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Communicating Conservation Status: How Different Statistical Assessment Criteria Affect Perceptions of Extinction Risk

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Although alternative forms of statistical and verbal information are routinely used to convey species' extinction risk to policymakers and the public, little is known about their effects on audience information processing and risk perceptions. To address this gap in literature, we report on an experiment that was designed to explore how perceptions of extinction risk differ as a function of five different assessment benchmarks (Criteria A–E) used by scientists to classify species within IUCN Red List risk levels (e.g., Critically Endangered, Vulnerable), as well as the role of key individual differences in these effects (e.g., rational and experiential thinking styles, environmental concern). Despite their normative equivalence within the IUCN classification system, results revealed divergent effects of specific assessment criteria: on average, describing extinction risk in terms of proportional population decline over time (Criterion A) and number of remaining individuals (Criterion D) evoked the highest level of perceived risk, whereas the single-event probability of a species becoming extinct (Criterion E) engendered the least perceived risk. Furthermore, participants scoring high in rationality (analytic thinking) were less prone to exhibit these biases compared to those low in rationality. Our findings suggest that despite their equivalence in the eyes of scientific experts, IUCN criteria are indeed capable of engendering different levels of risk perception among lay audiences, effects that carry direct and important implications for those tasked with communicating about conservation status to diverse publics.

KEY WORDS: Cognitive-experiential self-theory; IUCN Red List; risk communication; risk perception; threatened species

1. INTRODUCTION

When communicating about the threatened status of a species, conservation professionals face a choice in how to convey its risk of extinction. One straightforward and common approach is to use statistics derived from quantitative assessments, as when the public is informed that the population of African lions (*Panthera leo*) has "fallen by 30%" over the past two decades.[1] Alternatively, conservation messages sometimes focus on the absolute number of extant individuals as opposed to proportional changes in species population size. For example, amid the international outcry following the recent killing of an African lion named Cecil by an American trophy hunter in Zimbabwe, one news source reported that African lions numbered between 20,000 and 32,000 at the time, compared to 75,000 in 1980.[2]

In contrast to the use of statistics, another common practice is to convey extinction risk using verbal information that corresponds to a risk category within some formal inventory managed by an authoritative organization, such as the Red List maintained

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by the International Union for Conservation of Nature (IUCN). Experts working with the IUCN examine research data and apply a predefined set of assessment criteria to determine the categorical status label (e.g., "Critically Endangered," "Endangered," "Vulnerable") for each species. For example, the reporter covering Cecil's misfortune also noted that "the International Union for the Conservation of Nature calls the lion 'vulnerable,' one step away from endangered."[2]

Although alternative forms of statistical and verbal information are routinely used to convey extinction risk information to policymakers and the public, little is known about their effects on how audiences process and perceive the focal risks. It is possible, for instance, that these alternative descriptions can elicit different impressions or judgments among audiences, even when experts deem them as communicating similar levels of risk. For instance, according to the IUCN Red List Categories and Criteria,[3] a species with an extent of occurrence smaller than 100 km^2 faces a comparable risk with another species whose number of mature individuals is 50 or smaller because they both meet the criteria of the critically endangered category. Scant research has examined, however, whether the untrained public—that oftentimes constitutes the intended audience for conservation messages that contain these descriptions—will perceive similar levels of risk when provided with this information.

The present experiment aims to address this important gap in the literature. Specifically, we draw on theoretical perspectives from the literature on risk perception, communication, and related fields (e.g., the psychology of judgment and decision making) to explore the largely overlooked possibility that laypersons may perceive different levels of extinction risk as a function of the (normatively equivalent) statistical or verbal expressions employed. If so, the choice between alternative ways of communicating risk may cause unintended bias in public support for conservation policies, which would carry important and previously overlooked implications for conservation messaging efforts.

1.1. IUCN Red List Categories and Criteria

Although the IUCN began publishing extensive lists of threatened species with categorical labels in 1964, conservation biologists grew increasingly concerned about the subjectivity involved in the categorization of species.[4] Thus, in 1989, the IUCN started to develop a system of categories defined by numerical threshold values based on various assessment criteria.[3] Following extensive deliberation among conservation experts,[5–7] the IUCN Council adopted the Red List Categories and Criteria in 1994 as the standard by which to evaluate and categorize species. Further review and validation of the criteria in this initial document continued,[8] resulting in the current version of the Red List Categories and Criteria.[9] Although the primary aim of this system was to establish objectivity and consistency across evaluation criteria in categorization processes, conservationists have increasingly used information compiled in the Red List as a communication tool to educate the public and guide policy making.[10] To date, however, limited research has examined how audiences respond to the statistical criteria that underlie the well-known categories that comprise the IUCN Red List, an omission that may hinder communication outreach efforts aimed at informing the public and protecting threatened species. Among the nine categories used in the Red List,[9] we focus on the three categories of Critically Endangered (CR), Endangered (EN), and Vulnerable (VU), not only because these categories represent threatened species on which conservation efforts are concentrated, but also because they are defined with statistical threshold values that may hold important consequences for audience information processing.

Specifically, there are five broad classes of statistical criteria used to determine whether a species should be listed as CR, EN, or VU. Because researchers can assess species' risk of extinction using multiple approaches, a species can qualify for its categorical status by meeting any single specific criterion outlined in the Red List; the use of these different assessment criteria inevitably requires the use of alternative types of statistics. For example, Criterion D, which determines the taxon's risk solely by the number of its remaining mature individuals, is based on frequencies. Criterion A, in contrast, cites the diminished proportion of a taxon's population over time (i.e., 10 years or three generations), whereas Criterion C considers these two standards simultaneously. In comparison, Criterion E also features a percentage figure, although of a different type: the single-event probability of the species becoming extinct within a specific time frame. Finally, Criterion B uses units of area (km^2) denoting the geographic range of the taxon's habitat as the key statistic (see Table I).

Table I. IUCN Red List Criteria Descriptions Used in the Study, with Threshold Values of Corresponding Category Condition in Brackets (i.e., [Critically Endangered / Endangered / Vulnerable])

Criterion[a]	Anonymized Name in Study	Description
A2a	Species G	The population size of this species is observed to have been reduced by [80% / 50% / 30%] or more over the past 10 years. The causes of this reduction may not have ceased.
B2ab	Species H	The area occupied by this species is estimated to be less than [10 / 500 / 2,000] km^2 ([4 / 193 / 772] square miles; [2,471 / 123,553 / 494,210] acres). The species is also estimated to exist at [one location / no more than 5 locations / no more than 10 locations], and the size of the area occupied by this species continues to decline.
C1	Species X	The population size of this species is estimated to number fewer than [250 / 2,500 / 10,000] mature individuals and at least [25% / 20% / 10%] of this population is estimated to continually decline within [3 / 5 / 10] years.
D	Species Q	The population size of this species is estimated to number fewer than [50 / 250 / 1,000] mature individuals.
E	Species L	According to a quantitative analysis, the probability for this species to become extinct in the wild is at least [50% / 20% / 10%] within [10 / 20 / 100] years.
Label	Species P	This species is officially listed as Critically Critically Endangered / Endangered / Vulnerable.

[a]Within each class of criterion, A, B, C, D, and E, we chose the subcriterion that allowed for the most concise description defined by numeric thresholds.

1.2. Biases in Processing Statistical Information

Despite the consensus surrounding the comparability of these criteria among conservation experts, research in cognitive psychology and risk communication suggests that the different forms of statistical information utilized across IUCN criteria may invite different levels of *perceived* risk among laypersons. In much of this work, researchers observe bias even under conditions in which perceivers are confronted with mathematically identical statistics that vary merely in form. In one well-known demonstration, undergraduate students judged cancer to be riskier when told that it kills "1,286 people out of 10,000" rather than "24.14 people out of 100," presumably because participants are more attuned to the magnitude of the numerator while largely disregarding the denominator.(11) Although it is tempting to attribute such biases to the limited knowledge or processing motivation of novices, research challenges such assumptions by suggesting that experts are not immune. For instance, when members of the American Psychology-Law Society judged the risk of releasing a patient identified as "Mr. Jones" from a mental health facility, about twice as many participants refused to discharge him when presented with risk information in terms of relative frequency (e.g., "of every 100 patients similar to Mr. Jones, 20 are estimated to commit an act of violence") rather than probability (e.g., "patients similar to Mr. Jones are estimated to have a 20% probability of committing an act of violence").(12)

While these studies suggest that people are highly sensitive to risk information presented in the form of frequencies, others have shown that the processing of proportions is also prone to biases. For example, Fetherstonhaugh, Slovic, Johnson, and Friedrich(13) found that when judging two scenarios of humanitarian aid programs that would save an equal number of human lives, participants prioritized the program with the smaller reference group: they assigned a higher value to a program that would save 4,500 refugees out of 11,000 in a camp as compared to a program that would save 4,500 out of 250,000. Similarly, Friedrich *et al.*(14) found that a new automobile brake regulation received greater support when described as preventing 150 of 9,000 deaths every year rather than 150 of 41,000 deaths. Similar findings have been observed in scenarios involving endangered species, effects that depended on whether people construed the potential victims under risk as a single group rather than a multitude of distinct individuals.(15) Although the denominator in a proportion, which is often represented as a species' population size, is a valid consideration in many conservation contexts, these studies suggest that people's responses to proportion-based risk information are often prone to bias.

According to Slovic *et al.*,(16) these biases occur because people's risk-related judgments are driven in part by the affect they experience during information processing, feelings that can overwhelm fine-tuned distinctions between numerical values. This affect-based explanation draws on earlier research on cognitive-experiential self-theory (CEST),[17] which posits that people process information using two independent and interacting modes of thinking: the rational and the experiential. Whereas the rational system encodes reality in abstract symbols, words, and numbers, the experiential system encodes experience using concrete images and narratives. Accordingly, when people use the rational mode in judgments, they tend to engage in effortful reasoning following rules of logical inference, which can help solve problems requiring usage of statistical evidence.[18,19] In contrast, when people rely on the experiential mode for tasks that require careful analytic reasoning, it is more likely that their responses will be guided by their emotional reactions rather than thoughtful consideration of evidence.[20] The experiential mode is closely associated with affect, allowing the individual to automatically and rapidly generate valenced feelings of goodness or badness toward a stimulus. CEST scholars have taken an individual differences approach to the rational-experiential distinction by assuming that people vary in the degree to which they use these two modes of thinking—tendencies that are commonly assessed using the Rational-Experiential Inventory (REI), a personality inventory consisting of subscales measuring rationality and experientiality.[19,20]

1.3. The Present Study

We report on an online experiment that was designed to explore how perceptions of extinction risk differ as a function of assessment criteria using various statistics or the verbal label of the species' categorical status at three IUCN risk levels: Critically Endangered (CR), Endangered (EN), and Vulnerable (VU). In light of the research discussed above, we explored whether Criteria A, C, and D—which rely heavily on frequency and proportion information—would evoke particularly high levels of perceived risk (see Table I for descriptions of these criteria).

We also explored whether individual differences in rational versus experiential thinking, as measured by the REI scale, might moderate the effect of criteria on perceived risk, given that the IUCN criteria vary in the extent to which they feature abstract numerical representations (e.g., single-event probability of extinction; Criterion E) versus scenarios that are perhaps easier to mentally visualize (e.g., the number of remaining individuals; Criterion D)—information that may resonate more strongly with people high in rationality versus experientiality, respectively.[21] In addition to the REI, we also examined the role of gender, political orientation, and environmental concern, variables that frequently emerge as significant predictors of individuals' environmental-related risk perceptions.[22–24]

Importantly, in addition to a statistics based on alternative criteria, we also compared the effect of employing the verbal categorical label of the species' status (i.e., "Critically Endangered," "Endangered," and "Vulnerable") to convey comparable risks. Previous research suggests that judgments of verbal expressions of frequencies or probabilities are highly inconsistent across individuals[25,26] and contexts.[27,28] However, because the influence of verbal labels on risk perception is presumably contingent on the meaning of the words comprising them, it is difficult to generalize these findings to the present case of IUCN labels. As such, there is a need to consider the effects of these common verbal categorical labels as compared to those of the various statistical criteria employed by IUCN, which we examine here.

2. METHOD

To explore the effects of the verbal categories and statistical criteria that comprise the IUCN Red List on perceptions of extinction risk, we conducted an online experiment using a mixed design (6 × 3) with criteria (A–E and categorical label) as the within-subjects variable and threat category (CR, EN, VU) as the between-subjects variable. We also measured individual differences such as thinking style (rationality and experientiality) and various demographics, including gender, political orientation, and environmental concern, which were included as covariates in the subsequent analysis of our model.

2.1. Participants

We recruited 306 participants from Amazon Mechanical Turk, an online platform that allows users to crowdsource labor requiring human intelligence (for a validation of this participant pool, see Paolacci, Chandler, and Ipeirotis[29]). Participants were invited to complete a study to help researchers learn how people make decisions regarding matters of public import. Participants received a nominal fee for completing the web-based survey and, on average, completion time was less than 11 minutes.

2.2. Procedure and Materials

After indicating consent to participate in the study, participants received instructions asking them to imagine that they were serving in a public hearing process hosted by regional wildlife management authorities. The scenario explained that the authorities wanted to determine priorities regarding a list of threatened species. The instructions also asked participants to offer their opinions based solely on their beliefs about the extinction risk for each species. Participants were informed that they would read short descriptions of species, the names of which were replaced with alphabetic characters to prevent possible introduction of bias (e.g., favoring "charismatic" mega-fauna). Finally, they were also instructed to read each description carefully, to think deeply about what it means, and to prudently answer the questions. Following an instructional manipulation check to screen participants who failed to pay sufficient attention to the instructions (see Oppenheimer *et al.*[30]), participants were randomly assigned to one of the three threat-level groups using an algorithm provided by the online survey platform provider, Qualtrics. In this study, we refer to these threat-level groups as "categories," following IUCN.[3] In each group, all participants read six short descriptions, randomly ordered for each participant, of the conservation status of ostensibly different but anonymous species (e.g., "Species P"). In actuality, all descriptions were simply statements of different assessment criteria corresponding to the category to which the participant was assigned.

Each description was presented one after another on separate screens. On each screen, participants read a description of one species, presented together with two items measuring the main dependent variable: level of perceived risk. The first item measured the perceived likelihood that the species would become extinct within a given time frame ("*Given this information, how likely do you think it is for this species to become extinct within the next 30 years?*"; *1* = *Very unlikely* to *7* = *Very likely*). The second item was a more global measure of threat in general ("*Given this information, how threatened do you think this species is in general?*"; *1* = *Not at all threatened* to *5* = *Extremely threatened*). We transformed the scores of both items into scales ranging from 0 to 5, and averaged the resulting two items to create a composite scale of perceived risk. The reliability of the two transformed items assessed by the Spearman–Brown coefficient[31] was acceptable across all category levels ($\rho_{cr} = 0.749$, $\rho_{en} = 0.815$, $\rho_{vu} = 0.728$).

The REI scale, which was used to assess individual differences in rational and experiential modes of thinking,[19] consists of two five-item subscales, Need for Cognition and Faith in Intuition, measuring rationality and experientiality, respectively. Participants rated their agreement with statements such as "*I prefer complex to simple problems*" (Need for Cognition) and "*I believe in trusting my hunches*" (Faith in Intuition) on five-point scales ranging from *1* = *Definitely not true of myself* to *5* = *Definitely true of myself*. The reliability of the rationality and experientiality subscales assessed by Cronbach's α was acceptable ($\alpha_{\text{rationality}} = 0.728$, $\alpha_{\text{experientiality}} = 0.834$).

To measure political orientation, we asked participants: "*When it comes to politics, which of the following best represents your viewpoint on most issues*?" *1* = *Very liberal* to *7* = *Very conservative*. Self-reported level of environmental concern was measured with a single-item measure adapted from previous survey research (e.g., Guerin, 2011): "*Generally speaking, how concerned are you about the state of the natural environment?*" *1* = *Not at all concerned* to *7* = *Very concerned.* Finally, participants were debriefed and thanked for their participation.

2.3. Statistical Analysis

To test the effects of criteria, category, and key individual difference measures on perceived extinction risk, we ran a series of linear mixed models using the MIXED procedure in IBM SPSS Statistics Version 23. We chose to use the restricted maximum likelihood (REML) method because covariance parameters estimated through this method are known to be unbiased.[32] We first ran a simple model with only criterion, category, and the interaction between these two variables as fixed effect factors and individual survey identifiers of participants added as a random effect factor. The purpose of this model was to understand how laypeople's perception of extinction risk mirrors or deviates from the general assumptions underlying IUCN Red List Categories and Criteria. That is, we tested whether statements of assessment criteria at the same categorical level were perceived with equivalent risk. We also tested whether descriptions across categorical groups presented with the same criterion elicited discriminant levels of perceived risk. Then, in order to explore the moderating role of individual thinking styles, we added the two REI subscales as covariates to

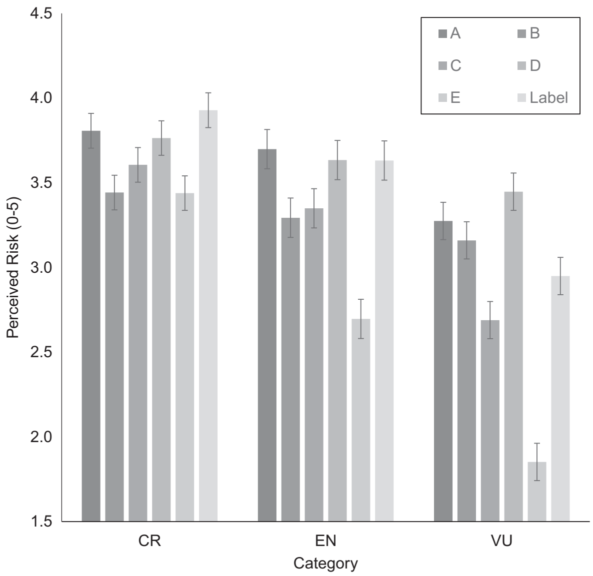

Fig. 1. Estimated marginal means of perceived risk as a function of category and criterion. Error bars represent the standard error of the mean. Criteria include statistics in the form of proportion of decline (A, C), size of area occupied (B), count of remaining individuals (C, D), and single-event probability for the species to become extinct (E).

the simple model, with the REI subscales as fixed factors that were allowed to interact with criterion and category (subscales were mean-centered prior to this analysis). Finally, we explored the effects of three other individual difference variables, namely, gender, political orientation, and environmental concern, using three separate linear mixed models where each of these variables was added as a fixed effect covariate that was allowed to interact with criterion and category (we mean-centered political orientation and environmental concern, and dummy-coded gender, prior to this analysis).

3. RESULTS

The analysis of the simple model without any covariates revealed a significant interaction between criterion and category, F (10, 1512.99) = 8.30, $p <$ 0.001. Bonferroni-adjusted pairwise comparisons of criteria within each category revealed an overall pattern whereby participants who read higher risk descriptions made smaller distinctions across criteria than did those who read lower risk descriptions (Fig. 1). Among participants in the CR condition, four of the 15 possible criteria pairs revealed significant mean differences in perceived risk: A versus B (0.37, $p < 0.05$), A versus E (0.37, $p < 0.05$), Label versus B (0.49, $p < 0.01$), and Label versus E (0.49, $p < 0.01$). Among those in the EN condition, six pairs emerged as significantly different: A versus B (0.41, $p < 0.05$), A versus E (1.00, $p < 0.001$), B versus E (0.60, $p < 0.001$), C versus E (0.65, $p < 0.001$), D versus E (0.94, $p < 0.001$), and Label versus E (0.94, $p < 0.001$). In contrast, nine pairs were significantly different in the VU condition: A versus C (0.59, $p <$ 0.001), A versus E (1.42, $p < 0.001$), B versus C (0.47, $p < 0.01$), B versus E (1.31, $p < 0.001$), C versus E (0.84, $p < 0.001$), D versus C (0.76, $p < 0.001$), D versus E (1.60, $p < 0.001$), Label versus D (0.50, $p =$ 0.001), and Label versus E (1.10, $p < 0.001$).

There were also significant main effects of both criterion, F (5, 1512.98) = 46.81, $p < 0.001$, and category, F (2, 302.75) = 30.71, $p < 0.001$. *Post hoc* pairwise comparisons with Bonferroni adjustments indicated that, on average, Criteria A, D, and the verbal Label yielded the highest level of perceived risk, followed by the second tier consisting of Criteria B and C. Criterion E induced lower perceptions of risk than any other criteria.

We also examined whether the categorical risk levels (CR, EN, VU) engendered discriminant levels of perceived risk judgments for each criterion, as assumed by the IUCN Red List. Pairwise comparisons with Bonferroni adjustments indicated that CR elicited greater perceived risk than did EN only when described in Criterion E (mean difference = 0.74, $p <$ 0.001). In addition, participants rated EN species as facing greater risk than VU species when they were described in terms of Criteria A (0.42, $p < 0.05$), C, E, or the Label (0.66; 0.85; 0.68; all ps < 0.001). Finally, CR species received higher risk ratings than VU species when described in terms of Criteria A (0.53, $p < 0.01$), C, E, and the Label (0.92; 1.59; 0.98; all ps < 0.001).[1] When the descriptions were written in terms of Criteria B or D, participants' ratings of perceived risk did not differ across any of the three risk categories tested in this study.

[1]To further test whether the unique differential effects of Criterion E across all risk levels was an artifact driven by the similarity in statistical format between the criterion and the first perceived risk item (i.e., both alluded to the probability to become extinct in certain time), we conducted a separate analysis using the second perceived risk item alone as the dependent variable instead of the two-item composite scale for perceived risk. The discriminating effects of Criterion E remained the same (CR vs. EN vs. VU = 3.265 vs. 2.486 vs. 1.812; all differences significant at $p < 0.001$ or $p = 0.001$).

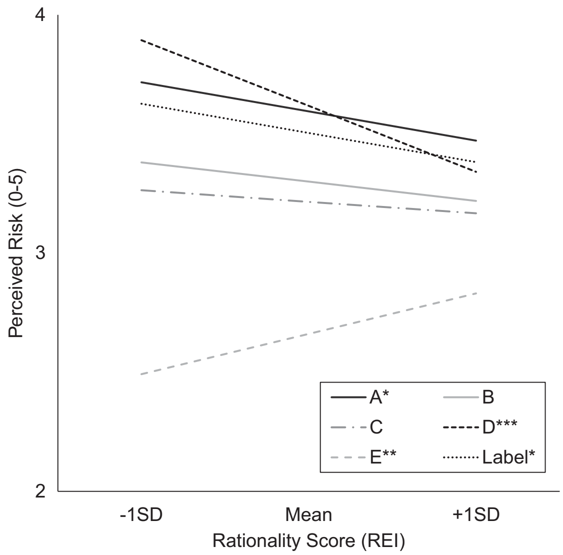

Fig. 2. Perceived risk as a function of individual differences in rationality (*significant at $p < 0.05$; **significant at $p < 0.01$; ***significant at $p < 0.001$). Criteria include statistics in the form of proportion of decline (A, C), size of area occupied (B), count of remaining individuals (C, D), and single-event probability for the species to become extinct (E).

Next, we added the two REI subscales to the previous model as fixed effect covariates with full-factorial interaction terms of the four variables. We then reduced the model by removing the highest order interaction term in the model with the highest p-value one at a time until all highest order interaction terms in the resulting model were significant. The reduced model included the two-way interactions of Criterion × Category, F (10, 1507.97) = 8.95, $p < 0.001$, and Criterion × Rationality, F (5, 1507.82) = 7.84, $p < 0.001$, as well as the main effects of Criterion, F (5, 1507.95) = 48.18, $p < 0.001$, Category, F (2, 300.73) = 29.70, $p < 0.001$, Rationality, F (1, 300.58) = 3.96, $p < 0.05$, and Experientiality, F (10, 300.56) = 18.26, $p < 0.001$. Analysis of simple slopes using coefficient estimates indicated that the higher in rationality participants were, the more risk they perceived from descriptions written in Criterion E, b = –0.04, t = 2.72, $p < 0.01$, but the less risk they perceived from descriptions in Criterion A, b = –0.03, t = –1.97, $p < 0.05$, Criterion D, b = –0.07, t = –4.44, $p < 0.001$, and the verbal Label, b = –0.03, t = –1.97, $p < 0.05$ (Fig. 2). In addition, experientiality was positively related to perceived risk, b = 0.05, t = 4.27, $p < 0.001$.

Finally, we assessed the effects of gender, political orientation, and environmental concern on perceived risk by separately adding each of these variables as covariates to the first simple model with full-factorial interaction terms and reducing the model using the same procedure described above. Although no effects of gender emerged (Fs < 1, *ns*), analysis revealed a significant interaction between political orientation and criterion, F (5, 1507.91) = 2.61, $p < 0.05$, in the final model where Category × Political Orientation and the three-way interaction terms were removed. Political conservatism was negatively associated with perceived risk in response to Criterion D, b = –0.10, t = –2.25, $p < 0.05$. The relationship between political orientation and perceived risk was not significant when participants were responding to descriptions based on other criteria. Finally, analysis also revealed a significant main effect of environmental concern, F (1, 302.45) = 35.14, $p < 0.001$, such that participants reporting higher levels of environmental concern perceived greater levels of extinction risk overall, b = 0.21, t = 5.93, $p < 0.001$. However, none of the interaction effects involving environmental concern were statistically significant.

4. DISCUSSION

When assessing the threatened status of biological species, conservation experts base their judgments on different statistical criteria and summarize these assessments with verbal category labels (e.g., "Endangered"), providing various means with which to communicate about extinction risk to policymakers and the public. Yet, limited research has attempted to systematically explore how these different criteria may shape how message recipients (e.g., the general public) perceive the focal risk. To address this gap, the present experiment explored whether the five different types of statistics used by a leading conservation organization (the IUCN) to denote a given level of extinction risk (i.e., CR, EN, or VU) might nevertheless evoke varying levels of perceived risk among laypersons, a question informed by decades of research on biased processing of statistical information from the psychology and risk analysis literatures. Overall, results suggest that despite their normative equivalence among scientific experts, these different statistical criteria are indeed capable of engendering different levels of risk perception in the eyes of the public, effects that we believe carry direct and important implications for those tasked with communicating about conservation status.

Our findings suggest that those who communicate species' extinction risk should carefully consider both strengths and limitations associated with each criterion in light of the objectives of their communication efforts. For example, frequency-based population estimates (Criterion D) gave rise to relatively high levels of perceived risk across all criteria regardless of risk category (CR, EN, and VU). Nevertheless, it did not appear to make a significant difference whether there were fewer than 50, 250, or 1,000 mature individuals of the species remaining, a finding that complements recent theorizing on the role of message construal in risk communication.[33] Thus, although conservation campaigners seeking to mobilize public support for a particular species may wish to highlight the small size of the species' population when such information is available, Criterion D appears inappropriate when the communicator's goal is to establish resource priorities among species based on their differing levels of risk. In contrast, whereas single-event probabilities (Criterion E) prompted risk perceptions that were most clearly distinct across the three levels of CR, EN, and VU, this criterion would appear less useful if the goal is to inspire urgent public attention to the threats faced by species. For Criterion E, risk was perceived as the least severe across all criteria, especially within categories that correspond to lower risk (i.e., EN and VU); in fact, mean perceived risk for the VU-level description with Criterion E (1.85) was lower than the scale midpoint (2.50), suggesting that this particular description may prompt remarkably low levels of perceived risk.

Importantly, our results also suggest that, overall, people's interpretation of statistical risk information can be influenced by individual differences in thinking style. Specifically, we found that participants high in rationality tended to express less bias (i.e., more similar levels of perceived risk across criteria) compared to low-rationality participants. That is, they perceived more risk in response to Criterion E, but less risk from Criteria A, D, and the Label, than did those low in rationality. By combining these findings with previous observations regarding how rationality correlates with other individual differences such as need for social dominance, self-esteem, or scholastic achievement,[19,20] future research can test more fine-grained hypotheses about how particular segments of the public will respond to statistical risk information. Alternatively, it is also possible to test whether particular instructions or procedures used to activate rational modes of thinking[34–36] can be applied to communication contexts where more balanced responses across statistics is desired.

Another individual difference that influenced participants' sensitivity to statistical criteria was political orientation. For example, whereas conveying the number of remaining individuals elicited higher levels of perceived risk than did mentioning the categorical label of the species' status among liberals (i.e., 1 *SD* below the mean in political orientation; mean difference = 0.35, $p < 0.05$ with Bonferroni adjustments), conservatives (i.e., 1 *SD* above the mean) did not exhibit this difference (mean difference = –0.11, $p > 0.10$). We suspect that this politics-contingent finding may reflect, in part, the different moral considerations that underlie liberals' and conservatives' attitudes toward environmental issues. For example, recent work[37] suggests that environmental messaging that is evocative of the moral dimensions of harm and care—as may be the case for Criterion D, which highlights the plight of individual animals—may resonate especially strongly with liberals, who have been shown to privilege these "moral foundations" above other considerations.[38] Future research may wish to explore whether political differences in moral judgment may underlie the present effects.

Although the present findings yielded strong support for the role of criteria differences in shaping risk perception, some findings were unexpected, and we offer some related speculations here. For example, Criterion C, which combines two appealing forms of statistics—frequency of remaining individuals and proportion of decline—might be expected to evoke high levels of perceived risk. However, on average, Criterion C elicited less perceived risk than did comparable descriptions in the form of Criteria A or D. Furthermore, the CR description in Criterion C and the EN description in Criterion D offer an interesting contrast. Both descriptions convey that only 250 individuals remain, but the CR description in Criterion C provides additional information that this population had declined by 25% over the past three years—yet, this description failed to elicit higher perceived risk than did the description that omits this additional information (Criterion D in the EN condition). We surmise that our participants may have paid more attention to the ratio of decline rather than the direction of the trend itself, which may alleviate the sense of urgency conveyed by the small number of remaining individuals. In addition, although individual differences in experiential style of thinking might be expected to moderate the effects of criteria, we found no evidence for this. It is possible that our choice to use the short form of the REI scale[19] for reasons of economy, as opposed to the more comprehensive scale, may have prevented us from detecting an effect (see Pacini and Epstein[20] for a relevant discussion).

We note some limitations to the study. First, our choice of participant population was guided by the study's focus on detecting experimental effects rather than estimating population-level parameters, and thus caution should be exercised in generalizing the present findings to the wider public. Nevertheless, previous research suggests that our sample population allows for reliable recruitment of participants who are demographically diverse.[39,40] In addition, we note that the current study did not comprehensively include all variables that are known to moderate individuals' susceptibility to statistics-related biases. For instance, while REI assesses self-reported preferences regarding cognitive tasks, which may speak in large part to an individual's confidence regarding statistical tasks, one's actual capacity to process numerical concepts may play an important role in the processing of these messages, as well.[41] Also, in the current design, we largely assumed that our participants lacked any knowledge about the IUCN Red List standards, given our interest in assessing the differential effects of categorization criteria among laypersons. Evidence from recent research finds that students with even moderate wildlife expertise relied heavily on rational thinking when they judged the risk of climate change to wildlife, but not when judging comparable risks to human society.[42] Future research may therefore wish to explore the extent to which the reported effects vary across individuals who differ in numeracy or domain-relevant expertise, in addition to the individual difference factors explored here.

Finally, future research can draw on findings in risk communication and social cognitive psychology to further illuminate how people respond to conservation messages. One possible avenue of research is to investigate how emotionally intense words or images influence people's understanding of risk. For example, it is possible that phenomena such as the widespread public outrage following Cecil the African lion's death is attributable, in part, to the identifiable victim effect, which has been widely discussed in literature.[43] Our findings, which support the interaction between perceived risk and individual thinking styles, suggest that statistical information and emotionally charged messages may have varying levels of persuasive appeal across different members of the public.

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