Sanitation is the greatest concern in outdoor cat management but ecological message frames promote biodiversity conservation in Japan

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Summary

Message framing contributes to an increase in public support for invasive species management. However, little is known about people's preferences for the multiple objectives of management within different contexts relating to the challenges and benefits of invasive species management. We examine Japanese citizens' preferences for the goals of free-roaming unowned cat (*Felis catus*) management in three contextual frames by applying experimentally controlled information and the best–worst scaling technique. Our results indicate that the ecological frame highlighting the ecological impacts of free-roaming unowned cats on native ecosystems significantly increases Japanese citizens' concern about cat predation, although the frame did not change the preference ranking of goals. There are differences in the effects of message framing depending on cat ownership. The best–worst scaling technique shows that Japanese citizens prefer to maintain a sanitary environment, followed by the prevention of zoonotic diseases. Although the ranking of sanitary environmental management does not depend on cat ownership, the ranking of the other goals differs depending on cat ownership. The findings highlight the importance of strategic message framing and its prioritization in encouraging public support for invasive species management.

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Introduction

Invasive species exert significant pressures on native ecosystems worldwide. Biodiversity conservation has been the primary reason for invasive species management since the Convention on Biological Diversity (United Nations 1992). However, invasive species management has several benefits beyond biodiversity conservation (Roberts et al. 2018, Hanley & Roberts 2019), such as in human health and well-being (Halfmann et al. 2020) and on the local economy (McNeely 2001, McNeely et al. 2001). Despite these benefits, invasive species management remains controversial; for example, the lethal management of species tends to raise ethical concerns (Lauber et al. 2007, Perry & Perry 2008).

Free-roaming unowned cats (*Felis catus*; hereinafter 'outdoor cats') are an illustrative example of an invasive species. Outdoor cat management has significantly contributed to improved biodiversity conservation (e.g., Lowe et al. 2000), public health (e.g., Toukhsati et al. 2012) and human well-being (e.g., Halfmann et al. 2020). Management may also enhance cat welfare because outdoor cats face hazards such as parasites and infectious diseases, traffic accidents and injury from living in car engines or storm drains (e.g., Loyd et al. 2013, Seo et al. 2021). In contrast, outdoor cat management can have a negative impact on human well-being. Interactions with free-roaming and unowned cats can relieve people's stress and improve human health (e.g., Barker & Wolen 2008, Levy & Crawford 2004). Cats can also contribute to killing pests such as mice.

Because cats are originally human companion animals, effective outdoor cat management requires public support (e.g., Lewis et al. 2019, Shackleton et al. 2019). However, owing to both the positive and negative impacts of outdoor cat management, this leads to difficulty in building consensus regarding outdoor cat management among stakeholders, thereby impeding public support for outdoor cat management, and hence impacting its effectiveness (McNeely 2001, McNeely et al. 2001). Moreover, policymaking that disregards public opinion may cause issues in outdoor cat management implementation, such as unforeseen costs, delays and public opposition to invasive species management (Estévez et al. 2015, Crowley et al. 2017). Therefore, policies and strategies for outdoor cat management must consider ways to build

support for conservation based on citizens' preferences; thus, policymaking should depend not only on natural scientific evidence but also on social scientific evidence (McNeely 2001).

Recently, the application of message-framing strategies has attracted attention as a means of encouraging public support for conservation (Fernández-Llamazares & Cabeza 2018, Reddy et al. 2020). In practice, such an application has the advantage of achieving better outcomes without regulating individual choices (Kusmanoff et al. 2020). According to Kusmanoff et al. (2020), message framing highlights various aspects of an issue and its context and influences people's choices and behaviours by providing information. For example, alternatively framing climate change as a public health or national security issue rather than an environmental one could increase citizens' support for measures to address climate change (Myers et al. 2012), as people could recognize the issue as substantively different through the framing approach (Druckman 2001). Moreover, framing the message in terms of public concerns rather than management concerns could theoretically contribute to increasing public engagement with conservation (Entman 1993, Rhee 1997). Empirical studies have revealed that message framing concerning the health and safety benefits of keeping cats indoors has encouraged cat owners to keep cats inside (MacDonald et al. 2015, McLeod et al. 2017). However, other studies have argued that more careful messaging should be developed to avoid unintended consequences (e.g., Wald & Peterson 2020). Walsh (2021) noted that effective message framing requires appropriate targeting strategies that adjust messages to take into account, for example, people's backgrounds and original interests.

In Japan, outdoor cats have been managed in limited areas, such as biodiversity hotspots and local areas in which the local government and non-profit organizations are working vigorously on the outdoor cat issue. Thus, Japan has many areas where outdoor cats are not managed. Moreover, although most Japanese cat owners living in urban areas keep their owned cats inside (Hall et al. 2016), there are many stray and feral cats (i.e., free-roaming unowned cats), especially in non-management areas. However, there has recently been a growing awareness of the issues associated with outdoor cats in Japan, especially on islands (e.g., Mameno et al. 2017, Mitsui et al. 2018, Glen & Hoshino 2020), and zoning management has been the primary strategy applied for outdoor cat management (Mameno et al. 2017, Ministry of the Environment 2018). In non-residential areas of isolated biodiversity conservation hotspots, environmental managers attempt to eradicate outdoor cats, as they are a significant threat to rare and endemic native species. However, there is no consensus on how to manage Japanese outdoor cats for biodiversity conservation, even at World Heritage sites (Ministry of the Environment 2020). Moreover, although outdoor cats in non-hotspot areas may affect biodiversity maintenance (Lepczyk et al. 2004), few outdoor cats are managed to conserve biodiversity in urban and residential areas. In these areas, outdoor cats are actively managed to improve human well-being, as local residents desire the prevention of soiling of the environment with cat excreta (Mameno et al. 2017). These unowned outdoor cats in residential areas are generally managed using the trap–neuter–return (TNR) method. However, the issues caused by returned cats raise controversy between cat owners and non-owners in Japan (Mameno et al. 2017); for example, returned outdoor cats contribute to the degradation of the sanitary environment, spread disease and depredate native wildlife. Additionally, TNR may be undesirable for cat welfare (Seo et al. 2021). For example, many outdoor cats have health problems such as alopecia, gingivitis, anaemia and feline

immunodeficiency virus (FIV) in Japan. Therefore, an outdoor cat management strategy is needed that includes effective communication and applies a message-framing strategy in Japan.

Given the many benefits and challenges of invasive species management, it is necessary to consider people's preferences for multiple objectives of management within multiple contexts. In this paper, we examine citizens' preferences for the goals of outdoor cat management in Japan regarding three contextual frames while evaluating the effects of cat ownership on preferences. In addition to the Control (minimum information), the ecological frame highlights information regarding the ecological impacts of outdoor cats on native ecosystems (hereinafter, 'Ecology'), whereas the risk frame highlights the risks posed by the outdoors to cats' welfare (hereinafter, 'Risk'). To elicit preferences, we applied the stated preference approach known as the best–worst scaling (BWS) technique, which was developed in the fields of marketing and economics (Finn & Louviere 1992, Louviere et al. 2015) and has since been applied to conservation and environmental issues (e.g., Tsuge et al. 2014, Kubo et al. 2018, Tyner & Boyer 2020, Shoji et al. 2021); however, its application to invasive species management has been limited.

Methods

Best–worst scaling design

We applied the BWS technique of Finn and Louviere (1992). The objective case (Case 1) of this technique is suitable for our study because, in this case, the alternatives are objects, such as opinions and attitudes (Louviere et al. 2015). The BWS technique elicits citizens' preferences and uncovers clear differences amongst management goals as participants select the best and worst alternatives amongst multiple-choice answers in questionnaires (Louviere et al. 2013). For example, consider a choice set of three goals from which a respondent chooses their most and least preferred goals. The choice set comprises Goal A, Goal B and Goal C of invasive management, and the respondent prefers Goal A the most and Goal C the least. In this case, we can obtain information regarding all possible paired comparisons ($_3C_2 = 3$ pairs): Goal A > Goal B, Goal B > Goal C and Goal A > Goal C.

This study focuses on the following four categories of outdoor cat management goals: (1) biodiversity conservation; (2) prevention of zoonotic diseases; (3) maintenance of sanitary environments; and (4) improvement of cat welfare. The biodiversity conservation goal is to prevent cat predation on wildlife; the prevention of zoonotic diseases goal is to protect humans from zoonotic diseases, such as a *Toxoplasma gondii* infection; the maintenance of sanitary environments goal is to eliminate the issues caused by cat excreta and their dispersing of garbage; and the enhancement of cat welfare goal is to protect cats (including free-roaming pets) from traffic accidents and infections, such as FIV. We assumed a non-correlation with preferences for each goal because most respondents were unaware of the biological relationship between cat faeces and zoonotic disease (e.g., Andiappan et al. 2014). Based on insights from previous studies and the existing methods of cat management strategies in Japan (Mameno et al. 2017, Mameno & Kubo 2021), we assumed the use of non-lethal options for cat removal in our BWS scenario.

Because the results may be affected by the form of the multiple-choice questions of this study, an essential aspect of the BWS questions is determining the design of the questions that are presented to the respondents. In this study, we applied a balanced incomplete

Table 1. Conversion from a balanced incomplete block design (BIBD) to the choice sets. *Note:* 'A' appears in three choice sets on the left side of the table (the first, third and fourth choice set). In these three choice sets, 'A' is compared two times each against each of the other goals (i.e., 'B', 'C' and 'D').

BIBD				Choice sets			
1	A	B	C		1	Biodiversity conservation	Prevention of zoonotic diseases	Maintenance of sanitary environment
2	B	C	D	⇒	2	Prevention of zoonotic diseases	Maintenance of sanitary environment	Improvement of cat welfare
3	C	D	A		3	Maintenance of sanitary environment	Improvement of cat welfare	Biodiversity conservation
4	D	A	B		4	Improvement of cat welfare	Biodiversity conservation	Prevention of zoonotic diseases

Table 2. Information that was provided to each group.

Control	Ecology	Risk
None: minimum information about answering the BWS questions	'Outdoor cats catch wildlife, including endangered species. For example, in the Ogasawara Islands, cats prey on a rare bird, the red-faced spotted pigeon, which is listed as 'Endangered' on the International Union for Conservation of Nature's Red List of Threatened Species'	'Outdoor cats face risks. For example, cats can be in a traffic accident, fight with other outdoor cats or get infected with a virus. Feline immunodeficiency virus is especially prevalent in Japan, where nearly 30% of cats are infected with it'

BWS = best–worst scaling.

block design (BIBD) to compare each goal (for details, see Raghavarao & Padgett 2005). The BIBD enables each alternative to appear an equal number of times; each alternative is equally compared with each other alternative across all choice sets (Table 1). In applying the BIBD, four choice sets composed of three attributes were constructed. In the BWS questions, respondents were asked to select a single most desirable goal and a single least desirable goal of outdoor cat management (Supplementary Box S1, available online).

We randomly assigned the respondents to three groups in order to evaluate the impact of message framing (e.g., McLeod et al. 2017, Shannon et al. 2019, Mameno et al. 2020). The Control was not framed, and the respondents answered the BWS questions without any information. Ecology included messages framing the ecological impacts of outdoor cats and Risk included messages framing the risks posed by the outdoors to cats' welfare. The message provided for Ecology was that outdoor cats pose substantial threats to biodiversity by preying on wildlife, including rare species. The message provided for Risk was that outdoor cats face serious risks, such as traffic accidents, cat fights and viral infections (Table 2).

Econometric analysis

We applied the maximum difference (MaxDiff) model for the econometric analysis (Appendix S1; Finn & Louviere 1992, Tsuge et al. 2014, Louviere et al. 2015, Tyner & Boyer 2020). In our analysis, each management goal was included as a dummy variable. Hence, the utility parameter for the 'sanitary environment' was set to zero for identification in order to avoid multicollinearity. The estimated results of each coefficient represent valuations relative to the variable of the sanitary environment. Based on the estimated coefficients, we also estimated the choice probability of each management goal (i.e., the ratio of each attribute chosen as the best among the four attributes; see Appendix S1, Equation 3). Given the different preferences between cat owners and non-owners (e.g., Mameno et al. 2017), in addition to pooled sample estimation (Model 1), we also estimate the model by dividing it into subsamples of cat owners and non-owners (Models 2 and 3).

Sampling procedure

We posted an online survey in the form of a questionnaire from 17 to 28 November 2016. The survey targets were the nationwide registered prospective respondents of a survey company, which is considered to represent Japan's general public. We recruited the respondents by considering age, gender and residence and received 1675 valid responses to the BWS questions. Some key characteristics of the different respondent groups are presented in Table 3. The socio-demographics of the respondents who were randomly assigned to Control, Ecology and Risk were approximately the same, and each group's characteristics were similar to those of the entire sample population of respondents (analysis of variance test: F value = 0.784, p = 0.457; Table 3).

Results

For the pooled sample (i.e., Model 1: adjusted R^2 = 0.0500; Akaike information criterion per the number of observations (AIC/n) = 3.393), the MaxDiff model coefficients for the variables of biodiversity conservation, zoonotic diseases and cat welfare were estimated to be significantly lower than the sanitary environment variable (Fig. 1). The coefficient for biodiversity conservation was higher than that for the welfare of cats but lower than that for zoonotic diseases. Thus, on average, respondents' preferences for the goal of cat management were as follows: sanitary environment > zoonotic diseases > biodiversity conservation > cats' welfare (Fig. 1).

The ecological framing positively impacted preferences for biodiversity conservation and the prevention of zoonotic diseases but negatively impacted preferences for the improvement of cats' welfare, although the coefficient for the improvement of cats' welfare was not statistically significant (Table 4). Conversely, the interaction term variables for each alternative and the messages regarding the risk to cats in outdoor environments did not have a statistically significant impact.

The choice probabilities for each management goal demonstrated that the maintenance of a sanitary environment was the most frequently chosen attribute, with *c.* 39% of respondents selecting it in the Control group (Fig. 2). Conversely, the rate of selection of the biodiversity conservation attribute significantly increased from 20% to 26% with the ecological message framing.

Furthermore, Model 2 (adjusted R^2 = 0.0169; AIC/n = 3.522) shows that cat owners' preferences differed from those of the pooled sample and non-owners (Fig. 1). In addition, ecological framing significantly impacted cat owners' preferences for all goals

Table 3. Socio-demographic characteristics of respondents.

	Control (n = 564)	Ecology (n = 522)	Risk (n = 589)	Japanese census data (%)[a]
Gender	Male 275; female 289	Male 256; female 266	Male 277; female 312	Male 48.6; female 51.4
Age	20s 88; 30s 129; 40s 123; 50s 96; 60s 128	20s 78; 30s 113; 40s 118; 50s 100; 60s 113	20s 74; 30s 117; 40s 140; 50s 106; 60s 152	20s 10.1; 30s 11.2; 40s 14.5; 50s 13.3; 60s 12.4
Academic background (educational level)	Junior high school graduate 9; senior high school graduate 126; post-secondary technical school 56; college/university graduate 320; master's/PhD degree(s) 53	Junior high school graduate 5; senior high school graduate 136; post-secondary technical school 37; college/university graduate 304; master's/PhD degree(s) 40	Junior high school graduate 6; senior high school graduate 132; post-secondary technical school 66; college/university graduate 343; master's/PhD degree(s) 42	Junior high school graduate 12.0; senior high school graduate 43.3; post-secondary technical school 16.0; college/university graduate/master's/PhD degree(s) 25.2
Cat owner	Yes 71; no but have had a cat 113; no never had a cat 380	Yes 60; no but have had a cat 120; no never had a cat 342	Yes 65; no but have had a cat 115; no never had a cat 409	–

[a]Japanese census data refers to the 2020 Japanese census (https://www.e-stat.go.jp). Gender and academic background information from the Japanese census data include data from those aged >60 years.
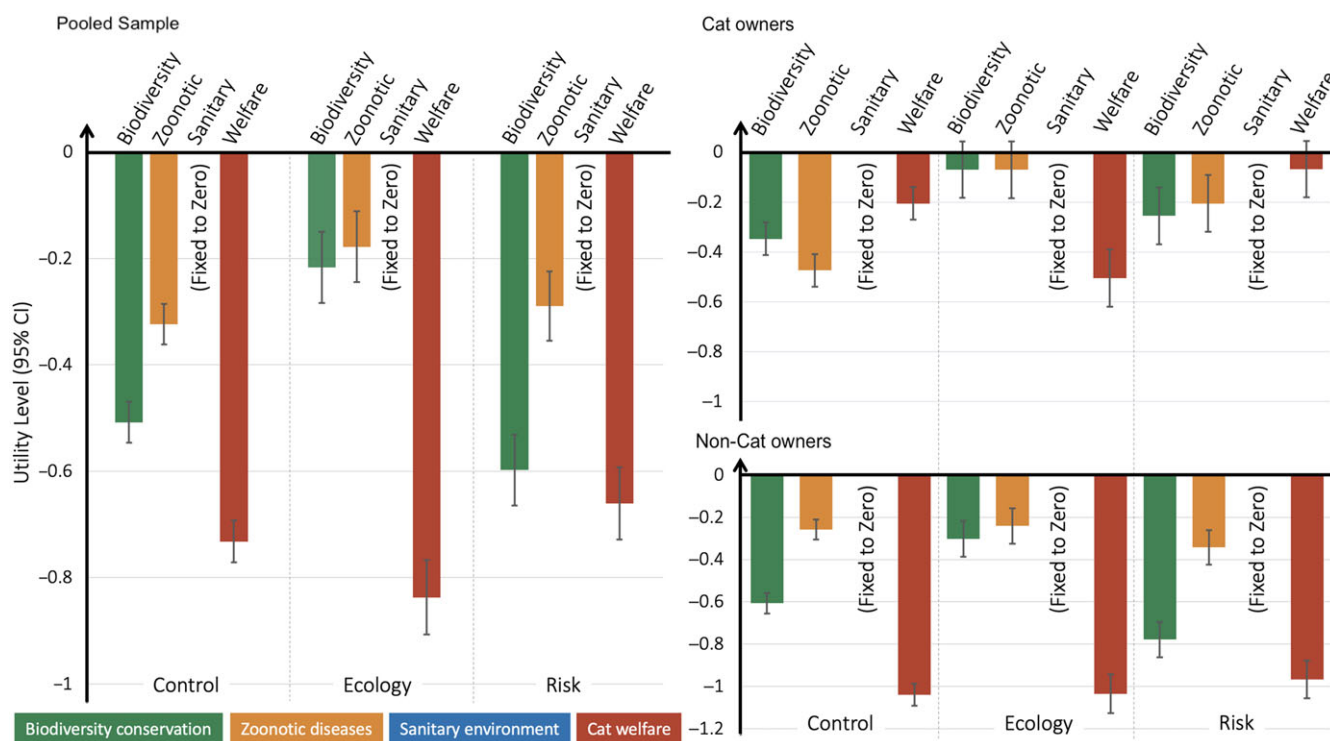

Fig. 1. Maximum difference model results of best–worst scaling for outdoor cat management goals. The average utility for each goal in each group is shown; that is, the utility for each goal in the Ecology and Risk groups was calculated by using the interaction term variables of each goal and information about Ecology and Risk, respectively. The error bars represents standard errors. CI = confidence interval.

and risk framing also positively impacted their opinions regarding zoonotic diseases (Table 4). Thus, in the Control and Risk groups, cat owners' order of choice probabilities for the cat management goal was as follows: sanitary environment > cats' welfare > biodiversity conservation > zoonotic diseases. Alternatively, in the Ecology group, the order of cat owners' choice probabilities was sanitary environment > biodiversity conservation = zoonotic disease > cats' welfare (Fig. 2).

Conversely, concerning the results of the non-owners (i.e., Model 3: adjusted R^2 = 0.0881; AIC/n = 3.253), the trend in results was similar to that of the pooled sample (Fig. 1). Ecological framing impacted preferences positively only for biodiversity conservation, and risk framing had no statistically significant impacts on the preferences for all of the goals (Table 4).

Discussion

The messages framing the ecological impacts of outdoor cats affected respondents' preferences (Table 4). Whether cat owners or not, the respondents in the Ecology group evaluated conservation biodiversity as a more appropriate goal, and the selection of the biodiversity conservation attribute increased by c. 6% (cat owners: 5.8%; non-owners: 6.7%) with the ecological message framing (Fig. 2). Interestingly, the results indicate that ecological message framing has the potential to change the ranking of cat management goals for cat owners. Biodiversity conservation had the second-highest choice probability in the Ecology group. This result is contrary to previous studies suggesting that cat owners tend not to change their attitudes with an ecological framing (e.g.,

Table 4. Estimated results using the conditional logit model. The numbers of respondents (and observations) are 1675 (6700) in Model 1, 544 (2176) in Model 2 and 1131 (4524) in Model 3.

Variable	Model 1 (pooled sample)			Model 2 (cat owners)			Model 3 (non-owners)		
	Coefficient	Standard error	p > |z|	Coefficient	Standard error	p > |z|	Coefficient	Standard error	p > |z|
Biodiversity conservation	-0.508***	0.0385	0.000	-0.348***	0.0654	0.000	-0.606***	0.0484	0.000
Zoonotic diseases	-0.324***	0.0381	0.000	-0.474***	0.0661	0.000	-0.258***	0.0476	0.000
Sanitary environment	0	Set to zero		0	Set to zero		0	Set to zero	
Cats' welfare	-0.732***	0.0395	0.000	-0.206**	0.0651	0.002	-1.04***	0.0519	0.000
Effect of information provision on each parameter variable									
Ecology: biodiversity conservation	0.291***	0.0550	0.000	0.278**	0.0925	0.003	0.304***	0.0693	0.000
Ecology: zoonotic diseases	0.146**	0.0547	0.008	0.403***	0.0931	0.000	0.0169	0.0687	0.806
Ecology: cats' welfare	-0.105	0.0578	0.070	-0.299**	0.0937	0.001	0.00382	0.0755	0.960
Risk: biodiversity conservation	-0.0900	0.0540	0.096	0.0922	0.0924	0.318	-0.172*	0.0680	0.011
Risk: zoonotic diseases	0.0344	0.0532	0.519	0.268**	0.0928	0.004	-0.0840	0.0663	0.205
Risk: cats' welfare	0.0716	0.0550	0.193	0.138	0.0919	0.133	0.0730	0.0715	0.307

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

MacDonald et al. 2015), which could be attributed to the fact that outdoor cats have recently been recognized as a reason for biodiversity loss in Japan. However, the results are consistent with previous studies that uncovered the positive impacts of the ecological framing on respondents' preferences regarding invasive species management (Marzano et al. 2015, McLeod et al. 2017, Mameno et al. 2020, Walsh 2021). Our results indicate that conservation-orientated information significantly increases citizens' concerns regarding outdoor cat threats to biodiversity.

Table 4 presents another interesting effect of ecological framing. Regarding the results for cat owners, their preference for improved cat welfare significantly dropped by as much as 11% with an ecological framing, although it is noted that the results for the coefficients of each variable are not independent (Fig. 2). Therefore, our study suggests that ecological message framing, especially towards cat owners, should be implemented with care regarding the dimension of animal welfare (MacDonald et al. 2015, Glen & Hoshino 2020), although such framing is potentially a powerful tool to encourage public awareness of conservation (Vane & Runhaar 2016, Mameno et al. 2020).

On average, the risk framing concerning cats' welfare outdoors has little effect on respondents' preferences (Table 4). However, the risk framing has different impacts on the preferences for management goals between cat owners and non-owners. Regarding the results for cat owners, the prevention of zoonotic diseases is positively affected by the risk framing; conversely, the risk framing negatively affects non-owners' preferences for biodiversity conservation. This indicates that the results of message framing can depend on the targets of the message framing, suggesting that risk framing towards non-owners could unintentionally reduce biodiversity concerns. Therefore, our findings support those of previous studies that indicate the importance of an appropriate targeting strategy (Kusmanoff et al. 2020, Walsh 2021).

Surprisingly, risk framing had little effect on the preferences for the cat welfare enhancement goal (Table 4). These results are probably related to Japan's unique culture: Japanese people may have already held social norms and beliefs that the outdoors are unsuitable for a cat. In particular, cat owners may recognize the outside as dangerous for cats without any additional information, as the cat welfare enhancement goal represents the second-highest choice probability in the Control group. Therefore, their preferences for the cat welfare goal might not be impacted by information regarding the inherent risks of the outdoor environment. Hall et al. (2016) showed that cat owners who keep their cats indoors consider this to be 'good manners' in Japan. Furthermore, Japanese people often enjoy directly interacting with cats inside cat cafés; therefore, they enjoy them in indoor spaces.

This study has several limitations. First, it excludes the impacts of invasive species on some industries, such as agriculture and fisheries. Serious impacts of invasive species have been reported in some industries (Lovell et al. 2006, Zhao et al. 2006, Paini et al. 2016). Our survey design also had some limitations. For example, because of it being an online experimental survey, our sample only included Internet users. Regarding message framing, we could not implement a pre-test, although the provided information was selected based on an Internet and literature review regarding government and public concerns about cats. Therefore, for effective management without conservation conflicts, further research should address the knowledge gaps that remain, including the impacts of other factors, such as social norms (Walsh 2021).

Our study carries management and/or policy implications. Approximately 35–40% of respondents prefer the maintenance
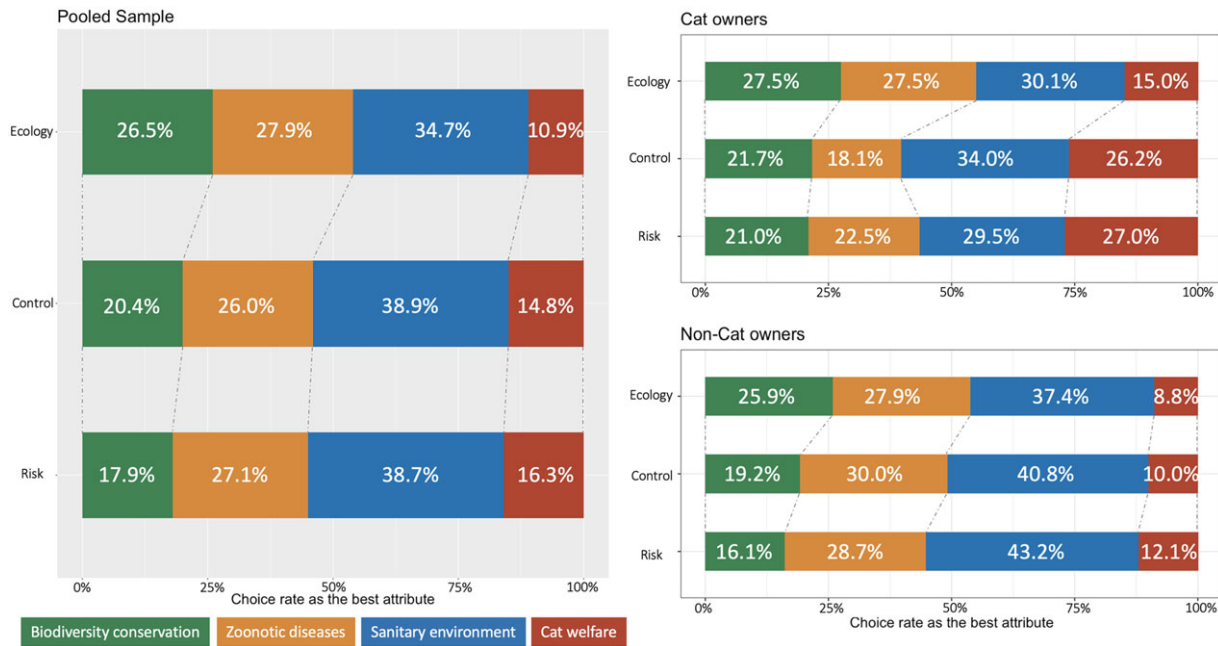
Fig. 2. Rates of choice amongst the four outdoor cat management goals in each group.

of a sanitary environment as the most important goal for outdoor cat management without any message framing; conversely, only 20% of respondents chose biodiversity conservation as the most important goal (Fig. 2). These findings indicate that environmental managers could implement cat management with relative ease when highlighting the maintenance of sanitary environment goals rather than biodiversity conservation; this is because sanitation is of greatest concern for Japanese citizens, and through this managers can easily build consensus on outdoor cat management. However, it should be noted that highlighting the maintenance of sanitary environmental goals may not lead to the eradication of outdoor cats because management can be implemented only when damage to the sanitary environment reaches an unacceptable level (e.g., agricultural damage; Ikeda et al. 2004, Suzuki & Ikeda 2019). Thus, it is necessary to gradually shift management goals and public support towards broader social and natural resource management with stakeholders, such as biodiversity conservation (Lowe et al. 2000) and cat welfare enhancement (Seo et al. 2021). Although it is assumed to be difficult for most citizens to accept biodiversity conservation goals in the current situation (i.e., only 20% of the respondents are in agreement with these goals), communication using ecological message framing can significantly increase public support for biodiversity conservation from both cat owners and non-owners, a goal that would require the eradication of all outdoor cats.

Our findings also highlight the challenges of managing outdoor cats due to them being pets with charismatic characteristics (Jarić et al. 2020). Our findings point to citizens' desire to address problems that are more closely related to themselves, which is similar to the 'not-in-my-backyard' phenomenon, such as the problems caused by large carnivores (e.g., Kubo & Shoji 2014). Even if cat owners were given risk framing, they were still most concerned about the sanitary environment (Fig. 1). However, a previous study indicated that local residents, especially cat owners, prefer for outdoor cats to live in their neighbourhoods, as they provide a feeling of comfort to local residents (Mameno et al. 2017). Thus, people expect outdoor cat issues to be appropriately managed in their neighbourhoods, all while living with nearby outdoor cats. This highlights the paradoxical problem of outdoor cat management.

This study also contributes to the methodological development of social conservation science. Our results demonstrate that the BWS technique can contribute to our understanding of the social prioritization of biodiversity-related issues, which has recently been instrumental for effective conservation with limited human and financial resources (Wilson et al. 2006, Beger et al. 2015). We present clear differences in citizens' evaluations of management goals by applying the BWS technique (Fig. 1). Regarding non-owners, there was a particularly large difference amongst the alternatives that closely involve human lives (e.g., sanitary environments and zoonotic diseases) and the other alternatives, such as biodiversity conservation and animal welfare enhancement. The BWS findings can be applied to the management of other invasive species that pose risks to human health, such as mongooses, raccoons and fire ants. For example, the eradication of the mongoose is required in order to achieve biodiversity conservation at a natural World Heritage site in Japan. In this case, messages regarding human health benefits could contribute to enhancing public support for mongoose management because mongooses have a negative impact on biodiversity as well as human health (Shiokawa et al. 2019). Alternatively, cat owners are more concerned about cat welfare than biodiversity and zoonotic diseases; as such, these results also indicate that the BWS technique clearly demonstrates varying preferences between cat owners and non-owners. In other words, the BWS technique was able to clarify the need for communication strategies tailored to each target. This implies that further studies using the research framework and methods that this study applied could lead to greater understating of these differences and improve the efficiency of outdoor cat management around the world. Cat management and public perceptions of outdoor cats vary between countries, meaning that tailor-made policymaking might be required in each country. Managing cats' urination and defaecation, for example, is not an evident concern in the UK (Crowley et al. 2019), and disease-related risks tend to be of less concern than the risks to biodiversity in the USA (Gramza et al. 2016).

In New Zealand, cat owners are more concerned about feral cat issues regarding biodiversity conservation and diseases to humans than those relating to feral cats being a nuisance to humans (Bassett et al. 2020).

Conclusion

We highlight the importance of carefully developing strategic message framing concerning invasive species management in order to win public support and minimize conflict (Kusmanoff et al. 2020, Wald & Peterson 2020, Walsh 2021). The findings support evidence from Belgium and Israel that the development of strategic communications towards each target is required to achieve effective outdoor cat management (Finkler & Terkel 2012, Ruyver et al. 2021). Our results show that ecological message framing can potentially contribute to increasing public support for biodiversity conservation-related aspects of outdoor cat management from both cat owners and non-owners. This study also demonstrates that the BWS technique can contribute to social conservation science by revealing clear differences in citizens' preferences for multiple cat management goals. We believe that our study contributes to improving efficient invasive species management with limited budgets and human resources.

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