The medium over the message: Differential knowledge of conservation outreach activities and implications for threatened species

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ABSTRACT

Conservation outreach is regularly conducted to increase support for conservation by altering local awareness and attitudes about species or environmental issues. However, there is often little assessment of the effectiveness of these activities. We investigated knowledge of past conservation outreach in 26 villages adjacent to Bawangling National Nature Reserve, Hainan, China, which contains the last population of the Hainan gibbon (*Nomascus hainanus*). The medium of past outreach activities was reported most frequently by interviewees, followed by who delivered them and the outreach topic, with the fewest interviewees reporting the specific messages being communicated (the consequences of following conservation management policies). Negatively-framed messages, emphasizing prohibited activities and associated punishments, were reported more than positively-framed messages that aimed to foster conservation support. Male interviewees and those with higher education levels reported more aspects of past activities. The Hainan gibbon had higher salience than other threatened native species, and reporting the occurrence (but not necessarily the content) of past outreach was associated with increased likelihood of knowing that gibbons were threatened. These findings highlight the need for conservation outreach to increase both exposure and retention of key messages among target audiences. Meaningful and concrete conservation benefits should be communicated to local communities, and the effectiveness of outreach using a flagship species could be expanded to also improve awareness of other conservation-priority species within the same landscape.

1. Introduction

Conservation outreach is increasingly used as a key tool for increasing conservation impacts, and has been adopted by major frameworks such as the Convention on Biological Diversity's Aichi Target 1 (Convention on Biological Secretariat of the Convention on Biological Diversity, 2020). Priority activities include using communication, education, and public awareness (CEPA) to promote pro-environment attitudes and behavioral change among target audiences (Convention on Biological Secretariat of the Convention on Biological Diversity, 2020). These activities aim to change people's knowledge, perceptions and attitudes about environmental conditions, governance, and conservation interventions (Rakotomamonjy et al., 2015; van der Ploeg et al., 2011). Increasing such awareness does not guarantee behavior change, and the pathway from awareness-raising to pro-conservation action involves complex social and psychological factors (Kidd et al., 2019; Schultz, 2011). However, awareness forms a foundation for engagement (Bennett et al., 2017; Bickford et al., 2012).

An evidence-based approach is increasingly used in conservation (Bennett, 2016; Sutherland et al., 2004), but the effectiveness of outreach activities is still rarely evaluated, putting projects at risk of wasting resources (Kapos et al., 2008; Thomas et al., 2019). In particular, context-specific evidence on effectiveness of conservation interventions is often lacking, and is especially problematic outside western developed countries and in non-English speaking regions where there are shortages of locally-relevant evidence available to conservation practitioners (Christie et al., 2020). Understanding how knowledge, perceptions and attitudes are influenced by outreach activities is thus important for better evaluation and ultimately increasing intervention success (Thomas et al., 2019). These factors are interdependent and

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often influence each other, with their interactions also increasingly studied to understand decision-making and individual behaviors, as postulated in the 'Theory of Change' (Biggs et al., 2011, 2017).

How messages are framed and delivered, and how audiences receive and retain messages, are key components of outreach. In social and communication theories, framing defines the organization and representation of information into concepts that highlight specific aspects of an issue (Chong and Druckman, 2007). For example, public health campaigns focusing on fear are more persuasive for behavior change (Witte and Allen, 2000). However, fear-based messaging may have unintended consequences, such as marginalizing vulnerable groups (Guttman and Salmon, 2004). In climate change messaging, framing issues with either positive or negative terminology also affects intentions to engage in personal behavior change (Dickinson et al., 2013; Morton et al., 2011). The identity of the messenger can also impact the effectiveness of outreach activities, because of factors such as social status and perceived trustworthiness (Kidd and Dayer, 2020). Within conservation, messages are shown to be more effective when normative statements are used, when framed about benefits rather than losses, and when contextualized with global issues (Giannetta, 2018; Jacobson et al., 2019).

Communication theory highlights the importance of how messages are transmitted, as the medium (e.g., newspapers, television, radio, internet) can influence what is communicated and received (McLuhan, 1964). Research in other domains that routinely employ outreach as a first step for behavioral change (e.g., public health interventions, political campaigns, social marketing) indicates that both medium and message can influence outcomes, in diverse ways (Guo and Moy, 1998; Low and Davenport, 2005; Randolph and Viswanath, 2004). When the medium overpowers the message, conservation outreach can fall short of intended goals. For example, audiences presented with online conservation campaigns endorsed by celebrities were less likely to recall messages than those presented by conservation professionals (Duthie et al., 2017). Positive attitudes towards European wolf recovery are also related to greater trust in certain information sources (books, science-based media), with lower trust and more negative attitudes to press and television (Arbieu et al., 2019).

Outreach activities also require an understanding of what is important to target audiences, and why. Measuring salience, or the relative prominence of items within particular mental categories, is widely used in anthropology, cultural studies and experimental psychology (Taylor and Fiske, 1978; Thompson and Juan, 2006), and can be used to monitor public awareness and understand how wildlife is perceived. For example, the online frequency of bird vernacular and scientific names has been used as an indicator of cultural salience, providing real-time trends of public interest (Correia et al., 2017; Ladle et al., 2016). Salience can be quantitatively measured through free-listing, which is used to evaluate conservation education programs and understand the relative cultural importance of species (Nekaris et al., 2018; Papworth et al., 2013). However, the relationship between outreach activities, recall, and salience is influenced by various factors; salience reflects where attention is focused, and information-content, involvement, arousal, and individual differences can all be manipulated to affect what is remembered (Taylor and Fiske, 1978). Market research has further shown that emphasis on one subject can increase its salience while reducing that of others (Alba and Chattopadhyay, 1986; Jin et al., 2008). In addition, individual demographic characteristics and experiences, including education level, exposure to awareness-raising and education programs, and direct interaction with nature, can also influence knowledge, awareness and perceptions of conservation (Hooykaas et al., 2019; Howe et al., 2012; Nyhus et al., 2003). For example, age, gender, income, and learning opportunities and experiences are known to affect people's knowledge and perception of wildlife, protected areas, and threatened biodiversity (Allendorf and Yang, 2017; Li and Chen, 2018), all of which could then influence species salience. Increased awareness of highly publicized species ('flagship species') might also influence interactions and values towards lesser-known, or less salient, threatened species (Bowen-Jones and Entwistle, 2002; Veríssimo et al., 2014), as human perceptions, awareness, and attitudes are all known to influence how people interact with biodiversity (Bickford et al., 2012; Nilsson et al., 2016).

Assessment of which aspects of outreach activities are most retained, and how these aspects relate to the salience of threatened species, is thus necessary to improve conservation communication. Whereas much research and evaluation of conservation outreach has documented what messages were communicated and to whom, what is reported by the recipients of such outreach activities has rarely been evaluated (Kidd et al., 2019; Thomas et al., 2019). Key questions include what people who were exposed to outreach activities can subsequently report about such activities, and whether accurate reporting of these activities is associated with greater awareness of threatened species, within the context of variation in demographic characteristics and personal experiences.

In this study, we explore the relative impacts of message and medium in conservation communication, local salience of threatened species, and correlates of individual characteristics relevant to these responses within the framework of local perceptions as a form of evidence for conservation (Bennett, 2016). We investigated how past conservation outreach activities are reported today, and how this relates to local perceptions about protected areas and threatened species, in communities surrounding Bawangling National Nature Reserve (BNNR), Hainan, China. Various governmental and non-governmental bodies have conducted conservation outreach in these communities focused on conservation of the Hainan gibbon (*Nomascus hainanus*), the reserve's flagship threatened species, but the effectiveness of these activities has not been assessed. We evaluated which aspects of past conservation outreach activities were most reported by local people, which demographic variables affected this awareness, and whether reporting past conservation outreach could predict people's awareness and salience of different threatened species. We demonstrate that even if baseline data on past outreach activities are lacking, novel approaches to assessment can be valuable for understanding the effectiveness of conservation messaging strategies. Our findings also have wider relevance for helping protected area managers and conservation organizations identify appropriate messages to communicate with target audiences, and tailor these activities in local contexts with effective media to maximize both the reach and retention of conservation outreach activities.

2. Methods

2.1. Study site

Bawangling National Nature Reserve (18°570-19°110 N, 109°030–109°170 E) is a protected area in Baisha and Changjiang counties, Hainan. It contains the only surviving population of the Critically Endangered Hainan gibbon, the world's rarest ape, which numbers around 35 individuals (Bryant, 2014; Chan et al., 2020). The reserve is surrounded by numerous small villages containing low-income, primarily agriculture-based communities, predominantly of Li or Miao ethnicities, with a long history of using natural resources from the nearby forest (Fauna and Flora International China Programme, 2005; Davies and Wismer, 2013).

All local communities have been exposed to some conservation outreach, although the activities, timing, aims, desired outcomes, and evaluation of these activities are not coordinated between stakeholders. There are no systematic records of what outreach activities have been conducted, or by whom; however, reserve management officials report that conservation outreach is routinely conducted by reserve wardens and targets all villages surrounding the reserve (Xuming Qi, Hainan Provincial Forestry Bureau and BNNR Management Office, *pers. comm.* 2018), and additional community-based conservation outreach activities are also periodically conducted by non-governmental conservation

organizations (Fauna and Flora International China Programme, 2007, 2008; Kadoorie Farm and Botanic Garden 2016) (see Supplementary Material Table S1 for a full list of these past activities).

2.2. Data collection

Twenty-six villages were sampled from the total set of 30 villages (86.7%) situated within 3 km of BNNR, including villages in both Baisha and Changjiang counties (Fig. 1); not all 30 villages were sampled due to time and logistical constraints. The total human population of these two counties is c. 25,300 (National Bureau of Statistics, 2019). The distance threshold of 3 km was chosen because it is a realistic walking distance from the village to the reserve, considering that local people traditionally walk there to collect natural resources, hunt, grow crops, and herd cattle.

Individual interviews were conducted in May–June 2018. Interviewees included both males and females aged 18 and above, and were selected opportunistically by walking through villages on foot and asking anyone encountered whether they were happy to be interviewed. A target sample of 10 interviews was conducted in each village, as this is the predicted threshold for response saturation to capture existing variation in responses (Guest et al., 2006). These methods followed those of other interview surveys previously conducted in this region (Nash et al., 2016; Turvey et al., 2017, 2019).

A standardized questionnaire including open and closed questions, which took ~45 min to complete, was used for all one-to-one interviews (Supplementary Material). Free, prior, and informed verbal consent was obtained from all interviewees before interviews began, and

interviewees were told they could discontinue at any point and choose not to answer any questions. Interviews were conducted in Mandarin by two of the authors (HM and JQ), although some older interviewees only spoke Li or Miao languages and family members helped with translation.

Demographic data were obtained first, including interviewee gender, age, ethnicity, highest level of education, annual household income, and whether they reported going into the forest more than once a month. Free-listing questions were then used to determine which wildlife species were perceived as threatened, first in China and then specifically in Hainan, with answers recorded in the order they were given to calculate salience. Finally, open-ended questions were asked about conservation outreach activities that had occurred in the village. These questions included interviewee knowledge of what content or information was communicated, who conducted the event, when the event took place, what medium of communication was used, what the interviewee thought the purpose of the event was, and what consequences there would be if they followed the reserve management policies they were told about. Interviewees were not prompted with possible responses, although interviewers often explained the questions and gave examples when necessary, since many interviewees were not familiar with participating in such interview surveys. The term 'environmental conservation education activities' (*baohu xuanchuan jiaoyu huodong*) was used to avoid prompting interviewees specifically about wildlife conservation, and because this is the standard Chinese term for this type of activity. Hereafter, these activities are referred to as 'conservation outreach activities'. Additional survey data about local people's comparative knowledge of Hainan gibbons and rhesus macaques (*Macaca mulatta*), sources of knowledge, and preferred method of future
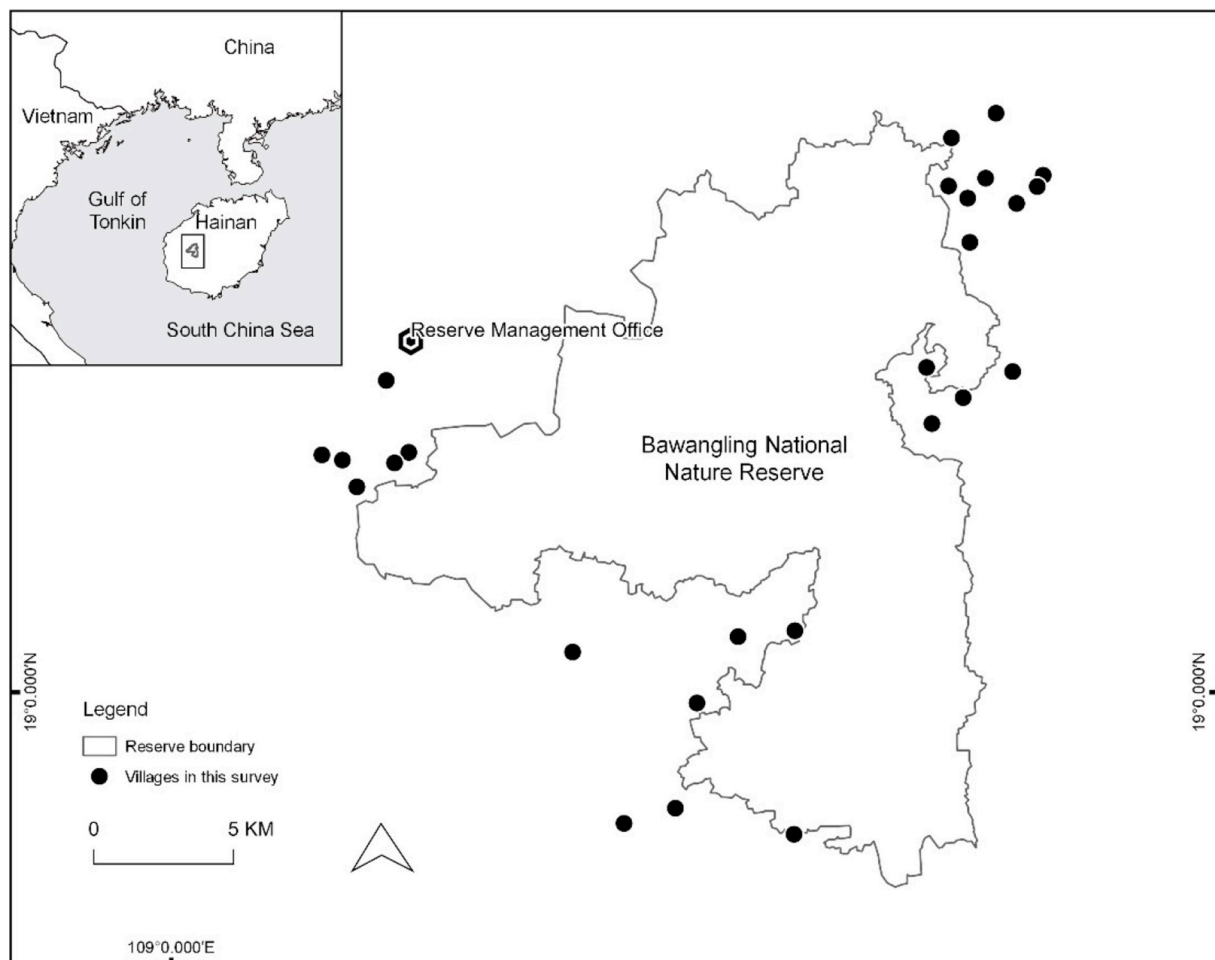

Fig. 1. Locations of the 26 villages surveyed in this study around Bawangling National Nature Reserve, Hainan, China.

conservation outreach activities were also collected and have been published elsewhere (Qian et al., 2021).

2.3. Data analysis

Data analysis was performed in R version 3.4.2 (R Core Team, 2017). Generalized linear mixed effect models (GLMMs) with binomial error structures and logit link functions were conducted using the R package 'lme4'. Because predictor variables were selected for their possible impacts on the responses based upon identified relationships in previous published studies, a full-model approach rather than a model selection approach was then taken. This approach was used to investigate which individual demographic variables predicted interviewees' reporting of different aspects of conservation outreach activities, reporting of positively and negatively-framed messages, and awareness of threatened species, and to reduce bias in preferentially reporting only significant variables (Forstmeier and Schielzeth, 2011). As systematic information on past outreach activities is not available, village was included as a random effect to control for possible variation in exposure to conservation outreach across communities around BNNR. Ethnicity was not included as a predictor in full models because there was little variation within this variable, with 91% (n = 192) of interviewees of Li ethnicity; GLMMs were performed only using the subset of Li interviewees. Income was also not included as a predictor because 92% (n = 195) of interviewees self-identified as either farmers or unemployed, but these terms were often used interchangeably because subsistence agriculture does not generate income, making it difficult to collect meaningful data for this question.

For GLMMs investigating which aspects of conservation outreach activities were reported, response variables included whether interviewees were able or unable to report: (1) if conservation outreach had occurred; for those who were reported outreach activities had occurred, (2) the medium of communication; (3) who conducted the conservation outreach; (4) the content; and (5) the consequences of following the reserve's conservation management policies. The reported content of conservation outreach messages was also grouped into two categories based on interviewees' perceptions of their impacts to local livelihoods and development: positively-framed messages associated with benefits to human wellbeing or environmental protection (e.g., conservation of wildlife, water and entire ecosystem; tourism development), and negatively-framed messages associated with regulations preventing certain activities or use of natural resources (e.g., not being allowed to hunt wildlife, set fires, cut down trees, or extract resource materials, all of which local people were permitted to do before establishment of BNNR in 1980). Of the subset of interviewees who reported conservation outreach content, two further GLMMs were conducted to test for demographic variables associated with the binary responses of (1) reporting positively-framed messages and (2) reporting negatively-framed messages. All GLMMs included the following predictor variables: age (continuous), gender (categorical), education level (categorical: none, primary school, middle school, high school and above), and frequency of forest visits (binary: at least once a month, or less than once a month). Possible collinearity between these predictors was tested for using variance inflation factors (VIF) in the R package 'performance', with all predictors showing VIF values below five (indicating low correlation).

Additional GLMMs were conducted for three binary response variables of interviewees' ability to free-list the following subjects: (1) perceived threatened species in China; (2) perceived threatened species in Hainan; (3) the Hainan gibbon as a threatened species in either China or Hainan. The same predictor variables were used for these analyses, plus whether interviewees reported conservation outreach activities having occurred at all (binary). The 'AnthroTools' package (Jamieson-Lane and Purzycki, 2016) in R was used to calculate Smith's scores, a quantitative metric for measuring salience that is calculated from both the order and frequency that a species is mentioned by interviewees in free-listing. A chi-squared test of independence was performed to test for association between interviewees who could name species in China and Hainan.

3. Results

3.1. Reporting of different aspects of conservation outreach activities

A total of 212 interviews were conducted, with a mean of eight interviews per village (Supplementary Material Table S2). Some aspect of local conservation outreach was reported by 104 people (49.1%). Gender (binomial GLMM, n = 191, $\chi2$ = 11.354, df = 1, p = 0.001) and education level (binomial GLMM, n = 191, $\chi2$ = 10.287, df = 3, p = 0.016) significantly predicted whether interviewees reported outreach having occurred (for full results of all models see Table 1). Men were more likely to report than women (Supplementary Material Fig. S1), and interviewees with up to primary school level education were more likely to report than those with no schooling (Tukey post-hoc test, primary school vs no school, estimate = 1.717, standard error = 0.543, z-value = 3.164, p = 0.002).

The aspect of outreach activities that was reported by the greatest number of interviewees was the medium of communication (92/104), followed by who conducted the outreach activities (84/104), and the message or content that was communicated (83/104). The fewest interviewees reported what the consequences would be for following the reserve's conservation management policies (66/104) (Fig. 2) (see Fig. 3).

The most frequently reported medium of communication was group meetings (34/92), followed by messages broadcast from vehicles (29/92). Other identified media, reported by 45 interviewees, included people going door-to-door to speak with residents, showing posters or display boards, handing out leaflets with information, conveying information through the village head, opportunistic discussions in the village, showing films, and school activities. Gender (binomial GLMM, n = 191, $\chi2$ = 11.307, df = 1, p = 0.001) and education level (binomial GLMM, n = 191, $\chi2$ = 8.635, df = 3, p = 0.035) significantly predicted whether interviewees reported a specific medium (Table 1). Men were more likely to report than women (Supplementary Material Fig. S1), and interviewees with up to primary school level education were more likely to report than those with no schooling (Tukey post-hoc test, estimate = 1.376, standard error = 0.522, z-value = 2.636, p = 0.008).

The majority of identified sources of information were nature reserve wardens or officials (60/84). The next most identified were village leaders (8/84) and provincial government staff (6/84). Other identified sources, reported by 19 interviewees, included people from mainland China, people from Hong Kong, students, police, foreigners, journalists, and the media or "*guanggao*" (including posters, banners, slogans, and the news). Gender (binomial GLMM, n = 191, $\chi2$ = 8.517, df = 1, p = 0.004) and education level (binomial GLMM, n = 191, $\chi2$ = 9.707, df = 3, p = 0.021) significantly predicted whether interviewees reported the source of information (Table 1). Men were more likely to report than women (Supplementary Material Fig. S1), and interviewees with up to primary school level education were more likely to report than those with no schooling (Tukey post-hoc test, estimate = 1.793, standard error = 0.578, z-value = 3.101).

Gender (binomial GLMM, n = 191, $\chi2$ = 5.251, df = 1, p = 0.022) and education level (binomial GLMM, n = 191, $\chi2$ = 10.193, df = 3, p = 0.017) significantly predicted whether interviewees reported the content of outreach activities (Table 1). Men were more likely to report content compared to women (Supplementary Material Fig. S1). Interviewees who had up to primary school and middle school level education were both significantly more likely to report content compared to those with no schooling (Tukey post-hoc tests, primary school, estimate = 1.578, standard error = 0.515, z-value = 3.065, p = 0.002; middle school, estimate = 1.181, standard error = 0.496, z-value = 2.380, p = 0.017).

Table 1
Summary test statistics of all GLMM predictors and responses.

Models and response variable	Predicting variables	Estimate	Standard error	p
1. Reported any awareness-raising (n = 191; marginal R²/conditional R² = 0.169/0.439)	(Intercept)	−2.310	0.906	**0.011**
	Age	0.012	0.015	0.414
	Gender (m)	1.456	0.432	**0.001**
	Education (high)	0.647	0.705	**0.359**
	Education (middle)	0.962	0.505	**0.057**
	Education (primary)	1.717	0.543	**0.002**
	Visit forest more than once per month	0.184	0.417	0.658
3. Reported awareness-raising medium of communication (n = 191; marginal R²/conditional R² = 0.158/0.406)	(Intercept)	−2.328	0.889	**0.009**
	Age	0.011	0.014	0.432
	Gender (m)	1.447	0.430	**0.001**
	Education (high)	0.088	0.713	0.902
	Education (middle)	0.929	0.497	0.061
	Education (primary)	1.376	0.522	**0.008**
	Visit forest more than once per month	−0.042	0.405	0.917
4. Reported who conducted awareness-raising (n = 191; marginal R²/conditional R² = 0.152/0.510)	(Intercept)	−3.104	1.009	**0.002**
	Age	0.018	0.016	0.242
	Gender (m)	1.385	0.475	**0.004**
	Education (high)	0.880	0.759	0.246
	Education (middle)	1.044	0.545	0.055
	Education (primary)	1.793	0.578	**0.002**
	Visit forest more than once per month	−0.064	0.448	0.887
6. Reported awareness-raising content (n = 191; marginal R²/conditional R² = 0.139/0.336)	(Intercept)	−2.296	0.861	**0.008**
	Age	0.009	0.014	0.517
	Gender (m)	0.946	0.413	0.022
	Education (high)	0.714	0.694	0.304
	Education (middle)	1.181	0.496	**0.017**
	Education (primary)	1.578	0.515	**0.002**
	Visit forest more than once per month	0.217	0.399	**0.587**
8. Reported what consequences there would be for following reserve policies (n = 191; marginal R²/conditional R² = 0.168/0.490)	(Intercept)	−3.708	1.079	**0.001**
	Age	0.017	0.016	0.281
	Gender (m)	1.897	0.534	< **0.001**
	Education (high)	0.019	0.802	0.981
	Education (middle)	0.428	0.568	0.451
	Education (primary)	1.107	0.587	0.060
	Visit forest more than once per month	0.278	0.476	0.559
10. Reported positively-framed messages (n = 78; marginal R²/conditional R² = 0.194/NA)	(Intercept)	−0.961	1.247	0.441
	Age	−0.005	0.022	0.814
	Gender (m)	0.972	0.627	0.122
	Education (high)	0.667	0.977	0.495
	Education (middle)	1.391	0.741	0.061
	Education (primary)	2.304	0.837	**0.006**
	Visit forest more than once per month	−0.103	0.604	0.865

Table 1 (*continued*)

Models and response variable	Predicting variables	Estimate	Standard error	p
12. Reported negatively-framed messages (n = 78; marginal R²/conditional R² = 0.259/0.359)	(Intercept)	2.334	1.680	0.165
	Age	0.033	0.023	0.158
	Gender (m)	−1.042	0.745	0.162
	Education (high)	−1.330	1.497	0.374
	Education (middle)	−2.022	1.227	0.099
	Education (primary)	−2.141	1.299	0.099
	Visit forest more than once per month	−1.077	0.659	0.102
14. Free-listed threatened species in China (n = 191; marginal R²/conditional R² = 0.055/0.200)	(Intercept)	−0.968	0.907	0.286
	Reported outreach activities	0.532	0.449	0.237
	Age	−0.016	0.016	0.316
	Gender (m)	−0.399	0.448	0.373
	Education (high)	1.048	0.717	0.144
	Education (middle)	0.012	0.571	0.983
	Education (primary)	−0.064	0.594	0.914
	Visit forest more than once per month	−0.133	0.441	0.763
19. Free-listed threatened species in Hainan (n = 191; marginal R²/conditional R² = 0.160/0.205)	(Intercept)	−1.883	0.853	**0.027**
	Reported outreach activities	1.328	0.416	**0.001**
	Age	−0.004	0.015	0.771
	Gender (m)	−0.356	0.416	0.392
	Education (high)	1.463	0.664	**0.028**
	Education (middle)	0.522	0.515	0.311
	Education (primary)	−0.198	0.564	0.725
	Visit forest more than once per month	0.331	0.403	0.411
20. Free-listed the Hainan gibbon (n = 191; marginal R²/conditional R² = 0.194/0.244)	(Intercept)	−1.660	0.919	0.071
	Reported outreach activities	1.295	0.467	**0.006**
	Age	−0.009	0.016	0.574
	Gender (m)	−0.660	0.460	0.151
	Education (high)	1.736	0.693	**0.012**
	Education (middle)	0.541	0.563	0.337
	Education (primary)	−0.763	0.678	0.260
	Visit forest more than once per month	0.065	0.491	0.895

Slightly more interviewees reported positive messages about the benefits of conservation (58/83) than negative messages that prohibited activities in the reserve (55/83), although there were more reported types (5) and individual mentions (86) of different negative messages (Fig. 2). The single most reported message was about wildlife conservation, mentioned by 57 interviewees. Reporting of positively-framed messages was significantly predicted by education level (binomial GLMM, n = 78, χ2 = 8.117, df = 3, p = 0.044; Table 1), with interviewees possessing up to primary school level education being more likely to report positive messages compared to those with no schooling (Tukey post-hoc test, estimate = 2.304, standard error = 0.837, z-value = 2.752, p = 0.006). No predictors were significantly associated with reporting of negatively-framed messages.

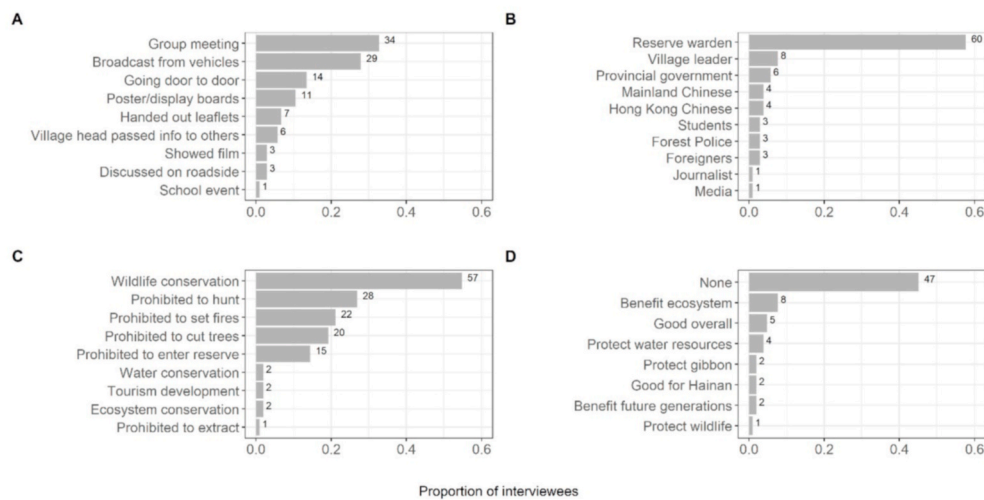Of the interviewees who said they could report what they were told

Fig. 2. **A)** Proportion of interviewees who reported the medium of communication (n = 92). **B)** Proportion of interviewees who reported who conducted local conservation outreach (n = 84). **C)** Proportion of interviewees who reported different types of message (n = 83). **D)** Proportion of interviewees who reported being told what the consequences would be for following the reserve's conservation management policies (n = 66). Numbers on bars represent the number of interviewees who reported each response. Proportions are of the total of 104 interviewees who reported local conservation outreach; some interviewees listed more than one response within each question.
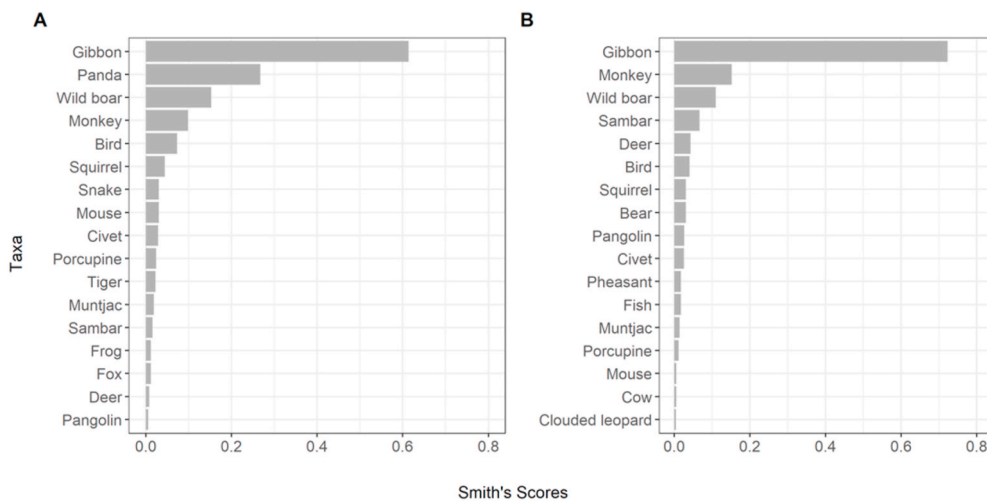

Fig. 3. Smith's scores of salience for free-listed taxa that interviewees perceived as threatened in (**A**) China (n = 44), and (**B**) Hainan (n = 57).

about the consequences of following the reserve's conservation management policies, 71.2% (47/66) stated that there were no consequences, while 28.8% (19/66) listed specific consequences, including protection of the forest ecosystem, water resources, wildlife and/or gibbons, and benefits for future generations, Hainan or China. Five interviewees reported being told that conservation is 'overall a good thing' but did not provide more detail. Gender (binomial GLMM, n = 191, $\chi2$ = 12.624, df = 1, p < 0.001) significantly predicted whether interviewees could report these consequences (Table 1), with men more likely to report consequences than women (Supplementary Material Fig. S1).

3.2. Awareness and salience of threatened species

In total, 20.8% (44/212) of all interviewees were able to free-list species they thought were threatened in China, 26.9% (57/212) could do so for Hainan, and 17.0% (36/212) could do so for both China and Hainan, while 69.3% (147/212) provided no response. There was a statistically significant positive relationship between interviewees who free-listed threatened species for China and those who free-listed threatened species for Hainan ($\chi2$ = 81.74, df = 1, p = 0.001).

The Hainan gibbon was the most frequently listed and most salient threatened species for China (28 people), followed by giant panda (*Ailuropoda melanoleuca*) (11 people) and wild boar (*Sus scrofa*) (nine people). The Hainan gibbon was also the most frequently listed and most

salient threatened species for Hainan (41 people), followed by rhesus macaque (10 people) and wild boar (nine people). Sambar deer (*Rusa unicolor*), Chinese pangolin (Manis pentadactyla), and carnivores including tiger (*Panthera tigris*), Asiatic black bear (*Ursus thibetanus*), clouded leopard (*Neofelis nebulosa*) and civets were also listed by a few interviewees for both China and Hainan, but were of low salience.

Of the subset of Li ethnicity interviewees included in statistical analyses (n = 192), 22 (23.4%) could free-list species they thought were threatened in China, 34 (36.2%) could do so for Hainan, and 26 (27.7%) mentioned the Hainan gibbon when asked about threatened species in either China or Hainan (Fig. 4). No significant predictors were associated with interviewees' ability to free-list threatened species in China, but interviewees who reported local outreach activities were significantly more likely to be able to free-list threatened species in Hainan (binomial GLMM, n = 191, $\chi2$ = 10.205, df = 1, p = 0.001; reported outreach, odds ratio = 3.77, 95% CI = 1.67–8.52, p = 0.001). Reporting of outreach activities (binomial GLMM, n = 191, $\chi2$ = 7.671, df = 1, p = 0.006) and education level (binomial GLMM, n = 191, $\chi2$ = 12.462, df = 3, p = 0.006) significantly predicted whether interviewees listed the Hainan gibbon. Gibbons were more likely to be free-listed by interviewees who reported local outreach (odds ratio = 3.65, 95% CI = 1.46–9.13, p = 0.006), and by interviewees with high school level education or above compared to those with no schooling (Tukey post-hoc test, estimate = 1.736, standard error = 0.693, z-value = 2.505, p =
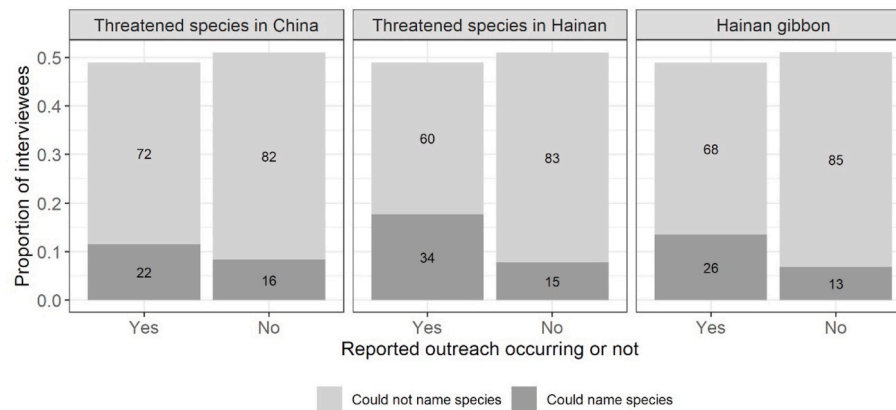
Fig. 4. Proportions of the subset of interviewees included in statistical analyses (n = 192) who could name at least one Chinese species, one Hainanese species, and the Hainan gibbon when asked to free-list threatened wildlife species. Pairs of bars in each panel show comparisons for each response between interviewees who reported local outreach activities and those who did not report them. Numbers on bars show number of interviewees who could name species.

0.012).

4. Discussion

Our study provides a novel, practical, and nuanced understanding of the awareness and perceptions of past conservation outreach activities by local people living in a conservation-priority landscape. This evaluation could be achieved despite a lack of baseline data on previous outreach activities, and has wider implications for understanding the effectiveness and optimal design of environmental education programs. Among the people interviewed around a protected area that have been exposed to conservation outreach, we observed higher levels of reporting of how outreach activities were conducted and by whom, compared to reporting of the content of these activities, indicating that the medium rather than the message has been preferentially remembered by people living within this landscape. Relatively few people also reported knowing the consequences of following conservation management policies, which indirectly reflects a low level of understanding of the protected area's purpose (Qian et al., 2021). These findings highlight the need to identify appropriate messaging techniques that increase recall and awareness of locally relevant conservation information, and to evaluate reporting of different conservation messaging approaches across other social-ecological systems.

For four of the five aspects of conservation outreach investigated in our study, higher levels of reporting were predicted by male gender and higher education level. These findings are consistent with previous investigation of other patterns of local knowledge about gibbons in communities around BNNR (Turvey et al., 2017; Qian et al., 2021), with correlates of conservation awareness in other social-ecological systems across China and southeast Asia (Allendorf and Yang, 2017; Nyhus et al., 2003), and with other studies demonstrating that education is related to increased awareness of local conservation issues and pro-conservation attitudes (Padua, 1994; Xiong et al., 2016). Improving the overall level of education available in rural village schools around BNNR could therefore improve local conservation awareness, and should be actively encouraged. We also recommend that gender-specific conservation outreach activities should be considered to reduce the observed imbalance in awareness between men and women, although further assessment should also be conducted to identify the primary reasons why they might have different levels of access to information within this system, and whether gender-specific activities might impact local biodiversity in different ways (cf. Xiao and Hong, 2010; Ding et al., 2014). We also note that in landscapes that are biologically and culturally unique, formal schooling that is not locally contextualized could lead to a decrease in awareness of the local environment (Howe et al., 2012; Reyes-García et al., 2010). Practical approaches to maximize local outreach

effectiveness within this and other priority systems could include improving the capacity of educational resources, collaboration between conservation NGOs and researchers with schools, incorporating non-utilitarian values of wildlife (e.g., "pride") into activities, and tailoring programs to account for the demographic, socio-economic and cultural backgrounds of local audiences (Jones et al., 2019; Kidd et al., 2019).

Interviewees in this study were more aware of conservation outreach messages that emphasized prohibited activities within the reserve, rather than messages about the benefits that people might receive from conservation. We lack information on whether more positively or negatively framed messages were originally communicated to local people, so it is not possible to establish which type of framing leads to better retention of conservation outreach messages. Despite this, our results suggest that there is scope to modify dialogue between communities, reserve authorities and conservation organizations about the benefits and costs of conservation. Negative attitudes can be reinforced if messaging focuses on penalties and exclusion from resource use (Ferraro and Pattanayak, 2006), and whilst "wildlife conservation" appears to be a positive outcome, this topic may not encourage favorable attitudes or compliance with regulations if it is associated with disadvantages of living next to protected areas (Chan et al., 2007; Nilsson et al., 2016). Conservation outreach could instead focus on the benefits of successful conservation and the intrinsic value of wildlife and unique local biodiversity, potentially utilizing social marketing approaches (Duthie et al., 2017; Green et al., 2019; Greenfield and Veríssimo, 2019) that have frequently been used in other sectors to alter public perceptions and behaviors (e.g., climate change mitigation, public health; Maibach et al., 2008; Morton et al., 2011), and ensuring clear delivery of messaging to increase overall retention (Novacek, 2009). However, the framing of messages as either positive or negative can be inherently subjective and depends on the target audiences' circumstances, and we advocate for more balanced messages that consider the social-ecological consequences of conservation as a whole.

Our results also show that reserve staff were the most frequently identified group of people associated with conducting outreach. Although nature reserves in China typically have limited resources and reserve staff often have low capacity (Xu et al., 2012; Gao and Li, 2021), reserve staff still play a considerable role in exposing local communities to conservation regulations, and our results highlight the importance of maintaining constructive relationships between reserves and communities (Herrold-Menzies, 2006). Some reserve employees and rangers at BNNR are recruited from local communities, and conservation outreach activities conducted by such community members should be encouraged, since these 'messengers' have been shown to be more trusted and effective communicators (Kidd and Dayer, 2020).

Although the medium of past conservation outreach around BNNR was more widely reported than the message, our results also reveal that whether interviewees reported that conservation outreach had occurred was correlated with their ability to name the Hainan gibbon as a threatened species, and to free-list species they perceived as threatened in Hainan but not elsewhere in China. Indeed, whereas the giant panda is arguably the most famous conservation icon in China, appearing frequently in national media (Buckingham et al., 2013; Huang and Wang, 2020), more interviewees around BNNR free-listed Hainan gibbons than giant pandas when asked about threatened Chinese species. A similar pattern was shown for interviewee responses about tigers, which have not occurred historically in Hainan (Turvey et al., 2019), but are one of China's twelve zodiac animals and constitute a major focus of national-level conservation efforts elsewhere in China (Tilson et al., 2009). The Hainan gibbon is increasingly promoted as a flagship species of BNNR (Liu et al., 2020) and has been the focus of a range of conservation outreach activities (Qian et al., 2021). Even though overall knowledge of conservation messaging is limited within rural communities in this system, these additional findings provide indirect evidence that past outreach around BNNR has successfully raised the profile of key threatened species. However, educational activities to support Hainan gibbon conservation have included not only village-based education sessions but also construction of permanent billboards and murals displaying gibbon-related information and images (Fellowes et al., 2008; Qian et al., 2021), so it is possible that increased local salience about gibbons might reflect knowledge uptake from these visual displays rather than from direct outreach activities. Indeed, such 'media-rich' environments containing numerous information sources are known to be effective frameworks for improving knowledge in other systems (Zukin and Snyder, 1984). Gibbons are also widely recognized and viewed positively (e.g., as "noble" animals) both within traditional Chinese culture (Van Gulik, 1967; Geissmann, 2008) and within the folklore and indigenous knowledge of Li and Miao communities around BNNR (Turvey et al., 2018), which may further enhance their local salience.

The relative salience of other free-listed species provides further insight into local perceptions and conservation outreach. Wild boar and macaque, the next-highest named species for Hainan and China, are both listed as Least Concern by IUCN (2020) but are protected nationally as Category II species (Standing Committee of the National People's Congress, 2018). The higher salience of these species might also reflect the fact that both are still seen relatively regularly around BNNR (Turvey et al., 2019), whereas species that formerly occurred in the local landscape but have experienced earlier declines and are now already extremely rare and hard to detect (e.g., black bear, clouded leopard; Lau et al., 2010) might have lower salience due to personal and generational amnesia of past ecological conditions, or shifting baseline syndrome (Papworth et al., 2009; Turvey et al., 2010). Notably, the Critically Endangered Chinese pangolin was once an abundant and economically important target species for local hunting and trade around BNNR, but is now very rare (Nash et al., 2016; Wang et al., 2021); this species was mentioned by only two interviewees for Hainan and one interviewee for China, despite the increased focus on pangolins in conservation awareness-raising campaigns and media in China (Harrington et al., 2018). Many other threatened Hainanese species that are also the focus of regional conservation efforts were not mentioned at all, including native turtle species, Eld's deer (*Rucervus eldii*), and Hainan peacock pheasant (*Polyplectron katsumatae*) (IUCN, 2020).

This generally low level of knowledge about wider threatened biodiversity highlights further opportunities for local awareness-raising. Advertising research has demonstrated that focusing on one issue or item in marketing campaigns can unintentionally reduce the uptake of information on wider topics (Alba and Chattopadhyay, 1986; Jin et al., 2008). Instead of focusing only on the Hainan gibbon, a 'flagship fleet' approach might therefore be more effective to raise local knowledge and support for conserving Hainan's unique but threatened biodiversity

(Veríssimo et al., 2014). Selection of locally appropriate species to create a flagship fleet requires careful consideration (Bowen-Jones and Entwistle, 2002; Veríssimo et al., 2014), and we recommend that while additional taxa (e.g., native birds, turtles, ungulates, and carnivores) could also be included in conservation outreach, it is important that the localities of any species vulnerable to trade should be concealed to prevent further exploitation (Meijaard and Nijman, 2014). Our data on local awareness and salience of threatened species around BNNR provides a quantified baseline to guide such future conservation outreach activities.

We acknowledge that our study may not be demographically representative of the entire local population around BNNR (e.g., people who have left the villages for elsewhere). As we do not know who within the villages were exposed to past awareness-raising, we are also not able to assess direct recall of conservation outreach activities, versus possible variation in levels of exposure to past activities. Indeed, some of our results could also be interpreted as evidence of demographic variation in outreach exposure; for example, higher levels of reporting predicted by men could suggest that past activities might have preferentially targeted them, possibly because men can have a higher willingness to interact with outsiders in rural China (Ratigan and Rabin, 2020). Having a more gender-balanced approach to sampling and outreach would build a more inclusive foundation for resilient local governance of protected areas (Baral and Stern, 2010). However, our insights remain informative for regional conservation management, since the target audience for future outreach will be people who still live in these communities and who will be most likely to engage with outside actors. Because the lack of robust studies evaluating the effectiveness of conservation interventions limits the usefulness of evidence to practitioners (Christie et al., 2020), assessments of local knowledge of past conservation outreach, even in the absence of details of such activities, can thus still be valuable for conservation management.

5. Conclusions

Effective communication through outreach activities can be a powerful way to engage local communities in conservation (Bickford et al., 2012; Nilsson et al., 2016). Indeed, recall of past awareness-raising is shown to be associated with positive attitudes towards species conservation in other systems (Howe et al., 2012), making it important to ensure a longer impact for outreach activities beyond the duration of a single event. Communication techniques should be chosen carefully based upon conservation objectives, and guided by research into how both the message and the medium can impact the outcomes, with effective measurement of both of these aspects conducted to improve evaluation (Duthie et al., 2017; Giannetta, 2018). Evaluation is especially important since existing studies of outreach messaging show that many factors can impact attitude and behavioral change (Howe et al., 2012; Smith and Sutton, 2008; van der Ploeg et al., 2011). We demonstrate that quantifying salience of wildlife species also constitutes an effective approach for revealing gaps in local knowledge and providing directions for conservation action, especially in areas undergoing rapid environmental change and biodiversity loss. Conservation practitioners must continue to improve their communication techniques, especially given the recognized shortfall in social marketing skills and training opportunities within the conservation sector despite their widely perceived importance (Green et al., 2019; Kidd et al., 2019). Overall, conservation outreach must engage more actively with theories and empirical evidence available from other disciplines to become more effective, and maximize its ability to support positive change for biodiversity.

Credit author statement

HM, **SKP**, and **STT**: conceptualization, methodology; **HM** and **JQ**: data collection, data curation; **HM**: formal analysis, visualization; **HM**,

SKP, and **STT**: original draft preparation, review and editing.

Data availability

The datasets collected during this study are available from the corresponding author upon request. Data are not publicly available because they contain potential sensitive information on the interviewees' location, behavior, and personal opinions that may compromise their identities and safety. Research was approved by Royal Holloway University of London's Research Ethics Committee (ID 535).

Author contributions

HM, SKP, and STT designed the study. HM and JQ conducted fieldwork. HM, SKP, and STT wrote the manuscript.

Ethics approval

Survey design was approved by Royal Holloway University of London's Research Ethics Committee (ID 535).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvman.2022.114716.

The authors declare no conflicts of interest.

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