Article

Threat Perception, Emotions and Social Trust of Global Bat Experts before and during the COVID-19 Pandemic

Tanja M. Straka [1,2,*] and Christian C. Voigt [2]

[1] Institute of Ecology, Technische Universität Berlin, Rothenburgstr. 12, 10165 Berlin, Germany
[2] Department of Evolutionary Ecology, Leibniz Institute for Zoo and Widlife Research, Alfred-Kowalke-Str. 16, 10315 Berlin, Germany
* Correspondence: tanja.straka@tu-berlin.de

Abstract: Speculations about the origin of SARS-CoV-2 have catapulted bats into the spotlight of scientific and societal attention, with unforeseen consequences for bat conservation. In two global surveys with bat experts before and during the COVID-19 pandemic, we assessed their (i) threat perceptions, emotions towards bats and social trust in decision makers and (ii) the predictive potential of emotions, social trust and socio-demographic variables on threat perceptions. We also discuss (iii) the potential influence of the pandemic on threat perception and antecedents (emotions and social trust). We received 495 responses from 65 countries in September 2019 and 320 responses in June 2020 from 77 countries. We identified three major threat categories (indirect, direct and prejudice). Comparing threat perception, emotions and social trust between both surveys, we found that indirect threats (e.g., habitat modification) were considered as crucial, yet less so during the pandemic. During the pandemic, experts rated indirect threats lower and the perceived threat through prejudice (e.g., myths) higher than before the pandemic. During the pandemic, bat experts also expressed more compassion and sadness related to bats and trust in researchers and NGOs, but less trust in laypeople than before the pandemic. Emotions were particularly important predictors for threats through prejudice besides social trust. Socio-demographic variables (e.g., cultural and professional background) had predictive potential predominantly for direct threats (e.g., hunting and trade, wind turbines) and threats through prejudice. Our study highlights the role of emotions and social trust on threat perception among bat experts who remained relatively invisible during the pandemic despite their key role for bat conservation. More importantly, we echo previous calls to be more attentive to ecological grief also within the scientific community; especially as discussions around zoonotic spillover with valued study animals intensify.

Keywords: biodiversity; Chiroptera; ecological grief; viruses; cultural values; perception; stakeholders

1. Introduction

With almost 1400 species known to science, bats are a diverse mammalian taxon that is widely distributed on our planet, except for the polar regions [1]. Over a third of bat species are considered threatened or data deficient according to the International Union for the Conservation of Nature (IUCN) and the population trends for half of the species are negative or unknown [2]. Clearly, bat conservation is crucial to prevent further biodiversity loss. Major threats to bats range from habitat destruction and modification to roost disturbance or persecution [2,3]. Bat conservation appears more challenging and urgent than ever given the global COVID-19 pandemic [4,5], since the putative origin of the ancestral form of SARS-CoV-2 in bats has brought bats into the focus of the scientific, media and public discussions [4]. Consequently, bats have also become the negative focal point with regard to future scenarios in which zoonotic viruses are transmitted to humans [6]. Fear and a decreased appreciation of bats in the public might pose a serious risk to bat populations and conservation efforts worldwide. We undertook two global cross-sectional

surveys among bat experts before the pandemic (September 2019) and during the first year of the pandemic (June 2020) on how serious they perceived prejudice as a threat to bats and their conservation compared to other threats [2]. Global bat experts are a relatively small, yet diverse, community. Hence, we included socio-demographic variables as well as cognitive and affective mechanisms that might vary among bat experts and that are known to affect people's perceptions of threats.

Threat perception, the conscious or unconscious estimation that something or someone is dangerous or in danger, is the 'decisive intervening variable between action and reaction in international crisis' [7]. It is a mental process that is influenced by various factors such as emotions and social trust [8,9], particularly when a threat is novel [10] or in response to a crisis [11]. For example, fear is known to be a major factor when it comes to the perceived severity of the threat of a species [12], and the importance of emotions is widely acknowledged in relation to wildlife-related issues see review by [13]. In fact, decisions are hardly free from emotional processes [14] and emotional processes of bat experts were likely influenced by discussions around their valued study taxon in this pandemic. The second explanatory factor, social trust, is 'the process by which individuals assign to other persons, groups, agencies, or institutions the responsibility to work on particular tasks' [15]. We hypothesized that social trust would be besides emotions relevant in the context of the COVID-19 pandemic given the role of social trust in human–wildlife conflicts [16].

We used this framework to assess, in a global survey of bat experts, (i) threat perceptions, emotions towards bats and social trust in decision makers and (ii) the predictive potential of emotions, social trust and socio-demographic variables on threat perceptions. While no one could have predicted the COVID-19 pandemic, we were in the unusual position to have conducted a survey of bat experts in September 2019, about half a year before the pandemic started. We cannot make a direct comparison of threat perception of participants before and during the pandemic because we did not control for identical survey participants. However, by using the same questionnaire in both surveys, applying the same recruitment approach and undertaking a statistical comparison among sociodemographic factors, we can put bat experts' threat perception during the COVID-19 pandemic in context much better than without this preliminary information and consequently, discuss (iii) the potential influence of the pandemic on threat perception and antecedents (emotions and social trust).

Expert opinions and decisions are crucial in science and practice of conservation, particularly when there is a lack of data and due to the imminent nature of many nature conservation decisions [17]. Expert views shape research directions [18] as well as conservation and management. Further, bat experts have a pivotal role in assessing threats and communicating bat ecology. In comparison to the public [5], bat experts remained relatively invisible during the COVID-19 pandemic regarding bat conservation and virus transmissions. This study shows how underlying cognitive and affective mechanisms can influence experts' threat perceptions. Most importantly, we see this as an important step in understanding how the COVID-19 pandemic may have impacted bat conservation and would like to draw attention to ecological grief, an understudied topic in conservation [19], and the importance of how to communicate about a threatened taxon.

2. Methods

2.1. Questionnaire Design

The questionnaire included four parts (Table S1) that were measured on 7-point scales: (a) threat perception based on the IUCN assessment of ten major threats to bats [2,3] (Table S1). While bat researchers generally have a positive view on bats, there is also a particular concern about the public's beliefs in myths and negative attitudes towards bats with negative consequences for bat conservation [20]. 'Hunting and trade' were only added to the survey in relation to the bat family Pteropodidae and wind turbines for all bats except for Pteropodidae. We further assessed (b) three positive (joy, interest and compassion) and three negative (anger, fear and sadness) discrete emotions in relation to bats and (c) the

extent of trust in stakeholders to do what is right for bat conservation [21] (Table S1). Lastly, we measured (d) socio-demographic variables (e.g., age, gender, professional background, country of origin). The surveys in September 2019 and June 2020 were similar, except that we included in the second survey in each section: ' . . . now, three months in the COVID-19 pandemic'. In our second survey (during the pandemic), we additionally asked experts in an open question what consequences and behaviors towards bats were observed in their countries since the start of the pandemic.

2.2. Survey Administration

In September 2019 and June 2020, we sent out self-administered online surveys (Lamapoll, Berlin, Germany) translated into English, French and Spanish. The first survey in September 2019 was shortly before (hereafter: 'before pandemic') and second survey in June 2020 approximately three months into the COVID-19 pandemic (hereafter: 'during pandemic') with the official WHO declaration of a pandemic on 11 March 2020 and first mentions in the media about the potential role of bats in the spillover by the end of March 2020 [22]. For both surveys, we used the same recruitment approach (Figure S1). However, since the occurrence of the pandemic and the second administration of the survey were not expected and since the participation was anonymous, it was impossible for us to draw conclusions whether participants took part in both surveys or only in one of them.

In both surveys, we used as a first step an internal email distribution list which was created via registration for previous bat conferences in which >400 international bat experts from research units, non-governmental organizations and governmental bodies were involved (hereafter: 'bat experts'). The invitation was sent out in this first step via email on behalf of the authors and we additionally asked the participants to forward the email to other bat experts following a snowball sampling design [23]. In a second step, we shared the survey in international bat groups (e.g., Africa, Asia, Australia, Europe, USA) using the email distribution list (e.g., Western Bat Working Group) or website (e.g., EUROBATS) of our networks and social media channels such as Facebook and Twitter (e.g., African Bat Conservation, Australasian Bat Society). We sent out a reminder 2 weeks after the initial call (via email or as posts on the social media channels). There were no institutional requirements for ethical clearance. However, the survey was undertaken in accordance with the General Data Protection Regulation (GDPR) of the European Union. A consent form was provided to participants ensuring their anonymity, information about the general aim of the study, data that would be collected, contact and that there would be no disadvantages for participants if they resigned from the study at any stage of their participation. Participants had to agree to this consent form before they could start the survey.

2.3. Data Analyses

In a first step, we grouped respondents according to their provided information on 'country of origin' into cultural value clusters (hereafter cultural clusters) based on categories derived from the World Value Survey (WVS, www.worldvaluessurvey.org (accessed on 16 March 2021)) (Figure 1, Table S6). The WVS is a global research project in which social scientists have been assessing people's values and beliefs in almost 100 countries since 1981. Based on this information, countries are grouped into cultural clusters based on common values and beliefs rather than geographic proximity. We decided for this approach to demonstrate the geographic range of our respondents since this clustering is based on guiding principles (e.g., values) rather than geographic nearness which we considered to be more relevant in this survey.
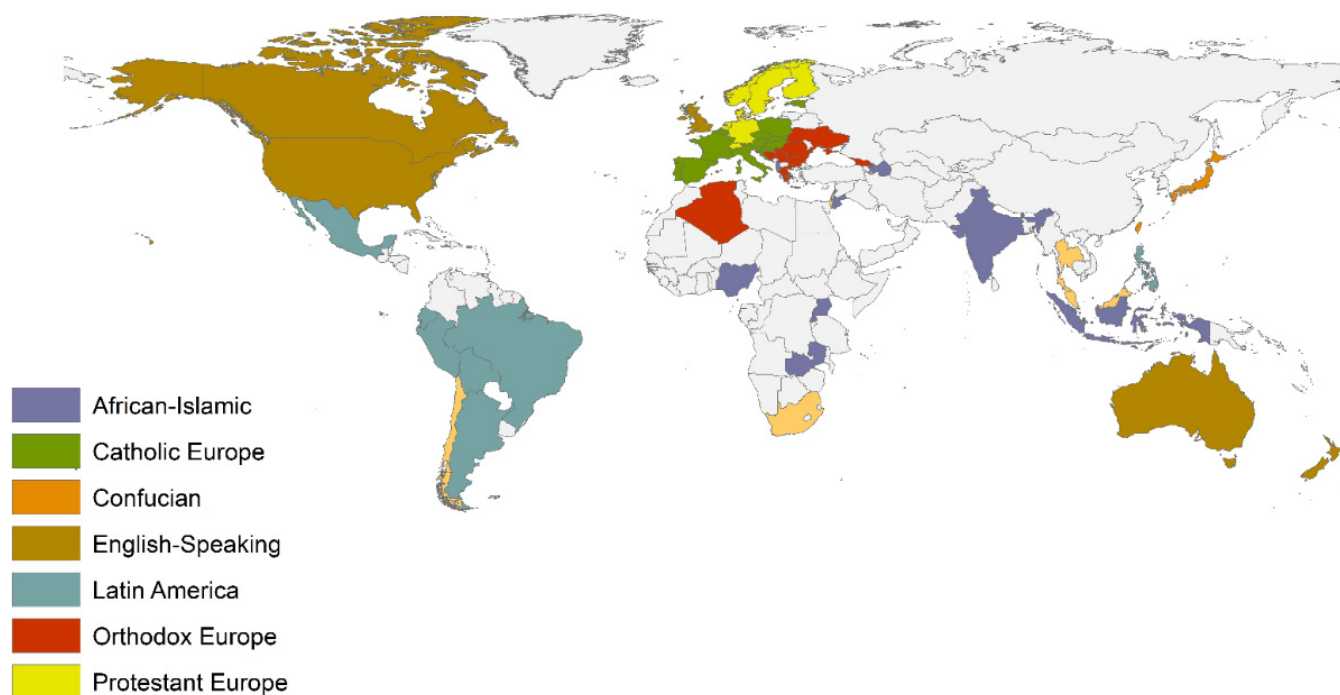
World Cultural Map

Figure 1. Countries of respondents clustered in eight value clusters according to the Inglehart-Welzel World Cultural Map (2020). This map demonstrates how participating countries are grouped based on shared values and beliefs assessed by the World Value Survey (WVS) rather than geographic proximity. Responses were also received from Bhutan, Cameroun, Chile, Costa Rica, El Salvador, Ireland, Kenya, Laos, Latvia, Madagascar, Malta, Mauritius, Mozambique, Nepal, Panama and Paraguay. These countries are not shown in the map since they were not part of the WVS in 2020. Detailed numbers of participants per cultural cluster are found in Table S6.

In a second step, we assessed statistically significant differences in participants' socio-demographics before and during the pandemic using a chi-squared test. In a third step, we aimed to reduce the number of factors for the ten items measuring threat perception and seven items measuring trust in different stakeholders during the pandemic. To do so, we undertook exploratory factor analyses (EFAs) with 'varimax' rotation using the package 'psych' [24]. We decided that three factors are useful to summarize the variation for threat perception and also for trust. We used item loadings > 0.50 and <0.50 on each factor (Tables S4 and S5). The first factor on threat perceptions explained 38% of the data; hereafter 'direct' since it included direct anthropogenic (hunting and trade, overexploitation and wind turbines) and natural (predators) life threats for bats. The second factor explained 34% of the data; hereafter 'indirect' since threats (habitat destruction, habitat modification and roost disturbance) are not necessarily directly related to the killing of bats, but rather to habitat deterioration and disturbance. The third factor explained 28% of the data and included persecution (e.g., through negative beliefs about bats) and myths (leading to negative behavior towards bats), hereafter 'prejudice' to capture the link between negative beliefs and behavior towards bats. Disease did not load clearly on any factor (Table S4). As for trust, the first factor included local and national authorities (38% of the data explained;

hereafter authorities), the second environmental and animal welfare NGOs (34%; hereafter NGOs), the third the public and volunteers (28%; hereafter laypeople); whereas researchers did not clearly load on any factor (Table S5). Average scores were calculated for the respective factors on threat perception and trust and used as latent constructs whereas discrete emotions were treated separately.

In the fourth step, we aimed to assess threat perception, trust and emotions of bat experts among bat experts before and during the pandemic. Here, we treated first each dataset independently to assess differences within each dataset using Kruskal–Wallis and Dunn's post hoc tests using 'dunn.test' version 1.3.5 [25] and 'FSA' version 0.9.3 [26]. Since socio-demographic variables were largely similar between both groups before and during the pandemic), we also assessed whether there were significant differences in these concepts before and during the pandemic using an unpaired two-samples Wilcoxon test.

Open comments were analyzed using qualitative content analysis [27]. The categories of the open comments were developed following discussions from two independent researchers to achieve a mutual understanding and sufficient consistency in inductive category formation.

The predictive potential of emotions, trust and socio-demographic variables on threat perception was calculated using ordinal logistic regression using the clmm function in the package 'ordinal' version 12-10 [28] to allow for mixed effects. Here, the first set of models included the three threat perception factors (direct, indirect and prejudice) separately as predictor variables and the six discrete emotions, the four factors of trust used as explanatory variables and the 'ID' of participants as a random effect. To compare models with and without emotions, we used log-likelihood values to measure the goodness of fit between models using the package 'pscl' version 1.5.5 [29]. In a second set of models, we used socio-demographic variables as explanatory variables. We carried out these analyses only for the dataset during the pandemic since this was our baseline and major focus of our study (i.e., predictive potential of antecedents on threat perception). All statistical analyses were undertaken using R version 4.1.2 [30].

3. Results

3.1. Survey Sample Characteristics

In the first year of the COVID-19 pandemic (June 2020), we received 320 responses from 77 countries (Table 1). Most respondents were from English-speaking countries (37%), followed by participants from Catholic Europe (during: 26%) and the least from the African–Islamic (2%) and Confucian (1%) culture clusters (Table 1). Most respondents were 25–39 (38.4%) or 40–59 years old (43.3%). Gender of respondents was slightly skewed towards males (54.6%). Respondents were mostly researchers (39.4%), followed by affiliates of NGOs (14.4%; no differentiation whether employee or volunteer) and government authorities (12.2%).

The distribution within the pre-pandemic sample, when 495 people from 65 countries took part in the survey, was equal in terms of cultural cluster (x-squared = 11.81, df = 7, *p*-value = 0.1071) and gender (x-squared = 2.26, df = 2, *p* = 0.33) distribution (Table 1). However, the sample before the pandemic was significantly younger (63.7% between 25 and 39 years old, x-squared = 49.94, df = 4, *p*-value < 0.001) and respondents from the consultant sector, volunteers and students participated in addition to the already mentioned professional groups (Table 1).

Table 1. Socio-demographics of respondents before (n = 495) and during (n = 320) the pandemic showing number of participants (n) and percentage (%) within each survey round. More details about the cultural clusters can be found in Figure 1 and Table S6. Only age differed significantly between the survey samples before and during the pandemic ($p < 0.001$, marked with ***).

	Before COVID-19	**During COVID-19**
Cultural cluster	n (%) or participants	n (%) or participants
English-Speaking	216 (44%)	117 (37%)
Catholic Europe	105 (21%)	82 (26%)
Protestant Europe	79 (16%)	47 (15%)
African–Islamic	13 (3%)	7 (2%)
West and South Asia	14 (3%)	15 (5%)
Latin America	13 (3%)	11 (3%)
Orthodox Europe	12 (2%)	10 (3%)
Confucian	6 (1%)	3 (1%)
Other	37 (7%)	28 (9%)
Age ***		
19–24	8 (1.6%)	8 (2.6%)
25–39	312 (63.7%)	118 (38.4%)
40–59	132 (26.9%)	133 (43.3%)
60–79	37 (7.6%)	46 (15.0%)
>79	1 (0.2%)	2 (0.7%)
NA	5 (NA)	13 (NA)
Gender		
Male	238 (48.9%)	139 (54.6%)
Female	247 (50.7%)	167 (45.4%)
Diverse	2 (0.4%)	0
NA	8	14
Professional background		
Consultant	40 (8.1%)	0
Government	58 (11.7%)	39 (12.2%)
NGO	91 (18.4%)	46 (14.4%)
Researcher	188 (38.0%)	126 (39.4%)
Student	15 (3%)	0
Volunteer	21 (4.3%)	0
Other [a]	82 (16.6%)	95 (29.7%)
NA	0	14 (4.3%)

[a] Other participants could not be grouped into any of these sectors.

3.2. Threat Perception, Emotions and Social Trust before and during the COVID-19 Pandemic

3.2.1. Social Trust

Comparison of trust in stakeholders before and during the pandemic

Before and during the pandemic, bat experts trusted researchers the most and authorities the least to do what is right for bat conservation (Table 2, Figure 2). During the pandemic, bat experts rated their trust in researchers and NGOs (in particular animal welfare NGOs) higher whereas trust in laypeople lower (in particular the public) compared to before the pandemic (Table 2, Figure 2). Trust in authorities did not differ significantly between both groups of experts before and during the pandemic (Table 2, Figure 2).

Table 2. Average scores (mean) and standard deviation (SD) of threat perception, social trust and emotions before and during the COVID-19 pandemic. Significance levels based on unpaired Wilcoxon rank sum test comparing threat perception, social trust and emotions before and during the pandemic with significant differences marked in bold.

	Before COVID-19 Pandemic (September 2019)	During COVID-19 Pandemic (June 2020)	
	Mean ± SD	Mean ± SD	W and *p*-Value
Threat perception			
Indirect	**6.02 ± 0.74**	**5.63 ± 1.24**	**W = 59,480, *p* = 0.003**
Habitat destruction	**6.47 ± 0.74**	**5.96 ± 1.34**	**W = 65,024, *p* < 0.001**
Habitat modification	**6.02 ± 0.96**	**5.24 ± 1.36**	**W = 68,707, *p* < 0.001**
Roost disturbance	**5.60 ± 1.05**	**5.72 ± 1.29**	**W = 47,463, *p* < 0.001**
Prejudice	**4.73 ± 1.27**	**5.92 ± 1.20**	**W = 25,575, *p* < 0.0001**
Persecution	**4.85 ± 1.33**	**5.95 ± 1.24**	**W = 28,261, *p* < 0.001**
Myths	**4.60 ± 1.48**	**5.88 ± 1.38**	**W = 27,710, *p* < 0.001**
Direct	**4.50 ± 1.09**	**4.19 ± 1.25**	**W = 60,375, *p* = 0.0006**
Hunting and trade (only Pteropodida)	**5.07 ± 1.68**	**4.55 ± 1.89**	**W = 64,065, *p* < 0.001**
Wind turbines (Pteropodidae not incl.)	**4.85 ± 1.49**	**4.43 ± 1.59**	**W = 87,114, *p* < 0.001**
Predators	3.88 ± 1.30	3.82 ± 1.47	W = 54,876, *p* = 0.68
Overexploitation	**4.21 ± 1.41**	**3.94 ± 1.69**	**W = 60,667, *p* = 0.01**
Disease	**4.29 ± 1.37**	**3.79 ± 1.62**	**W = 63,767, *p* < 0.001**
Social trust			
Non-governmental organizations	**4.99 ± 1.22**	**5.16 ± 1.23**	**W = 84,430, *p* = 0.001**
Environmental NGOs	5.39 ± 1.25	5.48 ± 1.26	W = 71,202, *p* = 0.19
Animal welfare NGOs	**4.59 ± 1.61**	**4.86 ± 1.55**	**W = 67,092, *p* = 0.01**
Laypeople	**4.13 ± 1.12**	**3.83 ± 1.10**	**W = 84,430, *p* = 0.001**
Volunteers	5.11 ± 1.22	4.94 ± 1.40	W = 79,780, *p* = 0.12
Public	**3.15 ± 1.45**	**2.72 ± 1.32**	**W = 65,315, *p* = 0.002**
Authorities	3.59 ± 1.44	3.54 ± 1.50	W = 76,081, *p* = 0.62
Local authorities	**3.45 ± 1.52**	**3.33 ± 1.58**	W = 76,081, *p* = 0.62
National authorities	3.73 ± 1.59	3.76 ± 1.62	W = 74,053, *p* = 0.80
Researchers	**5.58 ± 1.21**	**5.81 ± 1.21**	**W = 62,315, *p* = 0.001**
Emotions			
Positive			
Joy	6.24 ± 1.10	6.09 ± 1.33	W = 64,806, *p* = 0.44
Interest	6.61 ± 0.67	6.49 ± 0.87	W = 65,195, *p* = 0.80
Compassion	**5.64 ± 1.56**	**6.00 ± 1.39**	**W = 54,517; *p* = 0.002**
Negative			
Fear	1.36 ± 0.84	1.35 ± 0.88	W = 66,279, *p* = 0.09
Anger	1.35 ± 0.90	1.37 ± 1.03	W = 63,402, *p* = 0.47
Sadness	**2.21 ± 1.68**	**3.19 ± 2.15**	**W = 47,136; *p* < 0.001**

Comparing trust in stakeholders within each round

Pairwise comparisons using Dunn's test for the dataset during the pandemic indicated that trust in all stakeholders differed significantly ($p < 0.001$), except for trust in local and national authorities ($p = 0.10$), between environmental NGOs and researchers ($p = 0.26$) and animal welfare NGOs and volunteers ($p < 0.99$). Before the pandemic, trust in all stakeholders also differed significantly ($p < 0.001$), except for, similarly in this round, between local and national authorities ($p = 0.18$) and environmental NGOs and researchers ($p < 0.99$), but in this first round there were also no significant differences for trust in local authorities and the public ($p = 0.21$), as well as environmental NGOs and volunteers ($p = 0.08$).

3.2.2. Discrete Emotions towards Bats

Comparison of emotions before and during the pandemic

Overall, positive emotions such as interest, joy and compassion for bats were high among bat experts while negative emotions as sadness, fear and anger were low before and during the pandemic (Table 2, Figure 2). During the pandemic, experts rated sadness and compassion higher than before, whereas other emotions did not differ between periods (Table 2, Figure 2).

Comparison of trust in stakeholders within each round

The Dunn's test showed for the data during the pandemic that emotions significantly differed ($p > 0.001$) except for anger with disgust ($p < 0.99$) and fear ($p < 0.99$), disgust and fear ($p = 0.99$), compassion and interest ($p = 0.37$) and joy ($p < 0.99$) as well as interest and joy ($p = 0.96$). Before the pandemic, patterns were broadly similar. While all emotions still differed significantly from each other, in this case also compassion in relation to interest and joy as well as interest and joy ($p < 0.001$) while anger and disgust ($p < 0.99$) and fear ($p < 0.99$) and interest and joy ($p = 0.49$) were not significantly different from each other.
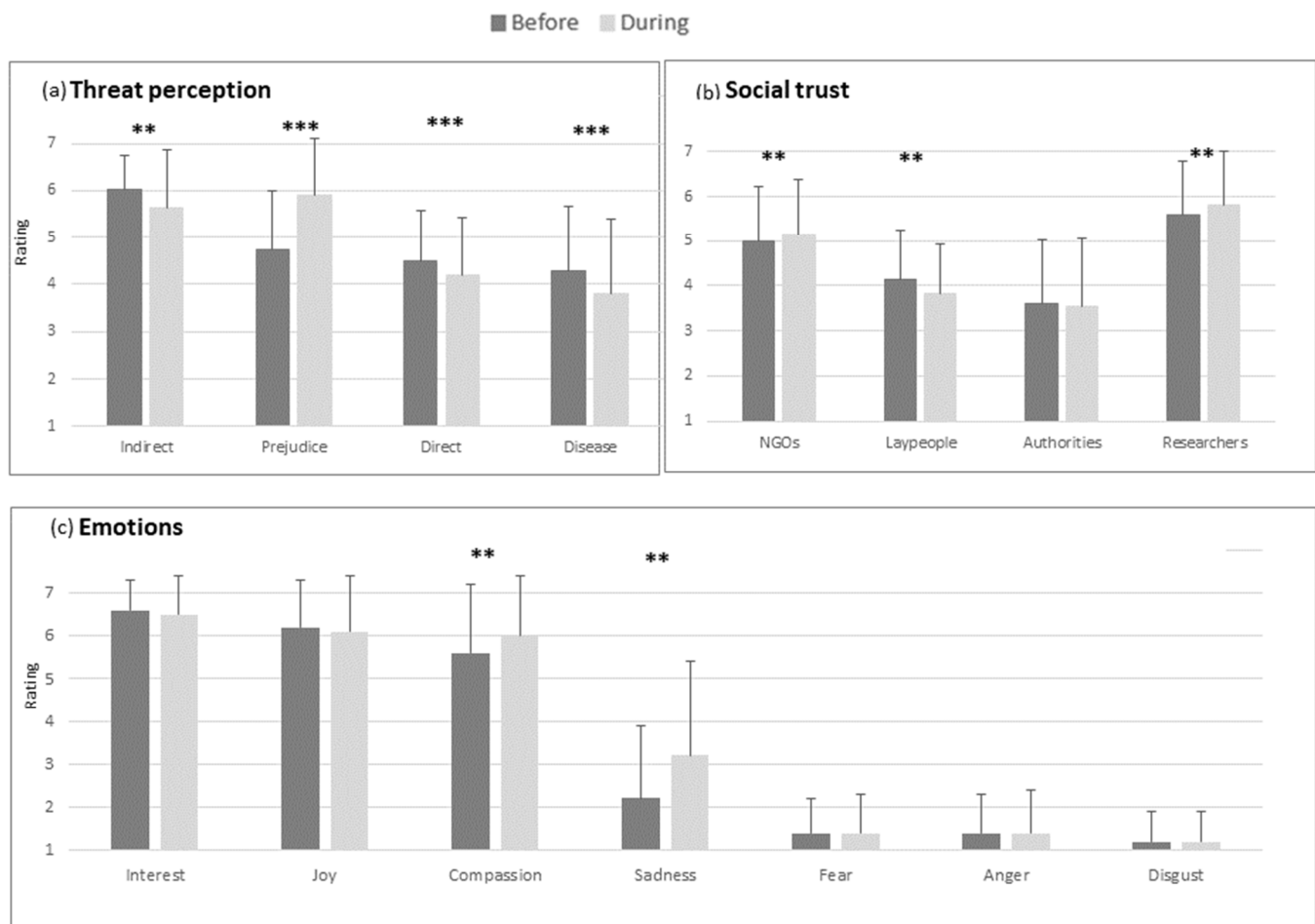

Figure 2. Differences in (**a**) threat perception, (**b**) emotions and (**c**) trust in decision makers 'to do what is right for bat conservation among bat experts before (September 2019) and during (June 2020, i.e., three months in the COVID-19 pandemic'). Significance levels based on unpaired Wilcoxon rank sum test are shown by ** $p < 0.01$, *** $p < 0.001$.

3.2.3. Threat Perception

Comparison of trust in stakeholders within each round

During the pandemic, threats through 'prejudice' were considered as a major threat whereas before the pandemic 'indirect' threats were considered as major and 'prejudice' as least concern (Table 2, Figure 2). Threat perception through 'prejudice' was significantly

higher in bat experts after the onset of the pandemic (Table 2, Figure 2). In contrast, 'indirect' and 'direct' threat factors as well as disease were rated as significantly less severe threats during compared to before the pandemic (Table 2, Figure 2).

Comparing trust in stakeholders within each round

During the pandemic, all threats were rated significantly different from each other as shown by a pairwise Dunn's test ($p < 0.001$), except for destruction with disturbance ($p = 0.49$), myths ($p < 0.99$) and persecution ($p < 0.99$), disturbance with myths ($p < 0.99$), persecution ($p < 0.99$) and modification ($p = 0.06$), disease with overexploitation ($p < 0.99$) and predators ($p < 0.99$), myths and persecution ($p < 0.99$), overexploitation and predators ($p < 0.99$) as well as hunting and wind turbines ($p < 0.99$). Before the pandemic, threats were considered slightly different than during the pandemic. While pairwise comparison using Dunn's test indicated again that all threats were considered significantly different from each other ($p < 0.001$), this did not relate to disease and myths ($p < 0.99$) and overexploitation ($p = 0.82$), overexploitation and predators ($p < 0.99$), hunting and wind turbines ($p = 0.26$) as well as persecution and wind turbines ($p < 0.99$).

Open comments during the pandemic

Open comments provided by participants during the pandemic (June 2020) could be grouped into seven categories that reflected their observations and concerns three months into the pandemic (Table 3). From most countries (n = 28), comments were about concerns related to a negative media coverage of bats, and this was followed by (observed) roost destruction from n = 24 countries, fear from spillover (n = 18) and request to kill bats and even observations of killing bats (n = 17). Few comments were about forced stopping of research (n = 5). Comments that mentioned that nothing specific was observed came from n = 25 countries.

Table 3. Categories (*in italics*) derived from open comments during COVID−19 (June 2020). More details about the comments from each country and number of countries are shown in Table S6.

Comment (#)	Value Clusters and Countries (Number of Comments)	Number of Countries
Concern about negative media coverage particularly through social media, image loss and increasing antipathy towards bats (n = 79) *Comments included, for instance, 'Social media being used to propagate propaganda against bats-increased persecution, less tolerance' or 'Social media has been a detriment to bat conservation at this time'.*	*African–Islamic*, Zambia (n = 2) *Catholic Europe*, Belgium (n = 12), Croatia (n = 2), Estonia (n = 1), France (n = 3), Italy (n = 2), Poland (n = 1), Portugal (n = 1), Slovenia (n = 1), Slovakia (n = 1) and Spain (n = 4) *English-Speaking*, Australia (n = 4), Canada (n = 6), New Zealand (n = 1), UK (n = 17) and USA (n = 13) *Latin America*, Mexico (n = 1), Peru (n = 1) *Protestant Europe*, Germany (n = 3), the Netherlands (n = 2), Norway (n = 1), Switzerland (n = 2) *Orthodox Europe*, Bulgaria (n = 1), Ukraine (n = 1), Serbia (n = 2) *West and South Asia*, South Africa (n = 3) comments from countries 'not in WVS 2020', Mauritius (n = 1), Saudi Arabia (n = 1)	28
Observed roost destruction (n = 48) *Comments included, for instance, 'Persecution of bats in buildings and destruction of roosts has been demanded repeatedly through conventional and social media, even by some medical experts' or ' . . . destroying roosting habitat, stopping action intended to create new roosting habitat . . . '.*	*African–Islamic*, Azerbaijan (n = 1), Uganda (n = 1), Zambia (n = 1) *Catholic Europe*, Belgium (n = 3), Croatia (n = 1), France (n = 4), Italy (n = 1), Poland (n = 3), Spain (n = 5) *English-Speaking*, Canada (n = 1), USA (n = 3) *Latin America*, Bolivia (n = 1), Mexico (n = 2), Peru (n = 1) *Orthodox Europe*, Algeria (n = 1), Bulgaria (n = 1), Greece (n = 1) *Protestant Europe*, Germany (n = 5), the Netherlands (n = 2) *West and South Asia*, Malaysia (n = 2), South Africa (n = 4) comments from countries 'not in WVS 2020', El Salvador (n = 1), Kenya (n = 1), UK (n = 2)	24
Fear from spillover (n = 48) *Comments included, for instance, ' . . . had issues dealing with people who believe bats droppings in (name of country deleted) have a toxoplasmosis risk, rabies fears and now spreading COVID-19 . . . ' or ' . . . people are more scared of having bats at home than before, mainly because of fear of disease transmission . . . '.*	*African–Islamic*, India (n = 1) *Catholic Europe*, France (n = 2), Portugal (n = 1), Slovenia (n = 2), Spain (n = 3) *English-Speaking*, Canada (n = 5), New Zealand (n = 1), UK (n = 8), USA (n = 11) *Confucian*, Japan (n = 1) *Latin America*, Peru (n = 1) *Orthodox Europe*, Ukraine (n = 1) *Protestant Europe*, Germany (n = 3), Switzerland (n = 2) *West and South Asia*, Malaysia (n = 2), South Africa (n = 2) comments from countries 'not in WVS 2020', El Salvador (n = 1), Saudi Arabia (n = 1)	18

Table 3. *Cont.*

Comment (#)	Value Clusters and Countries (Number of Comments)	Number of Countries
Request to kill bats or observation that bats were killed (n = 28) *Comments included, for instance, ' . . . (I) heard people are even more afraid of bats and are killing them . . . ' or 'Grounded bats killed immediately . . . '.*	*African–Islamic*, Azerbaijan (n = 1), Zambia (n = 1) *Catholic Europe*, Belgium (n = 2), Croatia (n = 1), France (n = 1), Poland (n = 2) *English-Speaking*, Australia (n = 4), UK (n = 1), USA (n = 1) *Latin America*, Mexico (n = 2) *Orthodox Europe*, Bulgaria (n = 1) *Protestant Europe*, Germany (n = 1), the Netherlands (n = 2) *West and South Asia*, Malaysia (n = 2) comments from countries 'not in WVS 2020', El Salvador (n = 2), Kenya (n = 1), Mauritius (n = 1)	17
Fear of having bats in buildings (n = 31) *Comments included, for instance, 'Fear concerns over colony in house or bat box and potential to get COVID-19 from bats' or 'Increased concern regarding maternity/nursery roosts in buildings'.*	*African–Islamic*, South Africa (n = 4), Uganda (n = 1) *Catholic Europe*, Italy (n = 1), Poland (n = 1), Portugal (n = 2), Slovenia (n = 1), Spain (n = 2) *English-Speaking*, Canada (n = 4), UK (n = 3) *Orthodox Europe*, Ukraine (n = 1) *Protestant Europe*, Germany (n = 3), Norway (n = 1), Switzerland (n = 5) *West and South Asia*, Malaysia (n = 2) comments from countries 'not in WVS 2020', Kenya (n = 1)	15
Forced stop of research (n = 5) *Comments included, for instance, 'All handling of alive or dead bats in wild has stopped' or ' . . . due to lock-down all fieldwork has stopped . . . '.*	*African–Islamic*, Albania (n = 1) *Catholic Europe*, Spain (n = 1) *English-Speaking*, Canada (n = 1), UK (n = 1), USA (n = 1) *Protestant Europe*, Germany (n = 1)	5
Nothing specific observed (n = 79) *Comments included, for instance, 'Nothing observed to date' or 'Nothing observed, yet'.*	*Catholic Europe*, Belgium (n = 1), Croatia (n = 1), Czech Republic (n = 1), France (n = 10), Hungary (n = 1), Italy (n = 1), Portugal (n = 3) *Confucian*, Japan (n = 2) *English-Speaking*, Australia (n = 1), Canada (n = 3), UK (n = 14), USA (n = 18) *Latin America*, Puerto Rico (n = 1) *Orthodox Europe*, Bulgaria (n = 1), Ukraine (n = 1) *West and South Asia*, Malaysia (n = 1), Singapore (n = 1), South Africa (n = 1) *Protestant Europe*, Finland (n = 1), Germany (n = 10), Switzerland (n = 2) comments from countries 'not in WVS 2020', Ireland (n = 1), Jordan (n = 1), Latvia (n = 1)	25

3.3. Predictive Potential of Emotions, Social Trust and Socio-Demographic Variables on Perceived Threats towards Bats

Emotions added to the predictive potential of all threat perceptions and the log-likelihood value (LL) increased when emotions were included in the model (Table 4). 'Prejudice' was influenced by all six emotions. Joy was the only emotion that was a positive predictor for all threat perceptions; particularly for 'direct' and 'indirect'. Compassion was a positive predictor for 'prejudice' and 'direct' threat perceptions.

Table 4. Effects (estimates) and standard error (SE) of trust and emotions on threat perception based on ordinal logistic regression using the dataset during the pandemic (June 2020). Significant results are presented in bold.

Threat	Indirect			Prejudice			Direct		
	Estimate ± SE	*p*-Value	LL (df)	Estimate ± SE	*p*-Value	LL (df)	Estimate ± SE	*p*-Value	LL (df)
Trust			−764.04 (34)			−641.99 (28)			−952.99 (57)
Authorities	**−0.23 ± 0.09**	**0.01**		**−0.22± 0.001**	**<0.001**		−0.08 ± 0.09	0.11	
NGOs	0.12 ± 0.11	0.29		**0.06 ± 0.001**	**<0.001**		0.19 ± 0.2	0.11	
Laypeople	0.03 ± 0.12	0.83		**−0.40 ± 0.001**	**<0.001**		0.02 ± 0.12	0.83	
Researchers	0.05 ± 0.11	0.83		**0.02± 0.001**	**<0.001**		−0.05 ± 0.11	0.61	
Emotions			−695.12 (40)			−589.28 (33)			−874.42 (63)
Joy	**0.45 ± 0.12**	**<0.001**		**0.13 ± 0.001**	**<0.001**		**0.42 ± 0.12**	**<0.001**	
Interest	0.02 ± 0.16	0.89		**0.07 ± 0.001**	**<0.001**		−0.23 ± 0.16	0.16	
Compassion	0.19 ± 0.10	0.06		**0.32 ± 0.001**	**<0.001**		**0.32 ± 0.10**	**0.002**	
Anger	0.21 ± 0.14	0.14		**0.06 ± 0.001**	**<0.001**		0.27 ± 0.15	0.06	
Fear	0.27 ± 0.18	0.13		**0.10 ± 0.001**	**<0.001**		0.28 ± 0.18	0.13	
Sadness	−0.03 ± 0.06	0.59		**0.07 ± 0.001**	**<0.001**		−0.08 ± 0.06	0.21	

Similar to emotions, 'prejudice' was influenced by trust in all four decision makers. In detail, increasing trust in authorities decreased bat experts' threat perception related to 'prejudice' and 'indirect'; similarly, increasing trust in laypeople decreased their perception of the threat 'prejudice'. In contrast, an increased trust in NGOs and researchers was a positive predictor for 'prejudice' threat perception (Table 4).

As for socio-demographic variables, male bat experts perceived all three threat categories as less severe compared to female bat experts (Table 5). Age showed predictive potential for 'prejudice' and 'direct' threats with older participants considering these threats less severe than younger participants.

Cultural differences were identified predominantly for 'direct' threats (Table 5). Here, participants from Confucian value clusters considered 'direct' threats as lower, but participants from Catholic Europe, English-speaking, Latin American and WSEA value clusters considered them as more severe than participants from African–Islamic cultures. As for threats through 'prejudice', participants from English-speaking value cultures considered these threats as more severe than participants from African–Islamic cultures.

As for professional background, participants working in NGOs, researchers and participants from the category 'other' considered threats through 'prejudice' more severe than participants working in governmental institutions (Table 5). In contrast, researchers considered 'direct' threats less severe than participants working in governmental institutions.

Table 5. Effects (estimates and standard error) of socio-demographic variables on threat perception based on ordinal logistic regression. Significant results are presented in bold.

Threat	Indirect		Prejudice		Direct	
	Estimate ± SE	*p*-Value	Estimate ± SE	*p*-Value	Estimate ± SE	*p*-Value
Socio-demographic variables						
Gender(compared to women)						
Men	**−0.66 ± 0.27**	**0.01**	**−1.35 ± 0.24**	**<0.001**	**−0.89 ± 0.001**	**<0.001**
Age (compared to 18–24)						
25–39	−0.37 ± 0.79	0.64	**−1.26 ± 0.001**	**<0.001**	**−0.60 ± 0.22**	**<0.01**
40–59	−0.40 ± 0.79	0.61	**−1.28 ± 0.23**	**<0.001**	**−0.42 ± 0.001**	**<0.001**
60–79	−0.30 ± 0.83	0.72	**−1.05 ± 0.36**	**0.003**	−0.19 ± 0.32	0.72
>79	−1.15 ± 1.31	0.38	−1.44 ± 1.09	0.19	−0.40 ± 1.06	0.71
Cultural cluster (compared to African-Islamic)						
Cath. Europe	−0.66 ± 0.50	0.07	−0.28 ± 0.28	0.32	**1.12 ± 0.27**	**<0.001**
Confucian	−0.56 ± 1.07	0.17	−0.13 ± 0.90	0.88	**−1.83 ± 1.01**	0.07
Engl.-speaking	−0.68 ± 0.48	0.48	**0.04 ± 0.001**	**<0.001**	**1.26 ± 0.001**	**<0.001**
Latin American	1.91 ± 0.69	0.53	0.64 ± 0.49	0.19	**1.70 ± 0.50**	**<0.01**
Orthodox	0.03 ± 0.71	0.97	0.05 ± 0.55	0.94	0.41 ± 0.64	0.52
Prot. European	0.78 ± 0.52	0.13	−0.50 ± 0.39	0.14	0.14 ± 0.32	0.66
WSEA	2.03 ± 1.40	0.15	0.44 ± 1.30	0.74	**2.21 ± 1.08**	**0.05**
Profession (compared to government)						
NGO	0.42 ± 0.47	0.38	**0.78 ± 0.32**	0.01	−0.39 ± 0.33	0.23
Researcher	0.77 ± 0.42	0.08	**1.19 ± 0.26**	**<0.001**	**−0.46 ± 0.001**	**<0.001**
Other	0.74 ± 0.42	0.08	**0.96 ± 0.001**	**<0.001**	−0.28 ± 0.25	0.34

4. Discussion

Expert views are crucial to identify research and conservation directions, particularly in the absence of data [17,18]. However, how the COVID-19 pandemic influenced bat experts' views globally has received little attention to date. Further, we were interested in our study about antecedents (emotions and social trust) of threat perception. We show that concerns in relation to persecution and myths as well as emotions of both compassion and sadness related to bats were higher among bat experts during the pandemic compared to the pre-pandemic survey. Trust in researchers and NGOs to do what is best for bat conservation was higher among experts during the pandemic compared to before. In contrast, trust in laypeople in this matter was lower among experts during the pandemic than before. Authorities were generally low trusted by bat experts, before and during the pandemic. While patterns of emotions related to bats, social trust in decision makers and threat perception differed among bat experts during the pandemic compared to before, besides social trust, emotions were important predictors for threat perception during the pandemic; particularly for threats related to prejudice.

4.1. Threat Perception, Emotions and Social Trust of Bat Experts before and during the Pandemic

Overall, bat experts stated before the pandemic that major threats to bats are 'indirect' such as habitat deterioration and disturbance compared to 'direct' threats such as predators. While threats through habitat deterioration (e.g., logging, agriculture or urbanization) are also assessed by the IUCN as major threats for global bat populations [2], concerns related to prejudice, e.g., persecution due to misinformation, were slightly but significantly higher and even considered as major threats to bats during the pandemic. In fact, a rise

in bat evictions from buildings and the legislative proposal for culling disease-relevant wildlife has been found in China shortly after the start of the pandemic and linked to the putative connection between bats and SARS-CoV-2 [4] as well as increased media coverage about the role of bats in the pandemic [22]. The open comments in the survey during the pandemic also underpin this concern about the negative media coverage of bats and possible consequences that were also already observed in some cases of roost destruction, and request to kill bats and even observations of killing of bats. Our survey was undertaken three months after the official declaration of the pandemic and is the immediate response of bat experts. Clearly, while at this stage it is still difficult to assess the long-term impact of the pandemic on bat populations, the coming years will reveal the consequences of this global pandemic on global bat conservation. The coming years will also reveal whether the concern about the public in relation to bat conservation (e.g., fear of bats in buildings) was justified. In any case, bat experts might benefit from working closely together with the public during this time to work with the fears and concerns related to e.g., 'living with or close to bats' among the public. While it is not surprising that bat experts expressed predominantly positive emotions about their study animal, they expressed during the pandemic more sadness and compassion when we asked them how they felt about bats. The pandemic has certainly changed our outlook on life and we cannot rule out whether this higher sadness or compassion was due to a general emotional process caused by, e.g., personal losses. Nevertheless, given that we asked participants in our survey to self-assess their emotions when they thought specifically about bats, we interpret the stronger expression of compassion and sadness during the pandemic as the concern about bats and their conservation, i.e., as a response to potential losses of a valued study taxon and ecologically driven grief [19].

4.2. Predictive Potential of Social Trust, Emotions and Socio-Demographic Variables on Threat Perception

Aligning with earlier studies, we found effects of emotions on threat perceptions [8]. Including the discrete variables 'emotions' even improved the goodness of fit in our models which underpins their important role for threat perception. However, while the category 'fear' is an important factor in explaining threat appraisal [12], fear was not the most prominent predictor for threat perception among bat experts but rather positive emotions joy and compassion. While 'prejudice' was predicted by all investigated emotions, joy and compassion predicted all three perceived threats. Here, we see the importance of the emotion compassion when it comes to non-human animal-related issues [31]. While emotions might be still considered cautiously within the scientific community [32], investigating the role of compassion within (wildlife) experts and their study animals might be an interesting avenue to pursue and could benefit the ongoing discussions about the extent of ethical consideration in wildlife conservation practices [33,34]. Sadness was the only negative emotion predicting threat perception (prejudice). Sadness is generally associated with the appraisal of permanent loss [35] that we interpret in our study as concern about the loss of bat species (i.e., 'ecological grief', [19]). In relation to trust, the more participants trusted authorities and laypeople, the less they were concerned about threats towards bats; particularly threats through 'prejudice', i.e., persecution and myths. While trust in authorities was overall low, this underpins the important role that trust in authorities plays in wildlife-related issues [36]. Trust in laypeople decreased during the pandemic. Here, including laypeople in conservation issues can benefit from communication strategies that address (mis)beliefs around bats and their role in the pandemic [37].

In relation to socio-demographic variables, while male bat experts considered all threats to bats as generally less severe than female bat experts, cultural differences were identified predominantly for 'direct' threats. We interpret these results accordingly: 'indirect' threats are commonly considered as major threats among bat experts whereas 'direct' threats are context- and consequently culture-specific (e.g., hunting and trade do not relate to all countries). The same relates to 'prejudice', while this was, however, only considered

as more severe among participants from the English-speaking country cluster compared to participants from the African–Islamic value cluster. Given the high number of participants from English-speaking countries, this could also have driven the high concern for threats through 'prejudice' in the second round of our surveys. As for professional background, all participants considered threats through 'prejudice' as more severe compared to participants working for governmental institutions, while participants working for governmental institutions considered 'indirect' threats more severe than researchers. Acknowledging these different perceptions about threat is crucial in this context; particularly if collaborations are the aim that require consensus of threat mitigations in contexts of concern.

With this study, we clearly took a unique opportunity to undertake the same survey with bat experts shortly before and after the start of the pandemic and can show how the COVID-19 pandemic has potentially influenced their threat perceptions, emotions and social trust. Since similar studies did not have the data before the start of the pandemic [4,5,22], we see our study as a unique contribution to the literature. Nevertheless, there are certain limitations that need to be considered. For instance, we cannot verify how many participants in the first round of the survey also participated in the second round of the survey, i.e., a comparison between both periods needs to be done carefully. Further, cross-sectional studies have predictive potential but only with longitudinal data is it possible to establish a true cause and effect relationship [38]. Consequently, evidence for the relationships between emotions, social trust and threat perception that we found in our study would require longitudinal surveys, possibly with the same participants, to detect the long-term effect of this crisis on bat experts. Lastly, most of our respondents were from the Global North and fewer from the biodiverse Global South where human–bat conflicts are highest and legal protection of bats lowest. Consequently, bat expert views and emotions as presented in this manuscript are biased towards the Global North. However, despite these limitations, there are three important lessons relevant for practice and policy. 'Prejudice' was the highest considered threat among bat experts within the pandemic that was also underpinned in the open comments provided, whereas trust in laypeople was lower compared to before the pandemic. Hence, a focus on mitigation strategies to address this issue should become a focus for bat conservation. One approach is communication strategies [37,39] and the next steps would be evaluating the effectiveness of these. Further, trust in researchers increased with the pandemic. Trust is an important component when it comes to collaborations and to the resolution of conservation conflicts [40] and the shared increased concern among bat experts for bats and their conservation during the pandemic provides clear opportunities for collaborations to avoid persecution of bats in the aftermath of the pandemic [41]. Lastly, sadness and compassion were higher among bat experts during the pandemic. With increased concern about zoonotic spillovers [6], 'ecological grief', i.e., intense feelings of grief as response to, e.g., losses of valued species [19]), might intensify within the conservation community. Hence, we support the idea of Cunsolo and Ellis [19] that this still underdeveloped area of inquiry requires urgent attention.

5. Conclusions

Bat expert assessments related to threats that bats are facing due to the COVID-19 pandemic are crucial, particularly in the absence of data. In our survey, experts assessed threats through persecution as more severe during the pandemic. While this has already been reported to some extent in China [4], it is still difficult to assess the long-term consequences of the pandemic on bat conservation and the coming years will shed light on the impact of the pandemic on bat conservation. In any case, working closely together with the public and their fears and concerns related to e.g., 'living with or close to bats' has received certainly another dimension during this pandemic. Trust in researchers increased among bat experts during the COVID-19 crisis which can be clearly an advantage to foster collaborative efforts and, in fact, calls for collaborative efforts among bat experts appeared since the pandemic [41]. Despite skepticism about the role of emotions within the scientific community [32], decisions are hardly free of emotional processes [14]. Here, we showed

that emotions are besides social trust important predictors for threat perception of bats. Recognizing emotions within the scientific community, particularly related to 'ecological grief' as a response to (potential) species losses is still an understudied area. Nevertheless, 'ecological grief' of experts related to the specific study species would benefit from more attention, particularly as situations related to species loss worsen; whether driven through human behavior or climate change.

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