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To List or not to List? Experts' Judgments about Threats to Greater Yellowstone Grizzly Bears

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Summary

The Endangered Species Act (ESA) demands that listing status decisions consider five statutorily-defined "threat" factors, and render a decision based upon the best available commercial and scientific data. Though the ESA's 'best available science' mandate appears to create a process whereby threats (or risks) to a species are assessed systematically and decisions rendered based upon assessed risk, the listing process defined by the Act actually conceals two questions: (a) what is the probability, or risk, that a species will go extinct? and (b) is the assessed probability or risk acceptable? The first question is explicit in the ESA, widely appreciated by scientists, and can be appropriately addressed through scientific means; however, the second question is implied by the ESA, and fundamentally normative. We reasoned that this subjectivity and a lack of certainty surrounding threats to grizzly bears created the perfect opportunity to study how experts make decisions in such contexts.

In December of 2014, we contacted 593 individuals who had published research related to grizzly or brown bears during the past decade. Of these, roughly 40% (234) completed the survey. We assessed experts' preferred conservation (or listing) status for bears, their perceptions of seven threats to bear populations, as well as a variety of factors that might potentially bias experts' judgments. Importantly, 115 individuals either were (at the time of the survey) or were formerly both (a) involved in some aspect of grizzly bear research or management, and (b) knowledgeable concerning the GYE population.

Highlights:

- Overall, 60% of respondents indicated that GYE grizzlies should continue to receive ESA protection. Approximately 20% of respondents stated that the GYE grizzly bear population should be delisted, and the others were unsure.
- Among respondents who felt knowledgeable enough to provide a listing status recommendation (n = 172), 74% indicated the GYE population should remain listed (25% recommended listing the population as 'endangered', 49% recommended listing as 'threatened').
- There was no association between self-reported experience (Groups 1 – 4) and listing status judgments ($\chi^2_6 = 10.37$, $P = 0.11$).
- Respondents with academic affiliations were more likely to recommend listing than those without an academic affiliation ($\chi^2_2 = 13.97$, $P < 0.01$), and those with state and federal agency affiliations were less likely to recommend listing ($\chi^2_2 = 24.94$, $P < 0.01$).
- When controlling for perceived biases, respondents' perceptions of the threats (risks) to GYE grizzlies were not significantly associated with their judgments concerning bears' listing status.
- When controlling for a wide variety of potential biases, three factors were associated with judgments about concerning bears' listing status—two were measures of respondents' wildlife-related values, and the third was expert norms (the extent to which respondents felt other experts endorsed listing).

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CH 1. Expert Judgments about Threats to Greater Yellowstone Grizzly Bears

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Abstract

Accelerating threats to biodiversity increases pressure on government agencies to determine which species require protection under the United States Endangered Species Act or similar statutes in other countries. We assessed scientific experts' judgments concerning threats to the Greater Yellowstone Ecosystem population of grizzly bears (*Ursus arctos horribilis*), and examined factors that may influence such judgments in the face of uncertainty. Additionally, we examined if increased relevant experience resulted in greater consensus among experts' assessment of threats and subsequent listing status recommendations. Respondents (n = 212) exhibited high variability in threat assessments for grizzlies; such variation was not related to experience with Greater Yellowstone Ecosystem grizzly bear research. A substantial majority (74%) of scientists recommended continued Endangered Species Act protections for Greater Yellowstone Ecosystem grizzly bears, and recommendation did not vary by experience level. However, scientists' professional affiliations—a potential source of bias— were strongly associated with listing status recommendations. These results indicate that expert judgment regarding imperiled species may not always be based solely on the best scientific data available, and suggest the importance of considering revisions to the policies and procedures that govern listing status determinations to explicitly address potential sources of bias.

Introduction

Mounting evidence suggests that earth is entering a sixth mass extinction [1,2] largely attributable to human causes [3]. In response, conservationists are considering novel approaches to protect species (e.g., assisted colonization), while maintaining more traditional means of conservation (e.g., setting aside protected areas). However, conditions more conducive to preserving biodiversity are not anticipated in the near term. As such, we expect increasing pressures on government agencies to make judgments about which species and populations require protections, and what types of measures need to be in place to prevent their extinction, and perpetuate their ecological function. In the United States, decisions about which species are threatened with extinction, and therefore entitled to federal protection, are made by two administrative agencies: the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Services (NMFS). Authority over these 'listing decisions' was delegated to these agencies by Congress via the federal Endangered Species Act (ESA; 16 U.S.C. §1531 [4]), which seeks to protect and conserve species threatened with extinction. The ESA mandates that listing decisions be based on the 'best available' commercial and scientific data. However, even the best available science contains is often riddled with uncertainty regarding the threats facing species. Despite the uncertainty, political pressure to reach definitive judgments can be acute [5].

Research on scientific judgment under uncertainty consistently finds that scientific experts are not

purely objective, and decision-making, even when uncertainty is minimal, is frequently swayed by heuristics [6], affect [7], and other biases [8]. ESA listing decisions are frequently rife with both complexity and uncertainty, but relatively little is known about what factors influence the experts called upon to make these decisions. Our study sought to (a) quantify consensus on the appropriate listing status of a controversial species (i.e., grizzly bear [*Ursus arctos horribilis*] in the Greater Yellowstone Ecosystem [GYE]), and (b) understand how scientists' experience and affiliations impact their judgments about the appropriate listing status of this species.

The Greater Yellowstone Grizzly

During the past two centuries, large carnivores were purposefully eradicated throughout much of the US by federal, state, and local governments [9,10]. By 1915, cougar (Puma concolor), grizzly bears, and gray wolves (Canis lupus) had been eradicated from most of the lower 48 states [11]. Currently, grizzly bears are protected within the conterminous US; however, ESA protections for large carnivores are controversial, and the USFWS is under considerable pressure to accelerate species recovery and delist species deemed 'recovered' [12,13].

The GYE is a 23,827 km2 expanse that includes parts of Wyoming, Idaho, and Montana. The GYE is the largest intact, or nearly intact ecosystem in the conterminous US, and includes seven national forests, three national wildlife refuges, and two national parks [14]. GYE grizzly bears have been listed as 'threatened' since 1975 [15], and are currently under consideration for delisting as the population has met recovery goals outlined in the Grizzly Bear Recovery Plan [16,17]. The population has a positive annual rate of increase [18] despite persistent threats of human-induced mortality, habitat destruction, and fragmentation. Current population estimates place abundance near 600 individuals, though some scientists question the validity of sampling methodologies due to detectability and other concerns [19, 20, 21].

In 2006 the USFWS issued a Final Rule [22] that removed GYE grizzlies from federal ESA protections; however, a Federal Court overturned the delisting largely due to uncertainties regarding the effect of climate on important food resources [23, 24]. Before and after the overturned 2006 decision, human-caused mortality (e.g., lethal conflict mitigation, vehicle collisions, illegal poaching) was the leading cause of GYE grizzly mortality [25] despite the abundant and vast protected areas that characterize the region [26, 27]. This suggests that human tolerance for grizzlies, similar to other large carnivores, is the primary limiting factor to the GYE grizzly [28, 29]; however, we are unaware of any studies that have assessed changes in tolerance for GYE grizzlies—an additional uncertainty. Moving forward, it is plausible to assume that ESA delisting would increase human-caused mortality, particularly if state management agencies initiate recreational harvest [30] as has been done with other species. In March of 2016, concurrent with the preparation of this manuscript, the USFWS proposed to delist GYE grizzlies from federal ESA protection and place the population under state oversight [30].

With much apparent uncertainties regarding ongoing and future effects of climate change and declining food sources, and how local residents will respond to changes in the bears' status, some researchers have urged caution in delisting GYE grizzlies, suggesting that removing ESA protections potentially jeopardizes recovery of the population [21]. Other scientists support the current delisting proposal because recovery goals have been met for population abundance and "threats to this population and its habitat have been sufficiently minimized" [30]. Even now, with public comments being submitted on behalf of the current proposed delisting, substantial scientific disagreement appears to surround the appropriate status of GYE grizzlies, though the extent to which scientists disagree regarding bears' status is unknown.

Listing Decisions under the Endangered Species Act

The ESA protects species threatened with or in danger of extinction and promotes their conservation [4, 31]. Listing consideration is triggered by internal USFWS or NMFS review or by third-party petition, and the law mandates that determinations about listing status be based on the 'best available scientific…data.' The ESA further mandates that (de)listing decisions ignore economic, social, or political consequences potentially resulting from any such decision. In essence, the ESA's language implies that determining a species' listing status involves an objective assessment of threats.

However, determining the listing status of a species involves answering two fundamental questions: (a) what is the probability, or risk, that a species will go extinct? and (b) is the assessed probability or risk acceptable? [32, 33]. The first question is explicit in the ESA, widely appreciated by scientists, and can be appropriately addressed through scientific means. The second, however, is implied in the ESA, and fundamentally normative [34]. In addressing the first question, agencies are required to assess five statutorily-defined threats for any species considered [4]. Agency experts review the scientific literature to determine how each potential threat is likely to impact a species' extinction risk [31]. However, a variety of cognitive and psychological factors potentially bias expert judgments under these conditions [35]. Psychological research on group norms and conformity indicates that strong identification with in-groups leads to conformity with perceived group expectations and norms [36, 37]. Similarly, it stands to reason that experts' social and professional affiliations may impact their interpretations and assessments of relevant science, thereby leading to divergent decisions concerning a species' status. Ultimately, scientists are not immune to biases inherent in human judgment and decision-making—especially under conditions of uncertainty [6].

Despite potential biases in decision making, the social expectation hypothesis states that increased experience and qualifications should lead to better performance when estimating facts within an expert's field [38]. This belief is shared by the general public and experts themselves [38]. An extension of the hypothesis is that more highly qualified pools of experts should exhibit less variance in their judgments (e.g., greater consensus)—within the context of the ESA, threat assessments and subsequent listing status determinations concerning threatened or endangered species. For decisions regarding imperiled species, we expected that uncertainty in expert judgments or gaps in existing scientific knowledge may be evidenced by lack of consensus among experts, and we predicted that higher levels of experience would result in higher agreement among experts about threat assessments and listing status recommendations for the GYE grizzly bear population. Though the social expectation hypothesis is commonly held, empirical evidence suggests that increased expertise does not necessarily transfer to improved performance [38]—perhaps similar results with convergence, or lack thereof, should not be unexpected.

The uncertainty and controversy surrounding the GYE grizzly bear population has created an opportunity to study how experience level and social and professional affiliations impact scientific judgments regarding the appropriate protections for species. Using an internet-based survey of wildlife scientists, we examined individual professionals' threat assessments and listing status recommendations to gauge consensus and evaluate biases on these two key ESA listing status components.

Materials and Methods

To select a panel of potential participants for our internet-based survey, we searched the database Academic Search Complete for authors and co-authors who published grizzly bear research in the last 10 years (search terms: “Ursus arctos”, “brown bear”, “grizzly bear”). The search identified 1,345 persons that we supplemented with ninety listed members of the Interagency Grizzly Bear Committee (IGBC; http://www.igbconline.org/). Our method of defining experts was intended to be as inclusive as possible, as we intended to contact interested researchers with varying levels of experience with grizzly bear research. Based on this approach, we identified email addresses for 1,216 experts. Of these, we successfully delivered emails to 593 recipients and asked them to complete a brief online questionnaire about the Greater Yellowstone grizzly population. Survey non-respondents were contacted two additional times by email following the initial solicitation. For those who felt they lacked sufficient qualifications, we provided an opt-out option. Human research was conducted under the overview, and complied with the policies, of The Ohio State University’s Institutional Review Board (Protocol# 2014E0617).

We asked respondents to indicate their level of experience with GYE grizzly bear research (Table 1), and we constructed groups based on experience relative to the GYE grizzly bear population—G1 for highest experience to G4 for lowest experience. Respondents who chose the option “I have no wildlife research or management experience at all” were removed prior to analysis. Our scale of ranking experience was somewhat coarse and did not explicitly incorporate length of professional experience, or tenure. Because Martin et al. [39] noted “…Few experts reach highest level of competence in less than a decade”, we examined whether length of professional tenure was associated with listing recommendations and related responses. Individuals also reported occupational affiliations and professional society memberships.

Table 1. Respondents’ experience with the Greater Yellowstone grizzly bear population.

Experience Group	Description
G1	I was/am involved in GYE grizzly bear research or management.
G2	I was/am involved in grizzly bear research or management focused somewhere other than the GYE, but have some knowledge of the population in the GYE.
G3	I was/am involved in grizzly bear research or management focused somewhere other than the GYE, and have no knowledge of the population in the GYE.
G4	I have no grizzly/brown bear research or management experience, but have other wildlife research or management experience.
Censored	I have no wildlife research or management experience at all.

We generated a list of specific threats to the GYE grizzly bear population that fit broadly into seven categories. These threats were previously identified by the USFWS in a prior attempt to delist the GYE grizzly population. The specific potential threats were as follows: “decrease in abundance of grizzly’s natural food source”, “loss of habitat to human development”, “habitat modification on public lands”, “human caused grizzly mortality”, “lack of genetic diversity and connectivity to other populations”, “lack of support for grizzly bear conservation”, and “shifting ecological conditions due to climate change.”

Research on risk perception has identified two components of risk; the severity of potential consequences produced by the risk and the likelihood that such consequences will occur. Survey respondents rated potential threats to GYE bears along two dimensions: one gauged the likelihood that the threat would occur over the next 10 years (0 indicated "not likely to happen", 10 indicated "certain to happen"), and the other assessed the severity of that threat to grizzly population viability were it to occur (0 indicated "no harm at all", 10 indicated "extreme harm to the population"). We multiplied the two scales (each ranging from 0 [no threat] to 10 [highest threat]) to generate an overall rating for each threat item (i.e., likelihood x severity)—a standard measure of perceived risk. As both likelihood and severity were measured on a 10-point scale, our final perceived risk scale ranged from 0 (no perceived risk) to 100 (very likely and severe risk). After the threat assessment, respondents indicated whether they believed the GYE grizzly bear population should be listed as endangered, threatened, not listed, or if they were unsure. The order of questions was designed to elicit thoughtful processing of information regarding the threats to grizzly bears before making a judgment about the appropriate listing status. Additionally, respondents were asked to indicate the level of extinction risk that, "if exceeded, would require a species to be listed as threatened under the Endangered Species Act". Respondents based their assessment on the probability of GYE grizzly bear population extinction over the next 100 years.

We tested for differences between listing status recommendations (excluding those who indicated "unsure") and 1) experience level, 2) occupational, and 3) professional affiliations. To assess if level of experience had any effect on risk tolerance of extinction or how each conservation threat was rated, we conducted an ANOVA and assessed differences (when significant) between respondent groups with the Games-Howell post-hoc test. For those respondents who rendered a listing recommendation, we used logistic regression to assess the relationship of listing recommendation and professional tenure, and a t-test was used to test for differences in listing recommendation and risk tolerance of extinction. To assess differing levels of variability in respondent groups' threat assessments, we calculated absolute deviance for each individual's threat score as compared to their group's mean score, and conducted an ANOVA coupled with a post-hoc pairwise differences test for each threat. Additionally, we used multivariate linear regression to test for potential associations between acceptable risk tolerance of extinction and length of professional tenure, occupational, and professional affiliations.

Results

Of the 593 individuals who opened the survey, nearly 40% (n = 234) completed the survey. Of those who did not complete the survey, many (n = 158; 27%) sent emails to explain that they did not feel they had sufficient knowledge or experience to complete the survey. We censored 22 additional respondents who reported limited experience with wildlife research and management.

Survey respondents worked for a variety of professional organizations with length of tenure ranging from <12 months to more than 70 years. 70% of respondents reported an academic affiliation (n = 149), 18% (n = 39) a state agency affiliation, and 23% (n = 48) a federal agency affiliation. In total, 36% of respondents reported a state and/or federal agency affiliation. Comparatively few respondents worked for non-profit organizations (n = 35) or captive breeding programs (e.g., zoos; n = 10). Almost half of respondents indicated membership in the Wildlife Society (TWS; n = 101), followed by the Society for Conservation Biology (n = 68). The Ecological Society of America, International Union for Conservation of Nature (IUCN), American Society for Mammalogists, and International Association for Bear Research and Management shared similar membership among respondents (range: 36-41). Over half (54.2%) of the survey respondents reported having direct research experience with grizzly bears and at least some knowledge of the GYE grizzly bear population, and only 12% of respondents indicated having "no

grizzly/brown bear research or management experience, but have other wildlife research or management experience."

The average pooled scores across the seven threat categories were similar, and each threat had substantial variation in responses spanning the entire range of possible values 0-100 (Fig 1). For threats of decreased food abundance (F = 2.43 3, 196, P = 0.07), habitat modification (F = 1.64 3, 189, P = 0.18), human caused mortality (F = 0.71 3, 197, P = 0.55), and climate change (F = 1.14 3, 194, P = 0.33), previous research or management experience did not affect mean assessments. The group with the least amount of relevant experience (G4) ranked habitat loss (rating difference = 18.34; F = 2.90 3, 192, P = 0.04) lower on the threat assessment scale than expert group 3. Groups 2 and 3 differed in ranking the threat posed by lack of support for grizzly conservation (rating difference = 11.41; F = 3.36 3, 191, P = 0.02) and genetic diversity (rating difference = 18.57; F = 6.50 3, 194, P < 0.01) – G3 perceived each threat as more serious. The absolute deviance of threat scores among experience groups did not vary for the seven threats to GYE grizzly bear conservation (Fig 1).

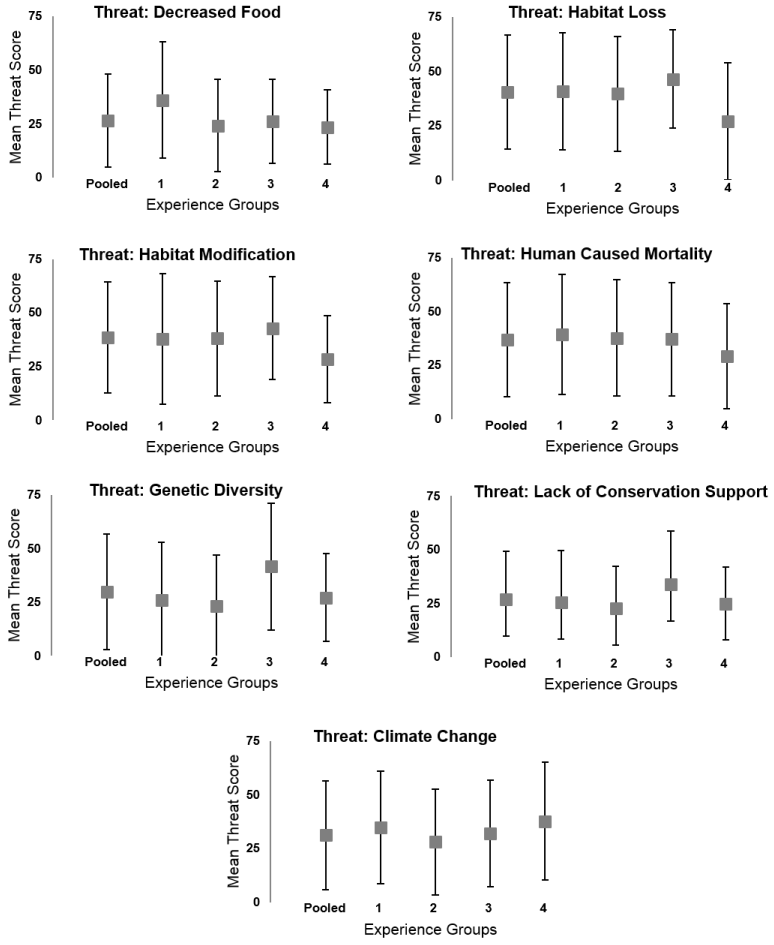

Figure 1. Threat assessment scores for the GYE grizzly bear population by experience groups *(Group 1 possessing highest experience and Group 4 lowest). Scores are the product of the likelihood that the threat would occur over the next 10 years (0 – no likelihood and 10 – imminent) and the potential severity of that threat were it to occur (0 – no severity and 10 – highest severity). Error bars represent 1 standard deviation in respondent assessment scores.*

Overall, 60% of respondents indicated that GYE grizzlies should continue to receive ESA protection. Approximately 20% of respondents stated that the GYE grizzly bear population should be delisted, and the others were unsure (Fig 2). The majority of "unsure" respondents had lower self-reported relevant experience (82% from G3 and G4). Among respondents who felt knowledgeable enough to provide a listing status recommendation (n = 172), 74% indicated the GYE population should remain listed (25% recommended listing the population as 'endangered', 49% recommended listing as 'threatened'), and there was no association between self-reported experience (Groups 1 – 4) and listing status judgments ($\chi 26 = 10.37$, $P = 0.11$). However, simply gauging experience by length of professional tenure, individuals with greater years of experience were more likely to recommend GYE grizzly delisting ($\beta = -0.027$, $P = 0.04$), though the association was weak.

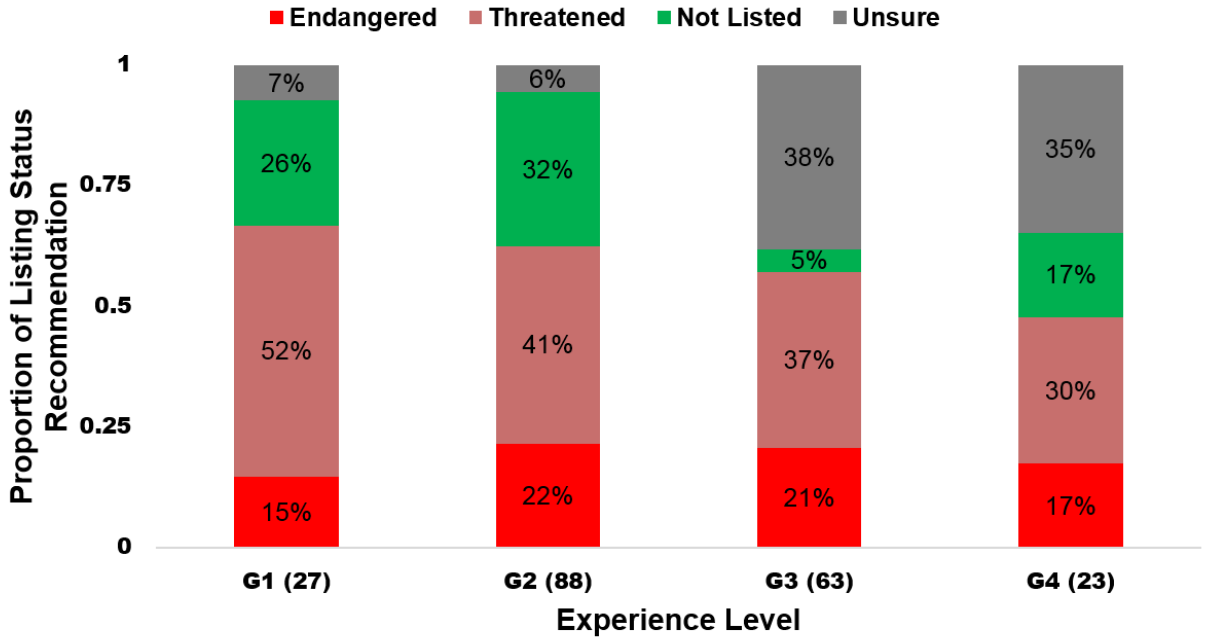

Figure 2. Listing status recommendations for GYE grizzly bear population by experience group *(Group 1 possessing highest experience and Group 4 lowest).*

Respondents with academic affiliations were more likely to recommend listing than those without an academic affiliation ($\chi 22 = 13.97$, $P < 0.01$), and those with state and federal agency affiliations were less likely to recommend listing (Fig 3; $\chi 22 = 24.94$, $P < 0.01$). Employees of state and federal agencies had more years of experience (26.3 years) than other respondents (18.2 years; $t = 3.37$, $P < 0.01$). Of professional societies with >30 members, only membership in TWS was associated with recommended listing status judgments ($\chi 22 = 23.78$, $P < 0.01$); TWS members were less likely to endorse continued listing. TWS members had more years of experience (23.7 years) than non-TWS members (16.6 year; $t = 3.91$, $P < 0.01$). The average professional tenure did not differ for members of other professional societies.

Regarding extinction risk tolerance, respondents varied in opinion with answers ranging from 0 to 1 with mean = 0.35 (SD = 0.23)—that is, on average, respondents were willing to tolerate a 35% chance of extinction over the next 100 years. Over three-fourths of individuals indicated that a species should receive ESA protections if the extinction risk exceeded 50%. Acceptable thresholds of extinction risk did

not vary between experience groups (F = 2.27 3, 194, P = 0.08), and there was no difference between experts' accepted risk of extinction between those who recommended delisting (0.38) and those who recommended continued ESA protections (0.33; t = 1.00, P = 0.32). Additionally, beta coefficients for expert's affiliation, employment, or professional tenure overlapped zero (at a 95% confidence level) in the acceptable extinction risk model.

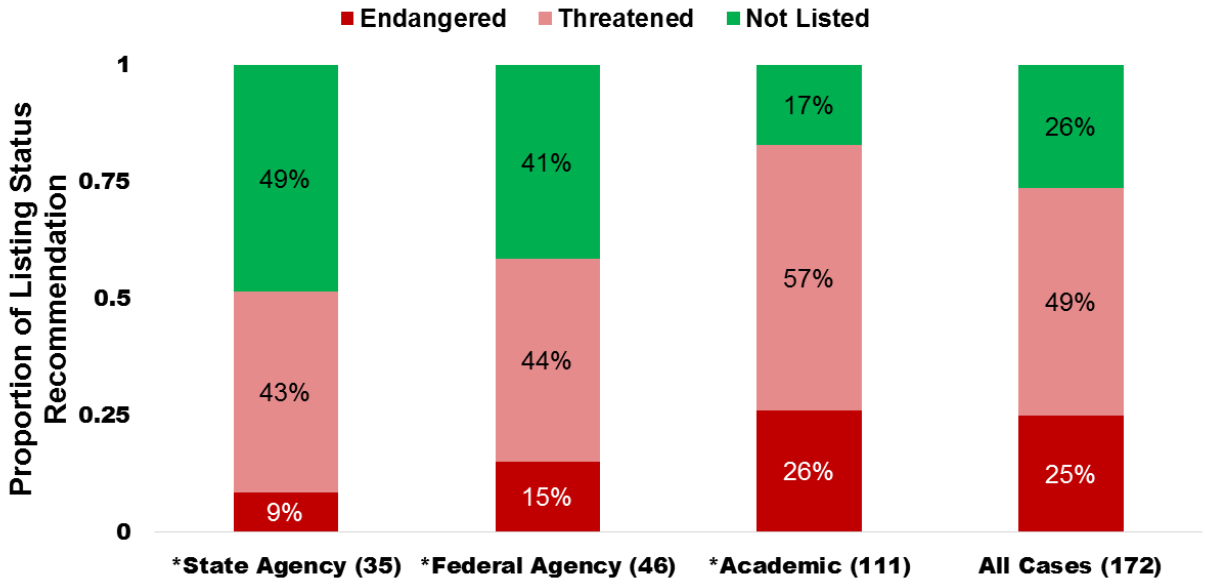

Figure 3. Listing status recommendations for GYE grizzly bear population by employer.

Discussion

A clear majority (74%) of respondents who provided a judgment regarding bears' appropriate listing status indicated that the GYE grizzly bear population should remain under the protection of the ESA. Almost three-quarters is certainly a majority, but is that consensus? Some have argued that in cases where empirical evidence or unanimity of opinion is lacking, the 'precautionary principle' (i.e., making decisions that err on the side of caution) may be invoked when the potential existence of a species or population is at stake [40]. Although other numerous tools for resolving uncertainty exist [41, 42, 43], it is not clear that such decision aides would be considered appropriate in this context, given the statutory requirement for listing decisions to be based solely upon the best commercial and scientific data. Several decision tools are available that can facilitate explicit consideration of empirical data with judgments under uncertainty (e.g., Structured Decision Making); however, while empirical testing of such tools shows promise [38], these tools often require explicit consideration of non-scientific factors (e.g., one's personal values) which appears to be prohibited by the ESA's 'best available science' mandate.

While there was some agreement among our sample regarding the ESA listing recommendations for GYE grizzly bears, the variance in threat rankings suggests substantial uncertainty regarding the most important threats facing the GYE grizzly. The three threats rated highest by our participants (habitat loss, habitat modification, and human caused grizzly mortality) are in concordance with other literature assessing the GYE population [16, 17, 44, 45, 46]. In contrast to our prediction, consensus (i.e., reduced

variance in threat ratings) did not converge with increasing experience [38]. This lack of convergence suggests that there is considerable uncertainty regarding threats even among those most knowledgeable about the GYE grizzly bear population. Though the threat assessment included in our survey was not as extensive as an actual ESA review, the high degree of collective uncertainty opens the door to biases in judgment and decision making [6]. Indeed, research indicates that decision making in the presence of uncertainty is prone to the use of heuristics (i.e., mental shortcuts such as one's innate tolerance of risk or ambiguity [6, 39]), and greater transparency of uncertainty in listing status determinations would be useful for potentially understanding when non-relevant factors are likely to bias judgments [47].

Our data indicate that judgments about the listing status of bears varied substantially by experts' employer and professional affiliations. This finding is not unexpected given the high degree of uncertainty [6] regarding potential threats and potential outcomes, and suggests that respondents' social networks and professional norms may play an important role in shaping their judgments about a species' appropriate ESA status. The additional nuance of professional tenure (i.e., years of experience) appears interwoven with these influences. Highly experienced individuals within state and federal agencies and academia likely have comparative mastery of the science regarding grizzly bear ecology and management. Although knowledge and expertise have high overlap, employment in government agencies and academia likely exert very different pressures on individual experts with regards to how freely knowledge (i.e., science) translates to decision making. Stated more explicitly, academicians are likely less bound by institutional expectations of conformity. Affiliation norms are likely to become even more pronounced in circumstances where professional organizations issue official position statements, as was the case when TWS affirmed USFWS' proposed GYE grizzly delisting in 2006 [48]. Unfortunately, distinguishing indoctrination from normative bias is not possible with our data. These findings underscore the fact that listing decisions—like any other, decisions are subject to a variety of biases and cannot be based solely on science [32, 33, 34].

This specific study highlights challenges with current ESA listing decisions. Although substantial literature has illustrated that the core of listing decisions centers on an evaluation of perceived threats of extinction to a particular species as well as an evaluative judgment about whether that level of risk is acceptable, listing decisions are still required to be based solely on the best scientific information available. Accordingly, listing determinations have yet to adopt more quantitative and structured frameworks for decision-making. At the same time, there was no statutorily-defined standards by which to judge what level of risk is acceptable (e.g., acceptable risk of extinction). Thus, evaluations of the acceptable level of risk are completed implicitly by experts who are operating without broader guidance or perhaps even recognition of the subjective nature of expert opinion in ESA processes; this is particularly acute in cases of high uncertainty (for specific examples see: [47, 49, 50]). Continuing to ignore decision-making uncertainty may even encourage overconfidence in particularly tenuous decision-making environments [51, 52]. Where social networks and salient identities reinforce shared beliefs, susceptibility to overconfidence is particularly acute [53]. Speirs-Bridge et al. [42] conceived a four-step method to lessen expert overconfidence and generate bounded intervals around estimated parameters. This is a compelling avenue that merits further consideration in listing status determinations, as the authors [42] offer practicable means for mitigating and accounting for overconfidence, which in turn, would offer a quantitative gauge of expert decision-making uncertainty.

Complete elimination of uncertainty, of course, is not achievable even within a highly researched population such as the GYE grizzly bear [54], and our results indicate that apparent agreement between a few GYE grizzly bear experts would be misleading of the true variance among the larger pool of scientists and managers. For instance, based on our results, if we drew a random sample of three respondents from our survey, there is a 41% probability that all three recommend GYE grizzlies remain listed and only

a 2% probability that all three agree on delisting. Lack of consensus, in any combination of listing status recommendations, is more likely. Generally speaking and across disciplines, increasing sampling effort to achieve desired precision is commonplace. Viewing consensus along similar lines, we suggest increasing the number of experts included in (de)listing review panels to better gauge variability in judgments, particularly in cases where uncertainty appears high. Provided that pertinent empirical scientific or commercial data is available, Bayesian frameworks could be modified to assimilate expert inputs into existing empirical priors, (e.g., similar to Delphi methods; [41, 55, 56]).

It is important to note some key potential limitations of our study. First, inclusion criteria for potential survey respondents were broader than those used in actual USFWS (de)listing decisions. This is not to insinuate that broadening the scope of experts would necessarily be a detrimental amendment to ESA status determinations. Consulting a wider breadth of experts may yield a more complete picture of a wildlife population's current status; however, identifying appropriate criteria for inclusion as an expert may prove difficult, as research or management experience did not affect listing status recommendations. Second, individuals summoned for actual ESA listing determinations are not granted the same anonymity as our study's survey. Anonymity, or lack thereof, may influence outcomes in a couple of different directions. Non-anonymous review may actually intensify pressures to reach a conclusion that conforms to one's peers, and thus, increase the influence of normative pressure. Conversely, anonymity may lessen one's commitment to thoroughness and due diligence in ESA determinations as expert participants may not perceive accountability for their decisions. Herein lies the tension between two important goals of any scientific peer review process – to demand a thorough and systematic review and to minimize pressure to conform to social or political expectations [57]. Despite prohibiting experts affiliated with the USFWS, IGBC, Wyoming, Montana, and Idaho from formally reviewing the proposed ESA delisting of the GYE grizzly bear population, eliminating all potential bias is not achievable [30].

Discussion of our study's results has potentially important implications for listing determinations of many imperiled species. The USFWS is currently obligated to complete reviews for a backlog of nearly 800 petitioned species by 2018 following litigation settlement with the Center for Biological Diversity in 2011. Given the anticipated near-term flurry of listing determinations, and pressure to show successes through recovery (and subsequent delisting), the USFWS is likely to face numerous delisting decisions in the immediate future, thus underscoring the importance of identifying processes and procedures that minimize bias. We encourage the USFWS to include more and diverse (in terms of expertise) experts on review panels, and assemble external peer review panels earlier in the process (before the public comment period begins). Earlier engagement and greater diversity of external experts would help ensure that uncertainty in threat assessments and extinction risk tolerance are adequately accounted for in the final listing decision, and utilizing peer review earlier would help alleviate concerns that experts are simply called upon to affirm listing decisions rather than rigorously and independently review the judgments to be issued. The USFWS could also benefit by formalizing guidelines for risk tolerance in listing status judgments. Without such guidelines, managers and peer-reviewers alike will continue to be left to their own judgments regarding tolerable risk.

The divergence of respondents participating in our study from the USFWS's current GYE grizzly delisting proposal suggest that tension remains in the conservation community regarding the specific case of GYE grizzlies. To the degree that our study lends insights into systemic biases intrinsic to decision makers and suggests alternative decision-making approaches to manage uncertainty, we anticipate that lessons learned from the GYE grizzly bear population can be applied to future ESA listing determinations.

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CH2. The Role of Expert Judgment in Grizzly Bear Listing Decisions under the Endangered Species Act

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Abstract

Decisions concerning the appropriate listing status of species under the United States Endangered Species Act (ESA) can be controversial even among conservationists. These decisions may not only determine whether a species persists in the near term, they can also have long-lasting social and political ramifications. Given the ESA's mandate that such decisions be based upon the best available science, it is important to examine what factors contribute to experts' judgments concerning the listing of species. We examined how a variety of factors influenced experts' judgments concerning the appropriate listing status of the Greater Yellowstone grizzly bear (*U. arctos horribilis*). Although experts' assessment of the threats to this species was strongly correlated with their listing status recommendation, this relationship disappears when other factors are controlled. Specifically, our results indicate that values related to human use of wildlife and norms (i.e., one's peers' expectation of assessments) were most influential in listing status recommendations. These results suggest that experts' decisions about listing, like all human decisions, are subject to the use of social and psychological heuristics. An understanding of how heuristics and related biases affect decisions under uncertainty can help inform decision-making about threatened and endangered species and may be useful in designing more effective processes for determining the listing status of species.

Introduction

The protection of charismatic mega-fauna, especially carnivores, is often a polarizing issue in conservation policy. Such species often receive a large amount of attention from the public and federal agencies (Dawson & Shogren, 2001; Feldhamer et al., 2002; Metrick & Weitzman, 1998; Sergio et al., 2006; Tear et al., 1993). Due to their prominence in conservation, decisions about whether to list these species as threatened or endangered under the Endangered Species Act (ESA) are often complicated, controversial and litigious. The listing of the grizzly bear population (*Ursus arctos horribilis*) of the Greater Yellowstone Ecosystem (GYE) is one such example of a decision involving a charismatic carnivore.

The GYE grizzly bear has been listed under the ESA as "threatened" in the lower 48 states since 1975 (Knight & Eberhardt, 1985; Schwartz et al., 2002;16 U.S.C. § 1531 et seq.). Prior to listing, grizzly bear range south of Canada has been reduced to 1% of its historic size (Miller & Waits, 2003; Paetkau & Waits, 1998). Presently, the GYE is the largest intact, or nearly intact grizzly ecosystem in the conterminous U.S., and it includes two National Parks, seven National Forests, and three wildlife refuges (Reading et al., 1994). With ESA protections in place, the estimated population (500-800 bears) recently

surpassed the target specified by the Grizzly Bear Recovery Plan (Kavanaugh & Benson, 2013; Kendall et al., 2009; Schwartz et al., 2002; Servheen, 1995). Given estimated population growth and data alleviating concerns about dwindling food resources (Felicetti et al., 2003), the U.S. Fish and Wildlife Service (USFWS) issued a proposed ruling to delist the GYE grizzly bear population from ESA protections in March (USFWS, 2016: Docket No. FWS-R6-ES-2016-0042).

By statute, the decision about whether a species can be listed as protected under the ESA should be based on scientific evaluation of the threats that the species faces (Id. § 1533(a)(1)(A)-(E)). The ESA mandates that status determinations be based on the 'best available' science, however, experts are not immune to the use of heuristics that may affect the quality of their decision-making under conditions of uncertainty (Kahneman, et al. 1982). The use of such heuristics, or decision making short-cuts, are extensively studied in the realm of medical decision making where predictable patterns of suboptimal reasoning often lead to errors in diagnosis s among highly trained practitioners (Bornstein & Emler, 2001). Understanding what factors might serve as heuristics and potentially bias decision-making related to listing status recommendations could help illuminate expert decision-making in current ESA processes.

Listing Status Decisions under the ESA

Under the ESA, listing status determinations must consider five, statutorily-defined risk factors: (1) "the present or threatened destruction, modification, or curtailment of its habitat or range," (2) "overutilization for commercial, recreational, scientific, or educational purposes," (3) "disease or predation," (4) "the inadequacy of existing regulatory mechanisms," and/or (5) "other natural or manmade factors affecting its continued existence " (Id. § 1533(a)(1)(A)-(E)). These risk factors are to be evaluated on the "best scientific and commercial data available," and listing status determinations based on this assessment (Freyfogle & Goble, 2009). Even though science can identify the types of risks a species faces, such studies cannot determine what constitutes an "acceptable" risk of extinction (Bruskotter, 2013; Freyfogle & Goble, 2009). In essence then, determining whether a species should be listed as "threatened" or "endangered" requires agencies to both (a) evaluate the likelihood of extinction in light of the best available science, and (b) determine if the threats to the species are sufficient to grant ESA protections i.e., is the overall level of risk and likelihood of extinction acceptable (Freyfogle & Goble, 2009; Wymyslo, 2009). It is this judgment of acceptability that is likely to be influenced by the values held by each individual, and where individuals may draw on a range of simplifying heuristics to navigate the inherent uncertainty of the choice (Kahneman et al., 1982).

Heuristics and Biases in Judgment and Decision-Making

The "rational actor" model of decision-making assumes individuals arrive at their judgments and decisions based on effortful calculations of "probability and multiattribute utility" (Gilovich et al,, 2002). However, evidence suggests that humans rarely follow the "rational actor" model of decision-making (Kahneman et al., 1982). In practice, decisions are often the result of simplifying shortcuts that help the individual to navigate the complex information that may be relevant to any one decision and avoid the more effortful consideration of all the relevant information that may be required for a more deliberative approach (Kahneman et al., 1982). Indeed, research indicates the decisions of experts, like all human decisions, are subject to a variety of well-known heuristics and potentially problematic biases under conditions of risk and uncertainty (Bostrom, 1997; Ghazal, et al., 2014; Kahneman & Klein, 2009).

Heuristics are typically associated with a more intuitive form of information processing based on past experience and available cues at the time of the decision. However, we often expect that well-informed experts are capable of engaging in more analytical and deliberative reasoning when dealing with

decisions under risk. The role of expert intuition in decision-making has been debated, but it may be appropriate in decision environments where the expert decision-maker is motivated and has had sufficient time and ability to learn the relevant decision cues and determine the most appropriate course of action based on those cues (Kahneman & Klein, 2009). However, given the complexity of the coupled socio-ecological system in which listing decisions must be made, it is highly likely that a reliance on expert intuition about "acceptable" risk may cause even the most informed decision makers to be biased in their assessment of the threats to the GYE grizzly bears. This biased assessment based on past experience and simplifying heuristics may result in ESA listing status recommendations for the population that are not based on the best available science.

Psychologists have identified a variety of factors that may serve as decision making heuristics (see generally Gilovich et al., 2002; Plous, 1993). Initial research on heuristics and biases focused on how an individual's perception of the probability of an event occurring was influenced by his or her ability to recall past examples of similar events (the availability heuristic) or the degree to which the particular event seemed representative of the general category of events (the representativeness heuristic) (Gilovich et al., 2002; Kahneman et al., 1982). More recent research identifies super decision-making performance under risk and uncertainty for individuals with greater mathematical competency (as opposed to education or knowledge) (Ghazal et al. 2014). However, there are a range of factors not necessarily related to one's ability to assess probabilities that may also simplify choices under conditions of uncertainty. These include one's values, norms and trust in others, among other factors.

In this study, we sought to examine the potential heuristics that might influence expert judgments regarding the appropriate listing status of the GYE grizzly bear (above and beyond, or in addition to, one's assessment of the threats). First, we reason that slow-forming, stable cognitions (i.e., values) concerning humankind's relationship with nature could impact experts' listing recommendation. Second, we predict that social norms, (i.e., participant beliefs about what other experts believe regarding the listing status) may influence their judgments. Third, we expect that each expert's trust and confidence in wildlife managing agencies might also influence their judgments.

The first set of simplifying heuristics we examine are values. Values are "affect-laden, enduring beliefs about life goals" (Manfredo et al. 2009; Rokeach, 1968). Being relatively stable throughout an individual's lifetime, values influence other cognitions such as attitudes and beliefs (Rokeach, 1968). In the context of wildlife, research has identified two broad categories of values called Wildlife Value Orientations (WVOs)—'mutualism' and 'domination'. Individuals scoring higher on the mutualism scale regard "wildlife as capable of living in relationships of trust with humans, as life forms having rights like humans, as part of an extended family, and as deserving of caring and compassion" (Manfredo et al., 2009). A domination WVO is characterized by anthropocentric utilitarianism, a perspective that grants humans near ubiquitous superiority (Manfredo et al., 2009). We hypothesize that such values would impact experts' judgments regarding the listing status of GYE grizzlies; specifically, that an individual's score on the Dominion WVO scale will be negatively related to their listing recommendation (more likely to recommend delisting) and an individual's score on the mutualism scale should be positively related to their listing recommendation (more likely to recommend the species be listed).

Social norms, or expert's beliefs about how his or her peers, or members of the public, expect him or her to behave, were the second set of heuristics examined. Norms can serve as a simplifying heuristic or set of decision cues when the "right" or appropriate behavior is unclear. Research indicates that people tend to be more influenced by the beliefs of individuals within their in-groups (i.e., groups with which they strongly identify) as opposed to the beliefs of more peripherally-related persons (see Schneider, 2004). Studies have found that norms are predictive of a suite of pro-environmental behaviors (see generally

Cialdini & Goldstein, 2004). This research suggests that individuals will be more likely to behave a particular way if they think others within their social group are also performing the behavior (Goldstein et al., 2008). For instance, an expert's listing status recommendation may be influenced by whether or not they think other wildlife managers or scientists believe that GYE grizzlies should remain listed. Normative pressure from the general public may also influence expert decision-making about bears' listing status. We hypothesize that both normative pressures from other experts and the public will be positively related to an expert's listing recommendation. Experts that feel that others expect them to list the bears will be more likely to recommend that the bears are protected under the ESA than experts who do not feel strong normative pressure to recommend listing.

A third set of heuristics that may impact expert listing status recommendations is the amount of trust and confidence an individual places in agencies charged with managing GYE grizzlies (see generally Bronfman et al., 2009; Cvetkovich & Winter, 2003). Generally speaking, higher trust in a managing agency increases the perceived benefits (and inversely decreases the perceived risks) of the hazard or object under consideration and ultimately leads to increased support for the object. If a species is delisted from federal ESA protection, species management reverts to state fish and wildlife agencies. Therefore, if an individual has high level of trust and confidence in state agencies, it is more likely that he or she will support delisting given the risks of extinction would be perceived as lower. Therefore we hypothesize that experts who are more distrustful of state agencies will be more likely to recommend the bears be listed under the ESA.

In this study, we first examine the relationship between experts' assessments of the risks faced by the GYE grizzly bears and experts' recommendation of whether or not the GYE grizzly bear should be listed as a protected species under the ESA. We then examine whether the potential heuristics identified explain listing recommendations by influencing expert's assessments of the risks. Based on a literal interpretation of the ESA, an individual's judgment about the appropriate listing status for a species should be based entirely on his or her objective assessment of the risk facing that species. However, drawing on existing research on decision-making, we expect a model accounting for heuristic information processing will be more effective at explaining variance in expert assessments and recommendations.

Methods

To assess expert opinion regarding the threats to the GYE grizzly bear and their listing status, an Internet survey was conducted with a sample of grizzly bear experts. For the purposes of this study "grizzly bear experts" were defined as individuals who had published peer reviewed articles about the species in the last 10 years (2004-2014). 1345 published authors were identified using the database Academic Search Complete. The current members of the Interagency Grizzly Bear Committee (IGBC) (90 listed members; http://www.igbconline.org/) augmented this initial list. Of this combined list, e-mail contact information was found for 1216 experts. Each expert was contacted three times and invited to participate in the survey (following Dillman et al., 2009). In total, 590 emails (48%) were opened, confirming that a potential study participant had received the invitation.

Respondents were asked a series of survey questions regarding whether the GYE grizzly bear should remain listed under the ESA as well as items designed to assess their perceptions about the risks facing grizzly bears, the acceptability of extinction and scales to assess the three heuristics variables that may serve as heuristics in the listing decision (summarized in Table 1).

To assess our dependent variable, an expert's listing recommendation, experts were asked to indicate whether they believed the GYE bear population should be listed as endangered, threatened, not listed, or if they were unsure about the appropriate listing status. This item was asked before any of the heuristic related measures to avoid priming. Respondents who recommended that the bears be listed as endangered or threatened received a score of 1. Respondents who recommended that the bears not be listed received a score of 0. Those unsure were removed from the analysis presented here.

To assess their perception about threats to grizzly bears, experts were asked to rate a series of 7 risks on two scales. The first scale asked each respondent to gauge the likelihood that the threat would occur and the second scale asked about the severity of the threat. These numbers were multiplied (likelihood x severity) to create an overall rating for each risk item. The series of threats were: a decrease in abundance of grizzly's natural food source, loss of habitat, habitat modification, human caused grizzly mortality, lack of genetic diversity, lack of support for grizzly bear conservation, and shifting ecological conditions due to climate change. As the reliability (Cronbach's $\alpha = 0.83$) for the seven risks was above the acceptable threshold of $\alpha \geq 0.70$, the ratings for the seven threats were averaged to create an overall risk perception score.

As a measure of risk acceptability in the context of species to be considered for ESA listing, experts were asked to indicate the highest probability of extinction they believe is acceptable (their judgment of the level of risk of extinction that, if exceeded would require ESA protection). Respondents were asked to provide an acceptable probability that ranged from 0 (no chance of extinction in 100 years) to 1.00 (a 100% chance of extinction in 100 years).

WVO's were assessed using previously published scales (Manfredo et al., 2009; Teel & Manfredo, 2010); both "mutualism" and "dominion" scales were measured. We reduced the items included in these scales to minimize response burden and maximize reliability. Five items ("Humans should manage wildlife populations so that humans can benefit;" "Wildlife are only valuable if people utilize them in some way;" "The needs of humans should take priority over wildlife protection;" "Wildlife are on earth primarily for people to use;" and "It is acceptable for people to kill wildlife if they think it poses a threat to their property") were averaged to create a Dominion WVO score (Cronbach's $\alpha = 0.61$). Three items ("I feel a strong emotional bond with animals;" "I take comfort in the relationships I have with animals;" and "I value the sense of companionship I receive from animals") were averaged to create Mutualism WVO score (Cronbach's $\alpha = 0.82$). The reliability statistic for the Dominion WVO was slightly below the acceptable threshold of 0.70 indicating that this scale may suffer from reliability issues.

To assess perceived norms regarding grizzly protection status, respondents were asked to respond to the statement: "Most scientists with whom I interact believe that grizzly bear populations in the GYE should be…" on two scales. The first was a scale of 1 to 7 where 1 was removed from the ESA and 7 was protected under the ESA. The second 1 to 7 scale ranged from 1 hunted to 7 was protected from hunting. These questions were iterated twice more to assess perceived norms among "most wildlife managers" and "the general public." Responses to the statements about the scientists and wildlife managers were averaged (Cronbach's $\alpha = 0.91$) to create a scaled measure for "Expert Norms." The responses for the two public items were averaged to create a scale for "Public Norms."

To assess trust and confidence in state wildlife management agencies (who would assume responsibility to manage GYE grizzly bears if they were removed from the ESA), respondents were asked to respond to six statements on a scale of 1 ("strongly agree") to 5 ("strongly disagree") if grizzly bears were removed from the ESA. Statement included: "I believe state fish and wildlife agencies will communicate honestly about the risks to grizzly bears," "Should it turn out that there are substantial risks to grizzly populations, I

believe state fish and wildlife agencies will openly and honestly inform the public," "I trust state fish and wildlife agencies to take the long term health of grizzly populations into account when planning grizzly management actions," "I believe that state fish and wildlife agencies will manage grizzly bears in a way that minimizes risks to grizzly populations," "I believe state fish and wildlife agencies have the knowledge and capacity to ensure grizzly bears in the Greater Yellowstone Ecosystem are not threatened with extinction again," or "I believe state fish and wildlife agencies possess the competence to mitigate threats to grizzly populations." Averaged together, the items had a Cronbach's α of 0.92 indicating that they were a reliable scale.

Lastly, respondents were asked a series of socio-demographic questions about their backgrounds and professional experience to serve as statistical controls.

Data was analyzed using IBM SPSS Version 23. Binomial logistic regression was used to examine the influence of multiple independent variables on expert's judgments regarding appropriate listing status (Table 3). A stepwise approach using two "blocks" of variables was used. The first block included the variables examining threat and acceptable risk. The second block (Table 3) included the same variables from the first block, but also includes the values, norms and trust variables along with the controls (whether they were employed by a federal, state or academic agency or institution and their affiliation with various professional wildlife organizations).

Results

Of the 590 experts who received and opened the email with a link to the survey, 234 completed the survey resulting in an adjusted response rate of 39.5%. Of the 172 experts who provided a listing recommendation, 73.8% (n = 127) recommended the bears remain listed in some capacity and 26.2% (n = 45) recommended that the bears not be listed under the ESA).

The respondents, on average, rated the threats posed to the bears as 32.31 (with a standard deviation of 17.82) on a scale of 0 to 100 (Table 1). The average score for acceptable risk to the GYE grizzly bear was 0.36 indicating that on average, respondents were willing to accept a 36% chance or less that bears would go extinct in the next 100 years without ESA protections. Examining the responses to the WVOs, respondents tended to score higher on the Mutualism scale (mean score = 3.71) than on the Dominion scale (mean score = 2.19) indicating that respondents generally expressed a greater mutualism orientation towards wildlife. The average scores for the expert norms and public norms were 4.38 and 4.76 respectively on a seven-point scale; as these scores are past the mid-point, they indicate that respondents perceived moderate agreement from other experts and the public to protect the bears. The average score for trust in state wildlife management agencies was 2.63. This indicates respondents tended toward moderate to low levels of trust and confidence in state management agencies.

The expert's listing recommendation was significantly positively correlated (Table 2) with their perception about the specific risks faced by the bears (r = 0.50), expert norms (r = 0.63) public norms (r = 0.33), and trust and confidence in state managing agencies (r = 0.46). Listing recommendations were significantly negatively correlated with the Dominion WVO (r = -0.44).

Table 1: Descriptive Statistics of Socio-Psychological Variables Used in Listing Decision Model

	N	# of items	Min.	Max.	Mean	Std. Dev.	α[a]
Risk Perception	205	7	0 (no threat)	100 (max. threat)	32.31	17.82	0.83
ESA Risk Acceptability[b]	198	1	0	1.00	0.36	0.23	--
Dominion WVO	218	5	1 (weak)	5 (strong)	2.19	0.57	0.61
Mutualism WVO	216	3	1 (weak)	5 (strong)	3.71	0.82	0.82
Expert Norms	180	4	1 (negative norm)	7 (positive norm)	4.38	1.55	0.91
Public Norms	166	2	1 (negative norm)	7 (positive norm)	4.76	1.65	--
Trust and Confidence in Wildlife Agencies	196	6	1 (low trust)	5 (high trust)	2.63	0.85	0.92

[a] *Chronbach's alpha*

[b] *ESA Risk Tolerance was measured by asking what percentage of extinction (in the next 100 years) was an acceptable risk. 0 = 0% chance of extinction while 1/00 = 100% chance of extinction.*

In the binomial logistic regression analysis, for Block 1 (Table 3), only the variable measuring perceptions of the risks facing grizzlies significantly influenced listing recommendations (at a 95% confidence level). In Block 2 (Table 3), the Dominion WVO and expert norms had statistically significant coefficients at a 95% confidence level. The Mutualism WVO had a statistically significant coefficient at a 90% confidence level. In Block 2, the Dominance WVO had a negative coefficient indicating that experts scoring highly on this WVO were less likely to recommend listing the GYE bears. The Mutualism WVO and the variable for expert norms had positive coefficients indicating that individuals scoring higher on this WVO, or who felt more normative pressure from other experts, were more likely to recommend listing the GYE grizzly bears. A respondent's affiliation with academia, federal agencies and state agencies were included as controls. However, none of these interactions or controls were statistically significant and therefore were removed to create a more parsimonious model given the limited sample size.

Adding in the simplifying heuristics reduced the -2 Log Likelihood of the model (Block 1 = 132.08; Block 2 = 66.42), raised the Cox & Snell R square value (Block 1 = 0.25; Block 2 = 0.48) and raised the Nagelkerke R squared value (Block 1 = 0.36; Block 2 = 0.70). Block 1 correctly predicted 47.5% of the "Not Listed" observations and correctly predicted 92.0% of the "Listed" observations. Block 2 correctly predicted 71.4% of the "Not Listed" observations and 91.8% of the "Listed" observations correctly. Prediction of listing was not improved by the addition of the heuristic variables; however, the addition of these variables considerably improved the prediction of non-listing recommendations.

Table 2: Correlations Between Variables

	Variable	1	2	3	4	5	6	7	8
1	Listing Recomm.	--	0.50*	-0.07	-0.44*	0.21*	0.46*	0.33*	0.63*
2	Risk Perception		--	0.04	-.35*	0.14	.5**	.19*	.52*
3	ESA Risk Acceptability			--	0.06	0.08	0.02	0.02	-0.02
4	Dominion WVO				--	-.14*	-.39*	-.29*	-.43*
5	Mutualism WVO					--	0.10	0.05	0.05
6	Trust Confidence						--	.29*	.41*
7	Public Norms							--	.41*
8	Expert Norms								--

** Correlation is significant at the 0.05 level (2-tailed).*

Table 3: Step-wise Binomial Logarithmic Regression of Expert Listing Decisions[a]

	B	S.E.	Wald	df	Sig.	Exp(B)
Block 1[b]						
Risk Perception	0.09	0.02	27.47	1.00	0.00	1.09
ESA Risk Acceptability	-1.51	0.94	2.61	1.00	0.11	0.22
Block 2[c]						
Risk Perception	0.02	0.02	0.91	1.00	0.34	1.02
ESA Risk Acceptability	-0.32	1.32	0.06	1.00	0.81	0.72
Dominion WVO	-1.64	0.68	5.84	1.00	0.02	0.19
Mutualism WVO	0.66	0.38	3.09	1.00	0.08	1.93
Expert Norms	1.40	0.36	14.82	1.00	0.00	4.05
Public Norms	0.28	0.22	1.67	1.00	0.20	1.32
Trust Confidence	0.28	0.46	0.38	1.00	0.54	1.33

[a]Dependent variable was whether a manager recommended listing grizzly bears (1) or not listing grizzly bears (0) under the Endangered Species Act.

[b]Block 1 included the variables assessing threat perceptions and ESA risk tolerance. The model for Block 1 had a -2 Log Likelihood = 132.08; a Cox & Snell R Square = 0.25; a Nagelkerke R Square = 0.36. It predicted 47.5% of the "Not Listed" correctly and 92.0% of the "Listed" correctly.

[c]Block 2 included the variables from Block 1 as well as the variables assessing the dominion and mutualist wildlife value orientations, normative pressure from other experts and the general public, and trust and confidence in managing agencies. How strongly an individual identified with environmentalist groups and hunting groups were included as controls. The model for Block 2 had a -2 Log Likelihood = 66.42; a Cox & Snell R Square = 0.48; a Nagelkerke R Square = 0.70. It predicted 71.4% of the "Not Listed" correctly and 91.8% of the "Listed" correctly.

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The majority of respondents recommended listing the GYE grizzly bears as either endangered or threatened under the ESA. When listing recommendations were examined through logistic regression, perceptions about the risks posed to grizzly bears significantly predicted listing recommendation. The log odds-ratio for this variable was 1.09 indicating that for each unit that threat increases, the probability that the listing recommendation changes from unlisted to listed increases by 9%. The odds-ratio for the ESA Risk Acceptability variable was not significant. When heuristics were added into the model, the WVOs and expert norms were significant predictors while the perception of the risks posed to grizzly bears and acceptability of risk were not significant. The odds-ratio for the Dominion WVO was 0.19 indicating that for each unit that the Dominion WVO increases, the probability that the listing recommendation changes from unlisted to listed decreases by nearly 80%. The odds-ratio for the Mutualism WVO was 1.93 indicating that for each unit that the Mutualism WVO increases, the probability that the listing recommendation changes from unlisted to listed nearly doubles. The odds-ratio for the expert norms variable was 4.05 indicating that for each unit of increase in expert norms, the probability that the listing recommendation changes from unlisted to listed quadruples.

Discussion

Our results indicate that, as expected, individuals' perceptions of risks posed to grizzly bears were strongly associated with their judgments concerning whether the GYE population of grizzly bears should be listed under the ESA. However, perception of risk was no longer significant when potential simplifying heuristics were added to the model. These data suggest that heuristics such as one's personal values and one's perception of social appropriate behavior can have a strong influence on judgments concerning endangered species—even among highly trained and knowledgeable experts. It is likely that these simplifying heuristics are actually driving expert's assessments of the threat as opposed to a more deliberative assessment of the relative risk posed by each threat from a purely scientific standpoint.

Of the heuristics we examined, those associated with the WVOs and expert norms were significant in predicting an expert's listing recommendation. Of these, expert norms had the greatest effect on listing status recommendation. A one increase in unit on this scale was equivalent to 400% change in the probability that an expert would recommend listing for the bears. Experts appear to be strongly influenced by perceived normative pressure from their peers. Therefore, one can expect that experts will be sensitive to information about how other scientists and managers think about ESA species listings. In discussing whether a species should be listed or not, agencies should take care about how they communicate about the appropriate listing status of these species among the community of experts. Managers and experts could interpret this information as a normative cue, which may affect their judgment irrespective of objective extinction risk.

Interestingly, normative pressure from the general public did not significantly influence expert listing recommendations. Assigning greater weight to expert judgments makes sense both practically and theoretically. Practically, experts 'manage' their reputations, in part, through interactions with their peers, and so would be expected to conform to with peer expectations. Theoretically, we might anticipate greater tendency to conform among more junior or lower status experts, who may be expected to acquiesce to those with more experience (see generally Cialdini & Goldstein, 2004).

Trust and confidence in state wildlife management agencies was not predictive of listing recommendations. This is contrary to literature that suggests that social trust and confidence are key determinants of risk perceptions and acceptance of hazards when the risk is collectively managed (see

generally Bronfman et al., 2009; Cvetkovich & Winter, 2003). It is possible that for experts the relative influence of social norms and one's own personal values simply outweigh the need to trust the individuals who will ultimately be managing the risk.

When simplifying heuristics were added into the model, perception about the threats that GYE grizzlies face was no longer a significant predictor of listing recommendation. The fact that the model with the heuristics included better predicted listing judgments supports the idea that expert decisions are a function of simplifying heuristics and decision cues as opposed to a more deliberative assessment of the likely threats and the acceptability of the risk posed to the species (Bostrom, 1997; Gilovich et al., 2002; Kahneman et al., 1982; Plous, 1993; Slovic, 1987). This is consistent with a wealth of research in judgment and decision making that indicates that risk perceptions are often the result of more intuitive and experiential information processing, as opposed to a calculated, cost-benefit assessment of the risk (Slovic, 1987). Although experts are often held to a higher standard, there is plenty of evidence that such patterns of decision-making are common to experts and laypeople alike (Bostrom, 1997).

While we found that adding in the simplifying heuristics improved the models ability to predict expert listing recommendation, we found that most of this improvement was for individuals recommending that the bears not be listed under the ESA. Both blocks of our model correctly predicted over 90% of the respondents who recommended the bears should be listed. However, Block 1 of our model correctly predicted less than half (48%) of cases recommending delisting. Adding the heuristic mechanisms in Block 2 improved the model to correctly predict over 70% of the experts who recommended that bears should not be listed. This suggests that heuristic processing is more prevalent and powerful among experts who favored delisting. Those in favor of delisting a species may be more motivated to justify their decision, causing them to engage in motivated reasoning, or the tendency to seek out information that confirms their preexisting beliefs, as opposed to systematically assessing the evidence for or against different positions (Kunda, 1990). This potential bias could perhaps be diminished by educating experts about this potential bias, encouraging perspective taking (e.g., considering the opposite position), and simply slowing down the decision process to more carefully assess the information that is available (Lilienfeld et al., 2009). Future research should focus on how the decision-making processes differ between experts on two sides of a resource management decision, and how best to intervene to ensure that decisions are as deliberative and thoughtful as possible.

Our objective is not to suggest that expert recommendations are flawed because they are based in heuristic processing. On the contrary, heuristics are often quite beneficial and can help individuals to navigate unfamiliar decision contexts more efficiently (see Gigerenzer & Goldstein, 1996). The tendency to engage in this form of intuitive processing is human nature, and the challenge is to find the balance between the use of mental shortcuts and more deliberative processing when necessary. Our results do indicate that an assessment of threats is an important component of an expert's listing recommendation; however, these assessments may be driven by simplifying heuristics based in one's personal values and the normative standard set by others. The challenge for those engaged in a listing decision is to carefully assess the likelihood of the potential threats and ensure that one's decision is not solely based on one's personal biases.

Overall, we found evidence that experts used a variety of heuristic patterns in deciding whether they would recommend the GYE grizzly bear for listing under the ESA. A tendency that is consistent with descriptive models of human decision-making, and quite common under conditions of risk, uncertainty and complexity. Personal value orientations toward wildlife and expectations about what peers would do significantly predicted expert listing recommendations. The "charisma" of large mega-fauna makes large carnivore conservation a socially and politically charged issue, and listing decisions must often be made

under conditions of risk and uncertainty. Therefore, it is not surprising that a variety of socio-psychological heuristics are influencing decision-making about these organisms. Further socio-psychological research on decision-making in regards to endangered species can help illuminate the influence of human and social factors, as well as identify ways to debias decision making to increase the consistency and quality of conservation decisions over time.

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