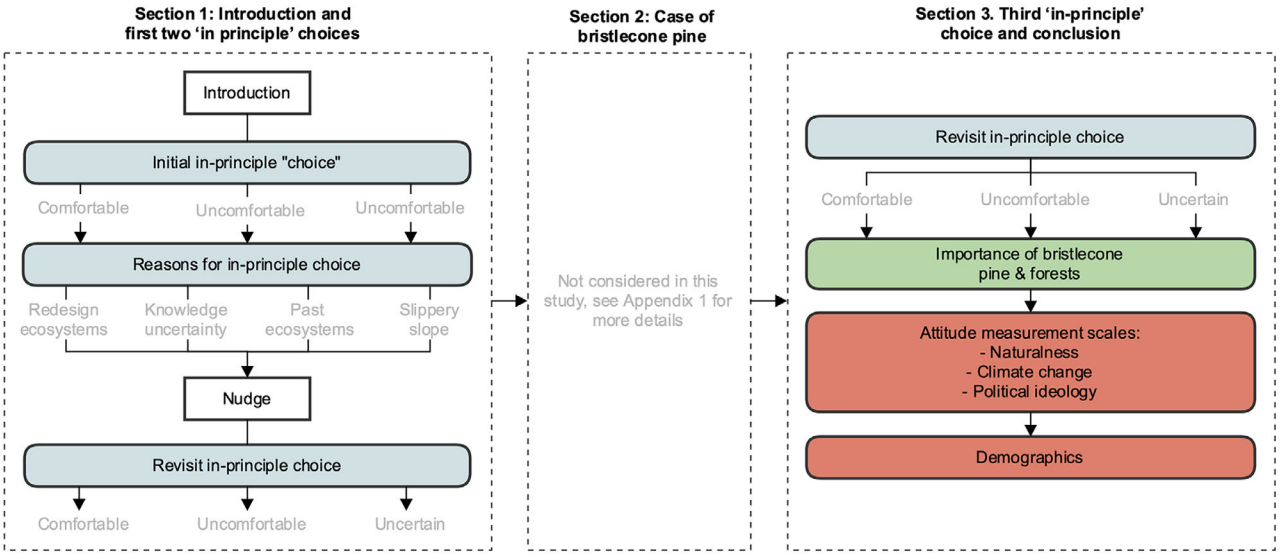


**FIGURE 1** Pathways survey design sequence highlighting the order of in-principle choices and nudges

trusted experts; and finally after a deliberation about interventions for bristlecone pine, an iconic tree species endangered by climate change (Figure 1). Questions about the bristlecone pine are best understood as a moment within the survey when participants had the opportunity to consider more deeply what interventions might look like and achieve for a specific species of concern. We also assessed the association between demographic (e.g., age and gender) and explanatory variables (e.g., views on climate change) and levels of comfort with forest interventions. The decision context, order, and question text and scales for the in-principle questions and nudges are in the Appendix.

## Sample, data collection, and analyses

Data were collected using Qualtrics software (https://www.qualtrics.com). We distributed the online survey between 1 May and 3 June 2019 to adults over the age of 18 living in the United States and Canada. We used a digital data collection company (Dynata, https://www.dynata.com) to generate a sample stratified by age, gender, education, and income across each state or province. After removing incomplete responses ($n = 288$) and those that were completed in <5 min ($n = 545$), the final analyzed sample was $n = 1490$. The average completion time for analyzed surveys was approximately 15 min. Statistical analyses were performed in R Studio (version 1.2.1335). We used descriptive statistics (e.g., frequencies) to summarize the different variables used in the study and to assess changes in positions. We also asked respondents to indicate their views on climate change based on a set of 7 Likert-scale statements (Appendix). Each item was assessed on a 6-point scale that included a *don't know* option. A climate change risk index ($\alpha = 0.72$) was created by averaging scores of the seven statements. Last, we ran a multinomial logistic regression to evaluate the relationship between determinant variables (gender, age, country of residence, and education) and respondents' levels of comfort. We also used multinomial logistic regressions to assess the extent to which independent variables predicted shifts in comfort levels given new information from trusted experts and after completing the survey and deliberating on the bristlecone pine case. We ran six regressions on dependent variables defined as respondents who were originally comfortable but then became uncomfortable or uncertain; originally uncertain but then became comfortable or uncertain; and originally uncomfortable but then became comfortable or uncertain.

# RESULTS

Our results reveal two primary insights for understanding public positions on climate-motivated interventions in forests and the fixedness or fluidity of these positions. First, in contrast to the bulk of the literature showing deep unease, we found high initial levels of public comfort with forest interventions. Second, we found a pronounced shift toward increasing comfort when new information was provided by trusted experts and the opportunity to change choice after consideration of a particular case was also provided. Specifically, people who were initially comfortable with interventions tended to remain so, whereas those who were initially uncomfortable or uncertain tended toward increasing comfort. Overall, comfort levels were high, and where uncertainty or discomfort existed, such positions did not appear to be strongly held.

## Characterizing states of comfort

Participants' baseline positions regarding climate-interventions in forests were comfortable (46%), uncertain (41%), or uncomfortable (13%). The rationales connected to these

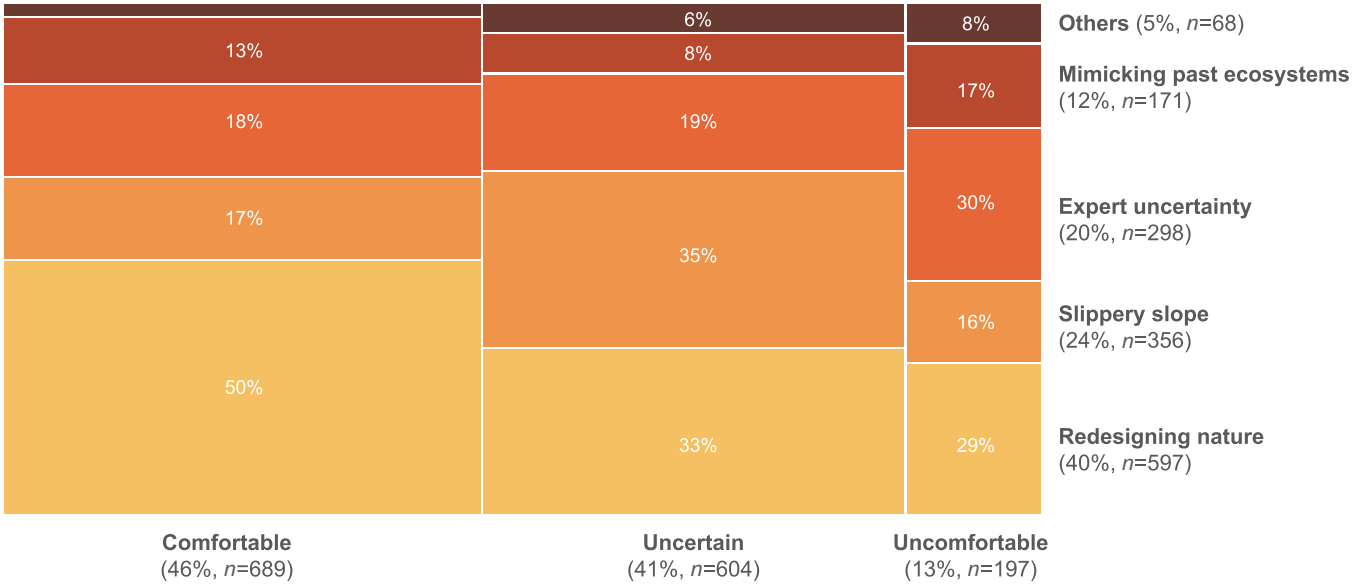


**FIGURE 2** Rationales connected with baseline, in-principle positions of being comfortable, uncertain, or uncomfortable with climate interventions in forests

positions were as follows (Figure 2): 47% of the comfortable group were of the view that "it is time to think seriously about redesigning nature," 18% were comfortable because "the outcomes of interventions are well understood by experts," and 17% were comfortable given they "didn't think intervening would take us too far in unwanted directions." Open-ended responses provided additional context for the comfortable position: "If we are causing climate change, we have a responsibility to try to negate the effects, even if we don't understand all the effects"; "We can't wait by, and let our forests die"; and "Intervention in forest systems has been going on directly and indirectly for many years…with terrible consequences. We may as well intervene in effort to do some good."

Rationales for the uncertain position were more varied: 35% of this group indicated "slippery slope" as the logic for their choice, 33% that "redesigning nature crosses a line," and 19% cited "expert uncertainty." The open-ended comments associated with this position conveyed the sense that respondents were uncertain about their own knowledge: "I don't know enough about proposed interventions to have an informed opinion" and "I am not educated enough about this issue to form an opinion yet."

Rationales for the uncomfortable position also varied, but differently from the uncertain group: 30% indicated "expert uncertainty" as the logic for their choice, 29% did so out of "opposition to redesigning nature" and 17% due to concerns about failing to "mimic past forest ecosystems." Open-ended comments for this position reflect these top two concerns of expert uncertainty: "The people making decision often do not understand the ecosystems, and the action needed"; and an aversion to intervening in nature: "I don't believe in manipulating nature, we don't know enough to play around with it"; "It is not our place to mess with nature."

## Durability of positions given new information and consideration of a specific species

The first test of the fixedness of these in-principle positions came in the form of a prompt about new information from "experts you trust" after which respondents were given the option to maintain or change their initial position (see Table 1 for text specific to each respondent's initial position). Figure 3a shows that a small to large majority of respondents in all positions maintained their original position. Sixty-five percent (65%) of those who were initially comfortable with intervention remained so; 21% and 14% shifted to uncertain and uncomfortable, respectively. For the initially uncertain group, a similarly high proportion (62%) maintained their initial position, but 28% shifted to the comfortable position. Only 9% shifted from uncertain to uncomfortable. Just over half (52%) of those in the uncomfortable group remained so. An equal proportion of remaining respondents shifted to comfortable (24%) or become uncertain (24%).

The second test of the fixedness of in-principle positions followed an opportunity for deeper consideration of the threat of climate change for bristlecone pine and different levels of intervention to help that species adapt. A large majority (79%) of those who were initially comfortable with intervention remained so following new information from trusted experts in combination with consideration of how interventions might be applied to a particular species (Figure 3b). For 13% and 9% of this group, further deliberation about the bristlecone pine prompted a shift to uncertain and uncomfortable, respectively. For the initially uncertain group, 47% remained so, but a full 40% shifted their position to comfortable with further deliberation. A much smaller proportion (13%) moved from uncertain to uncomfortable. Shifts toward comfort with deliberation were also observed for the initially uncomfortable group: 35%

**TABLE 1** Order, question text, and scales for in-principle questions and nudges in a survey of 1490 respondents[a]

| Question | Question text | Response options |
|---|---|---|
| In-principle comfort question | We'd like to begin by asking whether, in principle, you are comfortable, not comfortable, or uncertain about intervening in forest ecosystems, given climate change? | *Same for all participants*:<br>In principle, I am comfortable intervening in forest ecosystems given climate change<br>In principle, I am not comfortable intervening in forest ecosystems given climate change<br>In principle, I am uncertain about intervening in forest ecosystems given climate change |
| Reasons justifying in-principle question | Which statement below best explains why you are [comfortable OR uncomfortable OR uncertain] with intervening in forest ecosystems, given climate change? | Specific text varied depending on response to Q1:<br>Need to redesign forest ecosystems<br>Uncertainty around intervening in forest ecosystems<br>Importance of mimicking past forests<br>Intervening as a slippery slope Other reasons–fill in |
| Nudge following in-principle question | Three different nudges, depending on response to Q1, all regarding expert confidence or uncertainty:<br>If Q1 = "comfortable": What if you learned that intervening in forest ecosystems to better adapt to future climates caused changes in the forest unanticipated by experts you trust?<br>If Q1 = "uncomfortable": What if you learned that intervening in forest ecosystems to better adapt to future climates was closely monitored by experts you trust?<br>If Q1 = "uncertain": What if you learned that intervening in forest ecosystems to better adapt to future climates was only done when experts you trust thought it was the best option?<br>Are you in principle still [comfortable OR uncomfortable OR uncertain] about this intervention? | I would definitely not intervene further<br>I would probably not intervene further<br>I could go either way<br>I would probably intervene further<br>I would definitely intervene further<br>I don't know/am not sure |
| Bristlecone pine question set: Preferred bristlecone management approach, nudge about interventions, reasons for preference, other preferred actions | | |
| Return to in-principle question | Let's now return to the first question: We began by asking you to consider some impacts of climate change on forest ecosystems and the general range of interventions that are commonly proposed. In principle, would you now say that you are comfortable with, uncomfortable with, or uncertain *about* intervening in forest ecosystem given climate change? | In principle, I am comfortable intervening in forest ecosystems given climate change<br>In principle, I am not comfortable intervening in forest ecosystems given climate change<br>In principle, I am uncertain about intervening in forest ecosystems given climate change |

[a]The decision context text was: "A major challenge in forestry is how to manage for the impacts of climate change—particularly as the survival of species is in question and new species moving into existing forest habitats. Different interventions have been proposed. These range from taking no action, all the way through active manipulation of ecosystems."

of these respondents held to their initial position, with 42% shifting to comfortable and 24% to uncertain.

## Explanatory variables

An overview of respondents' demographic data is in the Appendix. Overall, respondents with higher scores for (the climate risk index) perceived a greater risk from climate change and agreed that climate change is anthropogenic in nature (Table 2). Respondents' perceived risks from climate change were highly correlated with political views, with conservative respondents generally having a lower average score ($r_s = -0.37$, $p < 0.001$). Consequently, we used only the climate change risk index in the regression analyses. Respondents with higher scores in the climate change risk index were more likely to be comfortable with intervening in ecosystems compared with respondents who were uncertain, whereas respondents with lower perceived risk from climate change were less likely to be comfortable with intervention. Gender and country of residence were strongly associated with levels of support. Male and Americans in our sample were more likely to be comfortable with intervention. In contrast, age was a negative predictor, with older respondents being less likely to be comfortable.

At least one explanatory variable was statistically significant in all six regressions related to shift in comfort for intervention (Table 3). The index of climate change risk was significant across all the regressions. Respondents who perceived less risk from climate change were more likely to shift from comfortable to uncertain or uncomfortable, whereas a higher perceived risk was positively associated with shifts in positions from uncertain or uncomfortable to comfortable. Similarly, other determinant variables (e.g., gender and age) were also statistically significant in some regressions. The results of how the determinant variables explained the regression models on shifts in levels of comfort (Table 3 & Table S2) were generally in line with the regression model on respondents' levels of comfort (Table 2).

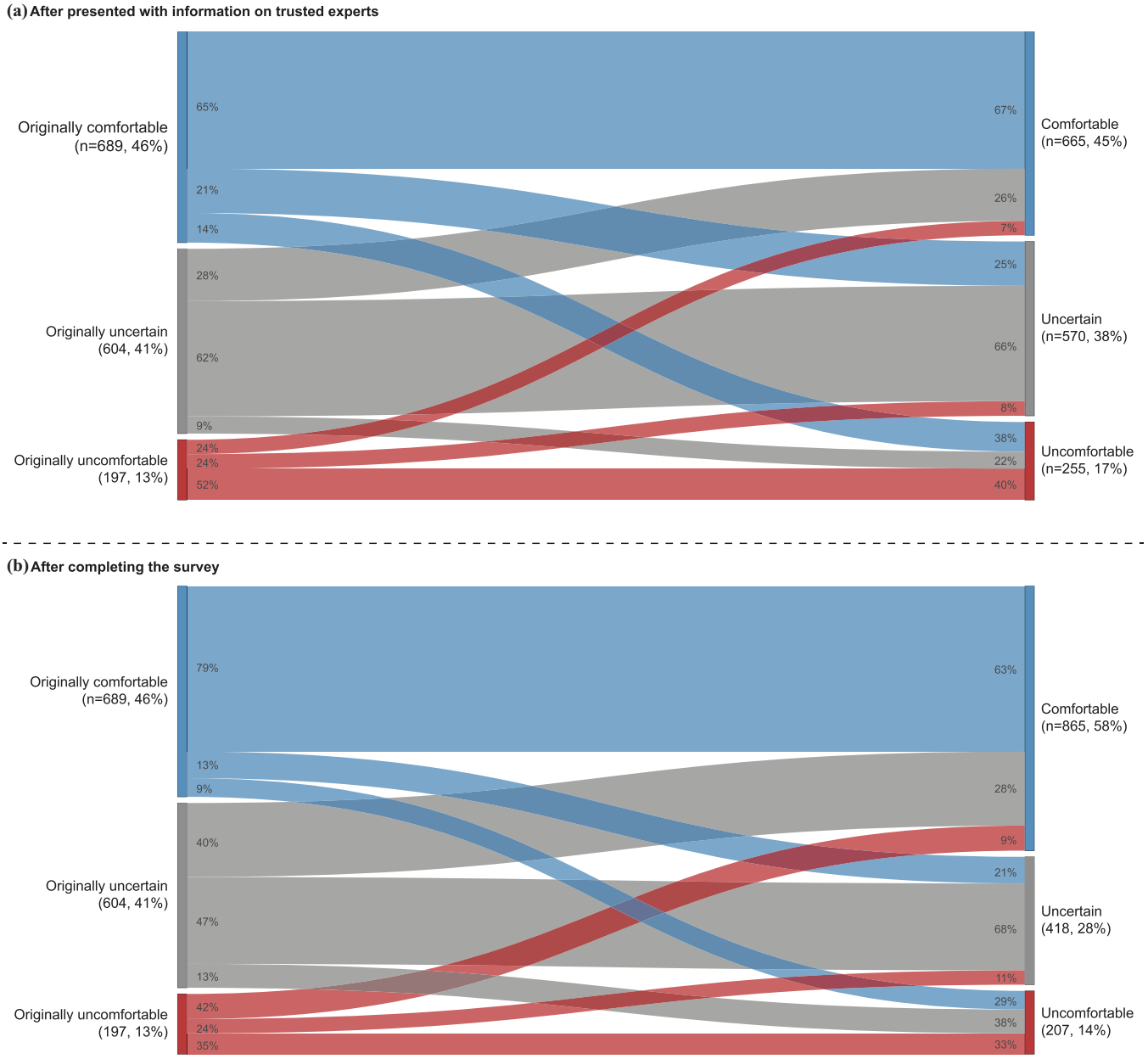


**FIGURE 3** Percentage of respondents who maintained or shifted their original comfort, uncertainty, or discomfort level with intervening in forest ecosystems (a) after being presented with information from trusted experts and (b) at the end of the survey

## DISCUSSION

We set out to answer three questions about how people think about novel, climate-motivated forest biodiversity interventions. Three key findings include evidence that a new default decision logic regarding intervening in nature may be operating, that comfort with interventions is common and relatively stable state of mind, and that assurances from trusted experts were generative of changing comfort levels, but even more so when combined with the opportunity to consider a particular species and place.

### Shifting decision logic

Our survey showed that respondents are generally comfortable with transformative interventions to conserve forest biodiversity and overall tended to become more so with information from trusted experts and consideration of a specific species. The commonly selected rationales and supporting comments linked to these initial positions suggest that comfort is being driven by the sense that the time for redesigning nature has arrived. This position is in stark contrast to previously observed dominant logics that are linked to the belief

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**TABLE 2** Results of multinomial logistic regressions ($n = 1418$) evaluating the association between the independent demographic variables and levels of comfort with intervening in forest ecosystems[a]

| | Comfortable | | Uncomfortable | |
|---|---|---|---|---|
| | odds ratio | 95% CI | odds ratio | 95% CI |
| Intercept | 0.36** | 0.17–0.75 | 0.81 | 0.28–2.33 |
| Gender[b] (male) | 1.61*** | 1.27–2.04 | 1.30 | 0.92–1.83 |
| Age | 0.98*** | 0.98–0.99 | 1.00 | 0.99–1.01 |
| Country of residence[c] (USA) | 1.34* | 1.05–1.70 | 1.25 | 0.88–1.78 |
| Education[d] | 1.04 | 0.96–1.13 | 0.97 | 0.86–1.08 |
| Climate change risk index[e] | 1.56*** | 1.31–1.84 | 0.75* | 0.59–0.96 |

[a]The group of uncertain respondents is used as the baseline in the regression. Classification table (percentage correct) with intercept only = 0.47 and predictors = 0.55. Probability: * $p \leq 0.05$; ** $p < 0.01$; *** $p < 0.001$.
[b]Reference category is female.
[c]Reference category is Canada.
[d]Scale from high school diploma or general education degree (spell out) (1) to doctorate or professional degree (6).
[e]Scale from strongly 1, disagree, to 5, strongly agree.

that nature would be best protected if essentially left alone (Hagerman et al., 2010) (e.g., don't-mess-with-nature logic). Our results may provide some evidence that guiding decision logics for conservation in an era of climate change are shifting toward a new default heuristic of anthropogenic responsibility. Put differently, as the impacts of climate change become increasingly clear and given recognition that humans are the cause, people may be increasingly feeling an ethical duty to act, including a greater willingness to intervene to help species affected by our actions. This interpretation is further evident in the open-ended responses and regressions showing that people who think that forests are important are also more comfortable with interventions.

We suggest that our results show a shift in logics about intervention from don't mess with nature to anthropogenic responsibility that is consistent with broader trends observed in conservation over the past decade. For example, support for climate-adaptive forest intervention among professional foresters in Canada (St-Laurent et al., 2021) is more recently evident, and conservation nongovernmental organizations are increasingly supporting more interventionist and transformative activities (St. Laurent et al., 2020). These aforementioned studies do not investigate underlying decision logics as we did, but they are consistent with the interpretation that a new default logic may be at work. Future work should test the relative salience of the two logics: Is one replacing the other as increasingly common? And, how might these logics operate differently (or not) in principle versus in specific (and varied) contexts (e.g., production vs. conservation landscapes)? Finally, the forests of Canada and the United States are widely recognized as already being highly managed and manipulated by human intervention. The context of forests, that serves as the center of this survey, may thus be further contributing to high levels of comfort with climate-driven interventions. Future work should examine how different logics operate in different ecological contexts.

## A tendency toward comfort

As for the question of how strongly held are different in-principle positions, two key findings are notable. First, relative to the uncertain or uncomfortable groups, comfort is a stable state of mind. The majority (79%) of people in this group maintained their initial position and did not change their position by the end of the survey (Figure 3b). In contrast, an initial in-principle position of uncertain or uncomfortable was comparatively less stable. For the uncertain group, less than half (47%) held to their initial position, which makes intuitive sense, particularly after being provided with a nudge by trusted experts and a specific example. Only 35% of those originally uncomfortable held to their original position at the end of the survey. Second, and more salient, is the directionality of change. Almost all movement for the uncertain and uncomfortable groups where it was observed shifted to comfort (40% of the initially uncertain group shifted to comfort, and 42% of the initially uncomfortable group shifted to comfort).

This observation of reversals for principled positions associated with values-based concerns (in this case, intervening in forest ecosystems) complicates the commonly held assumption that values-based positions are inviolable when making trade-offs. Such assumptions are worth questioning and challenging considering the scale of environmental disruption that a rapidly changing climate has introduced and the attendant interventions that may come to be seen as necessary. As above, it may be that anthropogenic responsibility is emerging as a default decision logic. If it takes root, the management actions that become newly acceptable will introduce a new suite of complicated trade-offs between species, among ecological and human well-being objectives, and among other trade-offs. Future work is urgently needed in the deliberative realm to ensure that decision processes associated with these interventions render trade-offs transparent and are informed by diverse forms of expertise. More specifically, methods for public engagement (qualitative or quantitative) need to improve opportunities for acquiring new information, consulting experts, providing opportunities to rethink original positions, or enabling deliberation and value reflection (Bachtiger & Parkinson, 2019).

The reversals in principles we observed are consistent with the large body of literature showing how preferences in general are constructed (Lichtenstein & Slovic, 2006) in contexts ranging from wildfire management (Arvai et al., 2006) to genomics technologies (Findlater et al., 2020). The idea of preference reversals is central to this literature, and these have tended to be observed when technologies are new and unknown (e.g., nanotechnology) (Satterfield et al., 2013), when value is expressed in dollars for nonmarket goods (Kahneman & Knetsch, 1992), or when evaluability of an option is poor (e.g., there is no way

**TABLE 3** Results of multinomial logistic regressions evaluating the association between independent demographic variables and changes in levels of comfort with intervening in forest ecosystems after completing the survey[a]

| | Originally comfortable ($n$ = 689)[b] | | | | Originally uncertain ($n$ = 604)[c] | | | | Originally uncomfortable ($n$ = 197)[d] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | uncertain | | uncomfortable | | comfortable | | uncomfortable | | comfortable | | uncertain | |
| | oddsratio | 95% CI | oddsratio | 95% CI | oddsratio | 95% CI | Oddsratio | 95% CI | oddsratio | 95% CI | oddsratio | 95% CI |
| Intercept | 0.38 | 0.08–1.77 | 4.61 | 0.69–30.64 | 0.10*** | 0.03–0.35 | 1.64 | 0.30–8.95 | 0.15 | 0.01–2.15 | 0.08 | 0.004–1.58 |
| Gender[e] (male) | 0.52** | 0.32–0.84 | 1.28 | 0.72–2.27 | 0.95 | 0.65–1.38 | 1.14 | 0.66–1.97 | 0.72 | 0.32–1.61 | 0.46 | 0.19–1.14 |
| Age | 1.00 | 0.99–1.02 | 0.99 | 0.98–1.01 | 0.99 | 0.98–1.00 | 1.00 | 0.99–1.02 | 0.96** | 0.94–0.99 | 0.97* | 0.94–1 |
| Country of residence[f] (USA) | 0.80 | 0.49–1.31 | 1.76 | 0.89–3.47 | 1.31 | 0.90–1.90 | 1.11 | 0.63–1.95 | 0.64 | 0.27–1.53 | 0.64 | 0.24–1.66 |
| Education[g] | 0.96 | 0.82–1.12 | 0.78* | 0.64–0.95 | 0.97 | 0.85–1.11 | 0.96 | 0.79–1.16 | 1.08 | 0.83–1.4 | 1.11 | 0.83–1.49 |
| Views on climate change index[h] | 0.87 | 0.60–1.26 | 0.37*** | 0.24–0.58 | 2.16*** | 1.60–2.90 | 0.52*** | 0.35–0.77 | 4.01*** | 2.2–7.29 | 3.71*** | 1.9–7.26 |

[a]Results for changes in levels of comfort with intervening in forest ecosystems after new information about trusted experts are in the Appendix. Probability: * $p \leq 0.05$; ** $p < 0.01$; *** $p < 0.001$.
[b]Reference category is comfortable. Classification table (percentage correct) with intercept only = 0.78 (predictors = 0.79).
[c]Reference category is uncertain. Classification table (percentage correct) with intercept only = 0.52 (predictors = 0.47).
[d]Reference category is uncomfortable. Classification table (percentage correct) with intercept only = 0.57 (predictors = 0.42).
[e]Reference category is female.
[f]Reference category is Canada.
[g]Scale from high school diploma or general education degree (1) to doctorate or professional degree (6).
[h]Scale from strongly disagree (1) to strongly agree (5).

of thinking about option A as compared with option B) (Li & Hsee, 2019). Overall, for both uncertain and uncomfortable groups, exposure to assurances from trusted experts and the specific case were more generative of change (almost doubly so) than trusted expertise alone. The abundance of literature demonstrating the role of trust in support for emerging policies (Arimoto & Sato, 2012) and our findings that expert uncertainty drives discomfort raise important questions about what constitutes a trusted expert in the eyes of an individual and about the nature of expertise more generally.

Given the relative newness of proposals for novel interventions, lack of data, and the attendant uncertainty that outcomes of such interventions hold, expert judgment has and will continue to be a key input to decision-making in this realm. Accordingly, the role of trusted experts was a key design feature in this survey. Overall, our findings suggest that publics are willing to reevaluate their positions in light of trusted expertise. This openness serves as an important reminder for thinking about the nature of expert judgments. As has been repeatedly demonstrated and reviewed extensively elsewhere, experts, like publics, are prone to values-based and cognitive heuristics in constructing their judgments (Burgman, 2015). Here, our concern is how best to think about and use expert judgments in novel interventions given what is known about these heuristics. Three key points are worth highlighting. The first is the need for a diversity of expertise. "Judgments based on inputs form multiple experts consistently outperform judgments from a single best expert" (Burgman, 2015: 145). Second, and related, is the need for careful consideration of how different forms of knowledge are validated. Research in the field of science and technology studies has consistently demonstrated how different forms of knowledge are asymmetrically connected to structures of power and thus problem formulation, solutions, and the costs and benefits that flow from these (Forsyth & Walker, 2012). Finally, for policies that are novel and value laden (such as we explored here), not trusting your gut (Burgman, 2015) is particularly salient. Instead, engagements between publics, stakeholders, and diverse experts should seek to foster slower thinking (Kahneman, 2011) with methods that encourage clarification of values, document reasoning, make motivational biases explicit, and provide opportunities to consider multiple perspectives.

## Importance of views on climate change

Both multinomial logistic regression analyses (for determinants of comfortability with intervention [Table 2] and for malleability in perceptions after being provided with information about experts [Appendix] and completing the survey [Table 3]) had similar results regarding the significance of the independent variables. Greater perceived risk of climate change and acceptance of its human origin were associated with a greater likelihood of being comfortable with intervening in forest ecosystems or of becoming comfortable after being provided with new information or completing the survey. As in previous studies (Flynn et al., 1994; Kahan et al., 2007), we found that men are less risk averse than women and thus more likely to be comfortable with intervention and less likely to become uncertain or uncomfortable. Age had the opposite association; older

respondents were more hesitant to be or become comfortable with intervention. It is worth testing, whether the more and less risk-averse groups we identified would be so in other geographical contexts.

Overall, our findings indicate an emerging, if conditional, degree of comfort associated with increased intervention in forest conservation and resource management. More fundamentally, we see some evidence of a new guiding logic for conservation—shifting from a logic of minimal intervention to a logic of responsible intervention to address past wrongs. We advise caution as to the conditions and contextual nature of comfort. The importance of carefully considering the particular histories of governance, legacies of trust, and the essential need to engage diverse expertise in locations where interventions may be applied cannot be understated.

Methodologically, the reversibility of positions we observed raises important questions for surveying publics and other groups on public policy issues. Although deliberative polling is increasingly used for discussing electoral candidates or addressing civic challenges (e.g., rising crime rates) (Luskin et al., 2002), the deliberative potential of surveys is nascent at best. The approach we took demonstrates the flaws with traditional attitudinal surveys, which assume that views are stable. Such approaches fail to distinguish between which views are deeply held and immoveable and which are responsive to information. However, it is also the case that future pathway designs could build in more design-verification questions. For example, we first began with an in-principle question because it is likely that people's thinking at this stage was nascent and fairly unstable. Better use of *don't know* or definitional questions to help discern whether people can interpret such a question might be wise.

Ultimately, pathway designs are quite different from conventional ones. They allow people to explore in depth a value or principle to the extent that they have a chance to think about the trade-offs involved or knowledge as it comes to be understood and to reflect on initial positions once they have been challenged by real-world and context-specific examples. However, such prescriptive decision-making principles are hard to reconcile through changes in experimental design; they are the opposite in some ways. Decision theory suggests that decisions need to be constructed by decomposing problems into their component parts and so decision aiding is a given, but just when that aiding crosses a line from a well-structured conversation to coersion and why is unclear.

Similarly, some of our findings could be equally evident had we used a more conventional survey design. People who were initially comfortable with intervening in forest ecosystems may have changed their position simply because they were not amenable to the suggestion that actions such as monitoring were cared for by experts they trust. Perhaps they distrusted all experts, as can be the case and thus they changed their minds due to a kind of backlash effect. More substantively, it might well be the case that some changes in attitudes captured here are simply the result of being asked the same question multiple times—repetition and not decision structure could explain these findings. Future work might include a more comparative or verifying design juxtaposing pathway and conventional survey work. With greater testing and precision of design, pathway surveys may eventually be applied to a wide range of decision contexts, where uncertainty is high, policies are new, and values are at stake. Finally, the importance of connecting questions to a particular context in place and time is a key design feature that can and should be included in future iterations.

There are limitations to any survey, including ours. Respondents to our survey made decisions in isolation, relatively quickly, and perhaps viewing the task as minimally relevant to their daily lives. We strongly suggest that any survey gauging public views be combined with other forms of data. In this case, future work could include a facilitated small-group version of this survey in which people would have a full day to work through the material, ask questions of each other, and deliberate. Would they then be more or less willing to shift positions in a more social, deliberative context?

In contrast with previously published indicators of public unease, our findings about comfort levels indicate that publics are open to considering the potential application of active interventions for protecting biodiversity given climate impacts. For this reason, and the potential ecological utility and necessity of such interventions, opportunities for enhanced public dialogue about what such interventions might entail and where they might be reasonably applied should be carefully and cautiously explored, not summarily dismissed.

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