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Short communication

Understanding individual risk perceptions and preferences for climate change adaptations in biological conservation

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ABSTRACT

Too little attention has been paid to the psychological factors (e.g., beliefs and perceptions) that determine the acceptability of conservation measures, despite the fact that all conservation occurs within a social context. Climate change in particular will demand adaptation strategies that may be cognitively difficult to accept. We conducted a survey online ($n = 312$) to examine preferences and perceived risks associated with a set of proposed adaptation strategies in a sample of the public. Preferences for proposed adaptation policies were significantly and negatively correlated with perceived risk in every case. Preferences also exhibited widespread conservatism with the greatest acceptance for measures most similar to the status quo, while environmental worldview and emotions of fear and anger appeared to influence perceived risk and acceptability. These results suggest that conservation planning should include considerations for risk perceptions, and greater support for certain conservation measures may be generated by deemphasizing their perceived novelty and emphasizing their contemporary usage.

1. Introduction

Climate change poses a major challenge to conservation efforts worldwide, from habitat shifts (e.g., Parmesan, 2006) to the threat of new invasive species (e.g., Hellmann et al., 2008). As a result, a number of adaptations for biological conservation have been proposed (Lawler, 2009). These include, among others: assisted colonization (e.g., Hoegh-Guldberg et al., 2008); the use of non-native species to restore ecosystem services (Hershner and Havens, 2008); the creation and expansion of protected areas, corridors and networks (e.g., Hannah et al., 2007); and, conservation triage (i.e., explicitly prioritizing conservation objectives to maximize efficient use of limited conservation resources).

While the need for adapting conservation policy is recognized, some strategies have received broad support while others have been markedly controversial, even within groups of scientists, conservationists and the public (e.g., Hagerman et al., 2010a; Hewitt et al., 2011; Marris, 2007). How can this diversity of views be explained? As the implementation success of adaptation strategies depends at least in part on their perceived risk and acceptability (Adger, 2003; Tompkins and Adger, 2005), identifying the factors that shape risk perceptions and policy acceptability is a key question for conservation (Hagerman and Chan, 2009). In particular, public

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Migration Corridors	Captive Breeding	In-situ Aid	Permitting Climate Migrants	Conservation Triage	Assisted Colonization	(New) Species Introduction for Ecosystem Function
Facilitating species migration in response to climate change through the establishment of protected passageways between protected areas.	Ex-situ preservation of species unable to adapt to climate change (e.g., zoos, seed banks, cryogenics, etc.).	Providing aid within protected areas to native species struggling to adapt (e.g., feeding, breeding, or dispersal).	Allowing species outside of a protected area to enter and become established in the ecosystem as they migrate in response to climate change.	Explicitly prioritizing conservation objectives to maximize efficient use of limited conservation resources.	Purposely transporting threatened species to areas outside their historic range to increase their chance of survival under climate change.	The introduction of better adapted non-native species to a protected area for the purpose of replacing lost ecosystem functions due to climate change.
Conventional Risk-averse Passive	←				→	Controversial Risk-tolerant Interventionist

Fig. 1 – The seven adaptation policies investigated in this study organized along a continuum of risk-averse to risk-tolerant.

perceptions are important for implementation by narrowing or widening the set of plausible alternatives available to conservation practitioners and policy makers.

In other domains, risk perception is a significant research topic and is identified as conceptually (Adger et al., 2009) and empirically important for motivating climate change adaptation (Grothmann and Patt, 2005). Evidence from broader risk perception and climate adaptation studies suggest that risk perceptions can influence adaptation outcomes (e.g., Grothmann and Patt, 2005; Patt and Schröter, 2008). However, research on the perceived risks of climate change adaptation in biological conservation has only just begun. Overall, studies find high recognition among scientists, experts and managers that climate change poses a significant risk to biodiversity and the need for adapting policy, but divergence in what is perceived to be the most appropriate and feasible courses of action and the importance of climate change relative to other threats (Schliep et al., 2008; Hagerman and Satterfield, personal communication; Lemieux and Scott, 2011; Rudd, 2011). However, no study, to our knowledge, has investigated public perceptions.

Research in cognitive psychology and behavioral economics has long demonstrated that people frequently make judgments that stray from normative precepts. Such 'biases' include greater preferences for the status quo over alternative futures (Samuelson and Zeckhauser, 1988), 'over-sensitization' to emotions as the basis of judgment (e.g., Loewenstein et al., 2001) and rigid adherence to prevailing worldviews (e.g., Kahan et al., 2009). According to the theory of Cultural Cognition (Kahan and Braman, 2006; Kahan et al., 2006), worldviews (or belief systems) predispose people to think about risks and hazards in ways that align with a person's values (Kahan et al., 2006; Slimak and Dietz, 2006).

More than benign curiosities of human cognition, these perceptual patterns can have significant implications for conservation policy: the status quo bias may manifest as resistance to novel adaptations; negative emotions may trigger avoidance behaviors (Peters et al., 2006) and shift preferences away from particular adaptation alternatives; and, if existent norms and worldviews of conservation are inflexible in the face of climate change, policies that challenge the dominant paradigm may be prematurely rejected, inhibiting sound policy evaluation and implementation.

Given the cognitive patterns highlighted above, we expect that the perceived risk and acceptability of adaptation policies will be situated along a continuum, with the most novel and interventionist measures (e.g., pre-emptive interventions) judged to be the most risky and least acceptable (Fig. 1). In other words, risk and acceptability will be judged along a spectrum "from ... precautionary and robust to more risky or deterministic, but specifically anticipatory" (Heller and Zavaleta, 2009, p. 27). We also expect that more negative emotions will be associated with greater perceptions of risk and decreased acceptability. Finally, more pro-environmental worldviews are hypothesized to increase perceptions of risk and decrease the acceptability of more interventionist policies.

To test our hypotheses, we conducted an exploratory internet-based survey of a public sample of convenience. We quantified the link between risk perceptions and preferences for adaptation policies, and tested the correlation between these and measures of environmental worldview and emotions. Finally, we discuss the implications of our findings for adaptation in conservation and areas of future research.

2. Methods

2.1. *Data collection*

Data was collected via online surveys (approved by the University of British Columbia Behavioural Ethics Board; certificate number H09-02174) made available on the Internet to the general public from February 2010 to June 2010. The surveys were hosted on the Norms Evolving in Response to Dilemmas (W. Maurice Young Centre for Applied Ethics at the University of British Columbia) research group website using their survey platform (Danielson, 2010). Convenience sampling was used and participants (19 years and over) were recruited through online social networks (i.e., facebook), e-mail discussion groups, posters, online ad sites (e.g., craigslist), and word of mouth. A total of 370 people were recorded as accessing the survey, however only 312 people logged responses on the final page (of demographics). The 312 individuals were retained for subsequent analysis for an overall dropout rate of 15.7% ($n = 58$).

At the beginning of the survey, participants were asked to read a single paragraph of text describing, in non-technical terms, the likelihood of future climate change, its broad impact on species, and the need for adaptation in policy response to protected area management. This is a common approach in risk perception studies, to ensure the participants have a common basic understanding of the concepts being discussed (Slovic, 2000). The text was created by the researchers to mimic the information found on the websites of various reputable environmental organizations (e.g., UNEP) that are easily found in the public domain.

Following the informational paragraph, participants were asked to provide a rating of how relaxed or afraid and how calm or angry they felt about the scenario they had just read. Five-point Likert scales were used for the ratings with lower scores associated with more negative valence. The questions were adapted from previous studies on risk perception (i.e., Leiserowitz, 2006; Peters et al., 2004) as well as the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988).

Next, seven different adaptation strategies (referred to here as *policies*) were presented to participants (for details see Fig. 1 and Appendix A), which were selected following an examination of the conservation adaptation literature. In particular, the selection process drew heavily from the comprehensive reviews and recommendations on adaptation by Heller and Zavaleta (2009) and the U.S. Climate Change Science Program and the Subcommittee on Global Change Research (CCSP, 2008). Each policy was presented as a question of its acceptability accompanied by a non-species or location specific example, for instance, "A species is expected to move from protected area **A** toward protected area **B** in response to climate change. To allow the species to move with less obstruction, a strip of land connecting the two areas is protected". For each proposed adaptation, participants were first asked to rate how risky they perceived that policy to be 'in general' on a five-point Likert scale, a question format adapted from Leiserowitz (2006) and Weber et al. (2002), with 1 being 'not at all risky' and 5 being 'very risky'. Given the many conceptions of risk, it was left intentionally undefined to capture the full range of responses. Participants were then asked to rate on another five-point scale how acceptable they found the policy, with 1 being 'not at all acceptable' to 5 being 'very acceptable'.

As cultural worldviews are theorized as an overarching orienting factor shaping risk perceptions and risk preferences, the 15-item New Ecological Paradigm (NEP) scale (Dunlap et al., 2000) was included to measure environmental worldviews. Since the NEP was first developed, it has become the most often used psychological measure of environmental beliefs and orientation. In addition, there is evidence that the NEP overlaps with the worldview categories conventionally used in Cultural Cognition theory (Poortinga et al., 2002). For each of fifteen statements, the participant was asked to rate from 1 to 5 their level of agreement, with 1 being 'strongly disagree' and 5 being 'strongly agree'. Finally, a range of socio-demographic measures were also included in the survey (e.g., age, country of origin and residence, level of education, frequency of park visits), including four questions in which respondents were asked to rate how certain they were that climate change: was currently occurring; would continue to occur; was currently having negative impacts on the environment; and, would continue to have negative impacts on the environment. Certainty was indicated on a five-point Likert scale, with 1 being 'very uncertain' to 5 being 'very certain'.

2.2. *Data analysis*

Using SPSS 17.0 we analyzed the survey responses through independent *t*-tests and ANOVAs. We used Pearson's correlation to identify the association between perceived risk and acceptability and the influence of emotions and worldview on each. Responses on all scales were analyzed as averages (other than demographics, climate change certainty and the NEP) and thus ranged from 1 to 5. We acknowledge that there is debate on the appropriateness of interpreting Likert scales as interval data. We have done so to maintain consistency and comparability with other studies. Results from non-parametric statistics did not deviate from those presented below.

3. Results

3.1. *Demographic variables*

The sample ($N = 312$) contained a higher proportion of females (59.9%, $n = 187$) than males (39.7%, $n = 124$) and one person who did not indicate a gender. The sample was also primarily made up of young participants with over half (54.8%, $n = 171$) of participants between 19 and 29 years of age and nearly a quarter (24.4%, $n = 76$) between 29 and 39 years old. In terms of political orientation 49.1% ($n = 153$) indicated they were 'liberal' or 'somewhat liberal' while only 7.7% ($n = 24$) chose 'somewhat conservative' or 'conservative'. The majority were also self-reported members or supporters of the environmental movement (61.2%, $n = 191$) and highly educated, with 91.3% ($n = 285$) holding degrees at or above the university and college level. When participants were asked how often they visited protected areas in an average year, the vast majority indicated that they visited at least once a year, while only 7.1% ($n = 22$) said never, and nearly a quarter (23.1%, $n = 72$) visited ten times or more. Most participants were Canadian residents (74%, $n = 231$; compared to 61.9%, $n = 193$ originating from Canada), with the United States (12.8%, $n = 40$; compared to 16.0%, $n = 50$ originating from the US), the UK (2.6%, $n = 8$; compared to 4.2%, $n = 13$ originating from the UK) and Australia (2.2%, $n = 7$; same number originating) rounding out the top four, together totaling 91.6% ($n = 286$) of respondents (compared to 84.3%, $n = 263$ originating from the top four). Another 16 countries were represented by the remaining participants ($n = 26$) and two individuals did not respond to that question. As a group, the participants were very certain of climate change's current and likely future negative impacts on the environment, with a high mean score on the certainty scale ($\alpha = 0.85$; Cronbach, 1951) and little variance ($M = 18.04$, $SD = 2.70$). Though the scale ranged from 4 to 20 (as we aggregated the four questions on certainty), the minimum score obtained was eight and 43.3% ($n = 135$) of participants registered the highest possible score of 20.

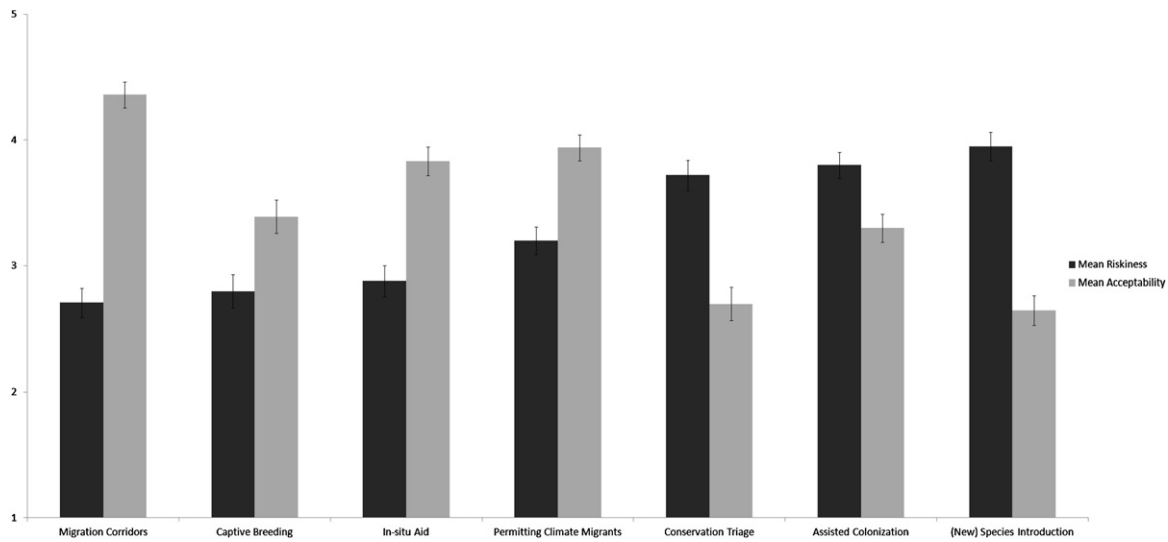

Fig. 2 – The mean ratings of acceptability and risk for each adaptation policy is shown ordered from least risky to most risky from left to right. 95% confidence intervals for each mean are displayed.

3.2. *Adaptation risk perceptions and preferences*

As expected, the perceived riskiness of the various adaptation policies was not uniform and appeared to be situated along a continuum from the risk-tolerant (i.e., the introduction of non-native species to maintain or enhance ecosystem processes; $M = 3.98$, $SD = 0.97$) to risk-averse (i.e., the use of migration corridors to facilitate species movement in response to change; $M = 2.69$, $SD = 1.15$); Fig. 2. Similarly, some policies were seen as more acceptable than others, with the same policies being judged the least (i.e., species introductions for ecosystem function; $M = 2.65$, $SD = 1.04$) and most acceptable (i.e., migration corridors; $M = 4.37$, $SD = 0.90$); Fig. 2. A close runner-up for the least acceptable policy was the use of conservation triage ($M = 2.69$, $SD = 1.15$). For every adaptation policy, risk and acceptability ratings were significantly and negatively correlated to a $p < 0.001$ level (see Table 1).

3.3. *Emotions*

Due to the limited range of participants' responses on the anger and fear scales, individuals indicating neutrality (i.e., the scale's center point) were excluded from analysis. Remaining individuals were separated into two groups representing the extremes on each scale.

Between-subjects *t*-tests only showed one significant difference in risk perceptions between the fearful and relaxed groups. Relaxed individuals saw conservation triage as less risky than the fearful group, $t(185) = 2.37$, $p < 0.05$, $d = 0.42$. In comparing acceptability ratings, significant differences were found on three different policies: Conservation triage was viewed as more acceptable by relaxed individuals than fearful individuals, $t(185) = -2.62$, $p < 0.01$, $d = 0.46$; the introduction of non-native species to maintain ecosystem function was more acceptable to the relaxed group than the fearful group, $t(187) = -2.15$, $p < 0.05$, $d = -0.39$; and providing in situ aid was less acceptable to the relaxed group than the fearful group, $t(56.05) = 2.13$, $p < 0.05$, $d = 0.39$ (Table 2). In general, with the exception of in situ aid and migration corridors, people who were fearful were less accepting of all the adaptation policies. Furthermore, people who were fearful saw all adaptations as riskier.

Between-subjects *t*-tests found no significant differences between individuals who were 'angry' and individuals who were 'calm' on either measure of riskiness or acceptability. However, the acceptability of permitting climate migrants, $t(202) = -1.74$, $p = 0.08$, $d = -0.34$ and of introducing non-native species to maintain ecosystem functions, $t(201) = -1.78$, $p = 0.08$, $d = -0.33$ were near significant (i.e., $p < 0.10$), as were differences in the perceived riskiness of providing in situ aid,

Table 1 – Two-tailed Pearson correlations between risk and acceptability for adaptations.

Migration corridors	Captive breeding	In situ aid	Permitting climate migrants	Conservation triage	Assisted colonization	(New) Species introduction for ecosystem function
$n = 304$	$n = 286$	$n = 295$	$n = 297$	$n = 287$	$n = 289$	$n = 293$
−0.42	−0.45	−0.37	−0.35	−0.46	−0.36	−0.46
[−0.51, −0.32]	[−0.54, −0.36]	[−0.46, −0.26]	[−0.44, −0.24]	[−0.54, −0.36]	[−0.45, −0.25]	[−0.55, −0.37]

Notes: All correlations were found to be significant to a $p < 0.001$ level. All confidence intervals are for 95%.

Table 2 – Between-subject *t*-tests for the effect of emotions on riskiness and acceptability ratings for each of seven adaptation policies.

	Migration corridors	Captive breeding	In situ aid	Permitting climate migrants	Conservation triage	Assisted colonization	(New) Species introduction for ecosystem function
Fear							
Riskiness							
Afraid	$n = 155$	$n = 146$	$n = 150$	$n = 151$	$n = 146$	$n = 147$	$n = 148$
	$M = 2.75$	$M = 2.93$	$M = 2.91$	$M = 3.24$	$M = 3.86$	$M = 3.33$	$M = 4.00$
	$SD = 1.05$	$SD = 1.11$	$SD = 1.07$	$SD = 0.96$	$SD = 0.99$	$SD = 0.87$	$SD = 1.02$
Relaxed	$n = 42$	$n = 41$	$n = 41$	$n = 42$	$n = 41$	$n = 41$	$n = 40$
	$M = 2.64$	$M = 2.59$	$M = 2.68$	$M = 3.10$	$M = 3.44$	$M = 2.59$	$M = 3.85$
	$SD = 0.96$	$SD = 1.25$	$SD = 1.08$	$SD = 0.98$	$SD = 1.03$	$SD = 1.25$	$SD = 0.95$
t	$t(195)$	$t(185)$	$t(189)$	$t(191)$	$t(185)$	$t(57.76)$	$t(186)$
	0.63	1.72	1.22	0.83	2.37	1.51	0.84
	$p = 0.53$	$p = 0.08$	$p = 0.22$	$p = 0.41$	$p < 0.05$	$p = 0.14$	$p = 0.41$
	$d = 0.11$	$d = 0.29$	$d = 0.21$	$d = 0.14$	$d = 0.42$	$d = 0.69$	$d = 0.15$
Acceptability							
Afraid	$n = 157$	$n = 145$	$n = 150$	$n = 152$	$n = 146$	$n = 147$	$n = 149$
	$M = 4.40$	$M = 3.42$	$M = 3.97$	$M = 3.90$	$M = 2.62$	$M = 3.33$	$M = 2.60$
	$SD = 0.92$	$SD = 1.16$	$SD = 0.93$	$SD = 0.93$	$SD = 1.07$	$SD = 0.87$	$SD = 1.04$
Relaxed	$n = 42$	$n = 41$	$n = 40$	$n = 42$	$n = 41$	$n = 41$	$n = 40$
	$M = 4.26$	$M = 3.8$	$M = 3.58$	$M = 4.17$	$M = 3.15$	$M = 3.41$	$M = 3.00$
	$SD = 0.96$	$SD = 1.15$	$SD = 1.06$	$SD = 0.82$	$SD = 1.24$	$SD = 1.20$	$SD = 1.01$
t	$t(197)$	$t(184)$	$t(56.05)$	$t(192)$	$t(185)$	$t(52.18)$	$t(187)$
	0.86	−1.88	2.13	−1.67	−2.62	−0.44	−2.15
	$p = 0.39$	$p = 0.06$	$p < 0.05$	$p = 0.09$	$p < 0.01$	$p = 0.66$	$p < 0.05$
	$d = 0.15$	$d = -0.33$	$d = 0.39$	$d = -0.31$	$d = -0.46$	$d = -0.08$	$d = -0.39$
Anger							
Riskiness							
Angry	$n = 172$	$n = 163$	$n = 168$	$n = 167$	$n = 164$	$n = 165$	$n = 167$
	$M = 2.75$	$M = 2.79$	$M = 2.92$	$M = 3.23$	$M = 3.82$	$M = 3.84$	$M = 3.99$
	$SD = 1.02$	$SD = 1.10$	$SD = 1.05$	$SD = 1.00$	$SD = 1.07$	$SD = 0.90$	$SD = 1.04$
Calm	$n = 36$	$n = 35$	$n = 35$	$n = 36$	$n = 35$	$n = 35$	$n = 35$
	$M = 2.50$	$M = 2.60$	$M = 2.57$	$M = 3.17$	$M = 3.71$	$M = 3.57$	$M = 3.91$
	$SD = 0.91$	$SD = 1.19$	$SD = 1.04$	$SD = 0.91$	$SD = 0.99$	$SD = 0.95$	$SD = 0.92$
t	$t(206)$	$t(196)$	$t(201)$	$t(201)$	$t(197)$	$t(198)$	$t(200)$
	1.37	0.89	1.77	0.37	0.52	1.6	0.39
	$p = 0.17$	$p = 0.37$	$p = 0.08$	$p = 0.71$	$p = 0.60$	$p = 0.11$	$p = 0.70$
	$d = 0.26$	$d = 0.17$	$d = 0.33$	$d = 0.06$	$d = 0.11$	$d = 0.29$	$d = 0.08$
Acceptability							
Angry	$n = 174$	$n = 162$	$n = 168$	$n = 168$	$n = 165$	$n = 126$	$n = 168$
	$M = 4.44$	$M = 3.41$	$M = 3.92$	$M = 3.85$	$M = 3.30$	$M = 3.21$	$M = 2.54$
	$SD = 0.92$	$SD = 1.12$	$SD = 0.96$	$SD = 0.95$	$SD = 0.91$	$SD = 0.92$	$SD = 1.02$
Calm	$n = 36$	$n = 35$	$n = 34$	$n = 36$	$n = 35$	$n = 149$	$n = 35$
	$M = 4.50$	$M = 3.57$	$M = 3.65$	$M = 4.14$	$M = 3.43$	$M = 3.37$	$M = 2.89$
	$SD = 0.85$	$SD = 1.29$	$SD = 0.98$	$SD = 0.72$	$SD = 1.01$	$SD = 0.97$	$SD = 1.13$
t	$t(208)$	$t(195)$	$t(200)$	$t(202)$	$t(197)$	$t(198)$	$t(201)$
	−0.35	−0.76	1.47	−1.74	−1.23	−0.77	−1.78
	$p = 0.73$	$p = 0.45$	$p = 0.14$	$p = 0.08$	$p = 0.22$	$p = 0.45$	$p = 0.08$
	$d = -0.07$	$d = -0.13$	$d = 0.28$	$d = -0.34$	$d = -0.14$	$d = -0.17$	$d = -0.33$

$t(201) = 1.77$, $p = 0.08$, $d = 0.33$. Nonetheless, the *pattern* of responses (see Table 2) shows that people in the angry group are by and large less willing to accept various adaptations with the exception of in situ aid. The angry group also judged adaptations as riskier than those who were calm.

3.4. *Environmental worldviews*

Overall, the participants scored relatively highly on the New Ecological Paradigm scale. The mean score was 60.01 ($SD = 8.99$), or 4.00 if averaged over all questions. This compares to an average of 3.75 in a representative sub-set of Americans (Dunlap et al., 2000), 3.62 in a study of Australians (Kurz et al., 2005), and 3.67 amongst Canadians (McFarlane et al., 2006). There were a total of 275 valid cases with 37 missing. While the index ranges from a low of 15 to a high of 75, participants scored a minimum of 26 and maximum of 75. A high Cronbach's alpha (Cronbach, 1951) was obtained ($\alpha = 0.83$), as such, following the interpretation of Dunlap et al. (2000), the NEP was viewed as measuring a single construct of environmental worldview and thus the NEP was preserved as a single index. However, for the analysis, a split at the median of 62.00 was used to create a relatively low group of NEP endorsers with a range of scores from 26 to 62 ($n = 149$,

$M = 53.97$, $SD = 7.80$) and a relatively high group with a range of scores from 63 to 75 ($n = 126$, $M = 67.15$, $SD = 3.22$). The splitting of NEP scores and the use of independent *t*-tests was used rather than simple linear regressions due to the non-normal distribution of the data to which *t*-tests are more robust.

Differences in acceptability between high and low NEP groups were observed in three different policies (Table 3). Support for migration corridors was greater amongst individuals with more pro-environmental worldviews compared to low NEP group, $t(269) = -3.84$, $p < 0.001$, $d = -0.46$. Conversely, the acceptability of captive breeding was lower amongst high NEP endorsers than low scorers, $t(273) = 2.28$, $p < 0.05$, $d = 0.27$. Similarly, people with higher environmental worldviews were less supportive than people with lower environmental worldview scores for the introduction of non-native species to maintain ecosystem function, $t(272) = 2.74$, $p < 0.01$, $d = 0.33$. Though not quite reaching statistical significance, the acceptability of conservation triage was lower amongst high endorsers than those who scored lower on the NEP, $t(272) = 1.92$, $p = 0.06$, $d = 0.24$.

Turning to risk perceptions, a clear pattern emerged wherein significant differences were found between the low and high NEP groups on nearly all the policies. Individuals with high NEP scores perceived all policies, except establishing migration corridors, as more risky than those with lower NEP scores. As can be seen in Table 3, significant differences were found between the two groups for the following policies: permitting climate migrants, $t(272) = -2.46$, $p < 0.05$, $d = -0.30$; introduction of non-native species for ecosystem function, $t(271) = -3.15$, $p < 0.01$, $d = -0.39$; assisted colonization, $t(273) = -3.58$, $p < 0.001$, $d = -0.44$; captive breeding, $t(273) = -2.27$, $p < 0.05$, $d = -0.27$; and, conservation triage, $t(272) = -2.35$, $p < 0.05$, $d = -0.28$. The riskiness of providing in situ aid was also nearly significant, $t(273) = -1.93$, $p = 0.054$, $d = -0.33$. These results suggest that risk perceptions and support for policy can be expected to differ depending on the strength of individuals' environmental worldviews.

Though worldviews appears influential, membership in or support of the environmental movement was not a strong predictor of risk perceptions or acceptability with the exception of two measures. In the first instance, supporters ($n = 190$, $M = 4.49$, $SD = 0.80$) viewed the establishment of migration corridors as more acceptable than non-supporters ($n = 91$, $M = 4.24$, $SD = 0.95$), $t(279) = 2.20$, $p < 0.05$, $d = 0.28$. In the second case, supporters ($n = 188$, $M = 2.82$, $SD = 1.14$) found conservation triage more acceptable than individuals who were not supporters ($n = 91$, $M = 2.42$, $SD = 1.11$), $t(277) = 2.82$, $p < 0.01$, $d = 0.12$.

4. Discussion

To meet a complex and multidimensional threat such as climate change, we argue that the full suite of adaptation alternatives needs to be made available for consideration and evaluation. A primary finding of this study is that climate adaptation policies currently offered in conservation appear to sit along a clear continuum of risk and a continuum of acceptability, with the policies judged most acceptable and least risky being the most similar to prevailing traditional conservation practices and rhetoric, supporting the existence of Heller and Zavaleta's (2009) suggested range of measures. Broadly speaking, preferences displayed widespread conservatism. Risk perceptions and acceptability ratings were also found to be significantly and negatively correlated, buttressing the argument that risk perceptions are an important factor in determining climate change adaptation responses (Grothmann and Patt, 2005).

Known cognitive biases may in part explain these results, such as the human tendency to loss aversion (Kahneman et al., 1991; Kahneman and Tversky, 1979; Tversky and Kahneman, 1992), and preference for the status quo even when inaction can result in equal or greater harms (i.e., the omission bias; Samuelson and Zeckhauser, 1988). At least one field study has found evidence consistent with omission bias (where causing harm is judged worse than allowing an equal harm to occur) in the perceptions of farmers in Mozambique toward climate change adaptation policies (Patt and Schröter, 2008). Scholars have also pointed to the status quo bias (in which the potential disadvantage of switching away from status quo overshadows the potential gains) to explain the lack of action on the part of governments to confront climate change (e.g., Bazerman, 2006). In general, however, a relatively high acceptance of adaptation policies was observed. Overall, this pattern of preferences parallels Hagerman et al.'s (2010b) finding among conservation experts, and their preference for less interventionist adaptations, along with a reserved acknowledgment that more interventionist measures are also necessary (Hagerman and Satterfield, personal communication).

In aggregate, individuals who were more fearful or angry perceived adaptations as generally more risky and less acceptable, however, while these differences were in the expected direction, they were largely non-significant statistically (possibly due to a lack of variance in responses and small effect sizes). Although the psychological evidence to date suggests that emotions are a strong indicator for the value of different alternatives which then guide judgment (e.g., Loewenstein et al., 2001; Slovic et al., 2005), the present study found only a minor role for emotional influences. This data also differs from the results of past researchers who have found that anger and fear exhibit divergent effects (e.g., Lerner and Keltner, 2001).

Our results suggest that greater pro-environmental worldviews are associated with a greater willingness to support *passive* adaptations and decreased willingness to support *interventionist* strategies. The differences between high and low NEP groups appear to support the central tenet of Cultural Cognition, wherein risk perceptions are manifestations of personal beliefs and values as impacted by culture (Kahan et al., 2006). Interestingly, though individuals who scored relatively higher on the NEP perceived nearly all adaptations (except migration corridors) as *more risky*, high NEP scorers rated the *acceptability* of three policies as greater (migration corridors, permitting climate migrants, and in situ aid) than low NEP scorers. Nonetheless, these strategies being arguably the least interventionist of the seven policies implies that the acceptability of certain policies is less determined by perceived risk than other policies. This link between greater NEP ratings and support for less interventionist strategies has

Table 3 – Between-subjects *t*-tests for the effect of environmental worldview on riskiness and acceptability ratings for each of seven adaptation policies.

	Migration corridors	Captive breeding	In situ aid	Permitting climate migrants	Conservation triage	Assisted colonization	(New) Species introduction for ecosystem function
Worldview (NEP score)							
Riskiness							
High	$n = 125$	$n = 126$	$n = 126$	$n = 125$	$n = 125$	$n = 126$	$n = 125$
	$M = 2.62$	$M = 2.97$	$M = 3.01$	$M = 3.36$	$M = 3.88$	$M = 4.01$	$M = 4.17$
	$SD = 1.11$	$SD = 1.17$	$SD = 0.10$	$SD = 0.97$	$SD = 1.03$	$SD = 0.86$	$SD = 0.93$
Low	$n = 149$	$n = 149$	$n = 149$	$n = 149$	$n = 149$	$n = 149$	$n = 148$
	$M = 2.72$	$M = 2.66$	$M = 2.77$	$M = 3.08$	$M = 3.59$	$M = 3.62$	$M = 3.80$
	$SD = 0.92$	$SD = 1.09$	$SD = 1.01$	$SD = 0.90$	$SD = 1.01$	$SD = 0.90$	$SD = 0.97$
t	$t(272)$	$t(273)$	$t(273)$	$t(272)$	$t(272)$	$t(273)$	$t(271)$
	0.89	−2.27	−1.93	−2.46	−2.35	−3.58	−3.15
	$p = 0.38$	$p < 0.05$	$p = 0.054$	$p < 0.05$	$p < 0.05$	$p < 0.001$	$p < 0.01$
	$d = 0.10$	$d = -0.27$	$d = -0.33$	$d = -0.30$	$d = -0.28$	$d = -0.44$	$d = -0.39$
Acceptability							
High	$n = 126$	$n = 126$	$n = 126$	$n = 125$	$n = 125$	$n = 126$	$n = 126$
	$M = 4.61$	$M = 3.25$	$M = 3.88$	$M = 4.02$	$M = 2.54$	$M = 3.21$	$M = 2.47$
	$SD = 0.72$	$SD = 1.18$	$SD = 1.00$	$SD = 0.90$	$SD = 1.12$	$SD = 0.92$	$SD = 0.97$
Low	$n = 149$	$n = 149$	$n = 148$	$n = 149$	$n = 149$	$n = 149$	$n = 148$
	$M = 4.22$	$M = 3.56$	$M = 3.80$	$M = 3.89$	$M = 2.81$	$M = 3.37$	$M = 2.80$
	$SD = 0.97$	$SD = 1.08$	$SD = 0.97$	$SD = 0.84$	$SD = 1.13$	$SD = 0.97$	$SD = 1.05$
t	$t(269)$	$t(273)$	$t(272)$	$t(272)$	$t(272)$	$t(273)$	$t(272)$
	−3.84	2.28	−0.64	−1.17	1.92	1.35	2.74
	$p < 0.001$	$p < 0.05$	$p < 0.001$	$p = 0.24$	$p = 0.06$	$p = 0.18$	$p < 0.01$
	$d = -0.46$	$d = 0.27$	$d = 0.08$	$d = -0.15$	$d = 0.24$	$d = 0.17$	$d = 0.33$

also been found in a sample of conservation experts (Hagerman and Satterfield, personal communication). This research also demonstrates that even a small degree of difference in environmental worldviews has a detectable impact on risk perceptions and preferences regarding the acceptability of alternatives in a homogeneous sample. This finding suggests that, in an actual policy context with a much more diverse set of stakeholders, a larger gulf in preferences might be expected.

Here we stress that convenience sampling was used and the results of this study cannot be generalized to a wider population. Although steps can be taken to mitigate the susceptibility of voluntary online surveys and convenience sampling to selection bias (e.g., the use of more traditional recruitment techniques by phone, letter, and in-person), the trade-off is significant in money and time. Future studies may want to assess the advantages and disadvantages of using online social networks for recruitment and include sufficient demographic variables to be able to detect bias. Nonetheless, we believe that the results presented in this study may still provide an indicator of the likely perceptions of interested and educated publics that may be important stakeholders in issues of conservation.

Given the evidence that risk perceptions can influence people's willingness to support adaptation, decision-makers could focus on shifting people's risk perceptions and thus preferences for policy. For instance, deemphasizing the perceived novelty of adaptation policies by pointing to examples of their historical application may temper negative reactions or sentiments. Risk and educational communications can be more carefully designed to avoid the inadvertent or purposeful use of fear and anger inducing messages about climate change which may create heightened risk perceptions and decreased support for adaptation.

Although public support for more interventionist policies is tepid relative to conventional strategies, this research shows that there is relatively high support for adaptation in general, at least within this sample. This may reassure some, more interventionist-minded scientists and practitioners, that public discourse on more unconventional adaptation strategies need not wait. However, between the conservative preferences revealed in this study's public sample and similar findings among conservation experts (Hagerman and Satterfield, personal communication), planning for adaptation are at risk of inertia. Scientists, as key sources of knowledge on scientific matters for the public (as translated by the media) thus have a role in shifting public perceptions of appropriate intervention.

5. Conclusion

Understanding differences of opinion and attitudes and their origins may help avoid flashpoints of disagreement and eliminate barriers to policy implementation, leading to more socially acceptable responses to change.

Future research on attitudes toward adaptation strategies in conservation should use representative samples from targeted populations. If the results are to be directly applicable to decision-making and planning for conservation, they will also need to be place-based and context-specific. Research on other perceptual influences such as protected values (i.e., values for which there is resistance to accepting any tradeoffs; Baron and Spranca, 1997) could be enlightening for policy development, as some policies were judged nearly equal in riskiness but not in acceptability (i.e., conservation triage vs. assisted colonization), indicating

that perceived risk is not the only relevant factor. Whether the apparent insensitivity to risk of high NEP scorers in judging acceptability of certain policies are related to protected values will require more targeted experimental studies.

Conservation activities will also continue and increasingly occur in areas outside of protected park spaces. Perceptions of adaptation strategies in that context may well differ from the observations in this research. Similarly, conservation challenges worldwide are not uniform, nor are the perceptions of those challenges (e.g., Schliep et al., 2008). Contextual differences borne out of history and contemporary social circumstances and ecology are likely to lead to differing points of view on appropriate courses of action in the face of climate change. We believe that the questions used in this study can apply elsewhere but may be more relevant in some contexts than others. We also anticipate that answers may change significantly when moving away from hypothetical scenarios to specific management decisions. All of these topics are worthy of future study.

As has been concluded by many practitioners and scholars, an expanded range of management practices for protected areas will be required in order to minimize imminent losses in biodiversity and ecosystem function from climate change. Navigating the expectations and concerns of stakeholders can be aided immensely by a more nuanced understanding of human psychology in this domain.

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Appendix A

Adaptation policies presented to respondents and the proportion of responses for each acceptability and risk.

Item	Not at all acceptable 1 / Not at all risky 1	2 / 2	Moderately acceptable 3 / Moderately risky 3	4 / 4	Very acceptable 5 / Extremely risky 5
(Migration corridors)	1.3%	3.6%	13.7%	20.8%	60.6%
Is it acceptable to link protected areas using corridors that allow species to move in response to climate change?	14.8%	22.7%	42.1%	17.1%	3.3%
(Permitting climate migrants)	1.3%	3.7%	25.2%	39.3%	30.5%
Is it acceptable to allow species from outside protected areas to become established within protected areas as they move in response to climate change?	4.7%	15.2%	43.1%	29.3%	7.7%
(In situ aid)	1.7%	8.8%	22.4%	39.0%	28.1%
Is it acceptable to actively promote the growth and establishment of a native (i.e., local) species, within a protected area, that may otherwise struggle to adapt on its own to future climate conditions?	10.1%	25.7%	36.1%	22.0%	6.1%
(New species introduction)	14.3%	29.9%	35.7%	16.3%	3.7%
Is it acceptable to introduce non-native (i.e., non-local) species, which are better adapted to future climate conditions, into a protected area?	1.4%	7.5%	20.8%	35.5%	34.8%
(Assisted colonization)	3.8%	13.1%	42.9%	29.4%	10.7%
Is it acceptable to assist valued species threatened by climate change by moving them to areas where they have never existed but where there is more suitable habitat under future climate conditions?	0.3%	8.0%	26.6%	41.2%	23.9%
(Captive breeding)	4.9%	18.1%	31.0%	25.4%	20.6%
Is it acceptable to breed and hold in captivity species that are unable to adapt to climate change?	13.2%	28.6%	30.7%	19.9%	7.7%
(Conservation triage)	17.8%	25.8%	31.4%	19.2%	5.9%
Is it acceptable to divert resources and protection away from a species that is unlikely to survive climate change in order to protect another species that is more likely to survive?	2.4%	9.4%	28.2%	33.8%	26.1%

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