Chapter 3
How to Engage Tourists in Invasive Carp Removal: Application of a Discrete Choice Model

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Abstract Invasive alien species management requires public participation to overcome a lack of human and financial resources in management; however, little is known about the demand for public participation in invasive alien species management. To address this knowledge gap, the present study evaluated demand for management of invasive carp, which is one of the worst but publicity invasive species worldwide. A choice experiment survey was conducted in Amami Oshima Island, Japan to quantify tourists' demand for participating in invasive carp removal in nature-based tourism, and to evaluate the impact of ecological information provision on their preference. The results show most tourists would avoid participating in carp removal activities as a tour option without any financial discounts; however, over 35.2% of tourists were willing to work for carp removal, based on their own motivations. We also found that ecological information encouraged tourists to participate in tours that included carp removal activities. Incorporation of invasive alien species management in nature-based tourism can enhance the economic benefits for local tourism industries. Our findings indicate that tourists could play an important role in invasive alien species management by compensating for a lack of human and financial resources in management.

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O. Saito et al. (eds.), *Managing Socio-ecological Production Landscapes and Seascapes for Sustainable Communities in Asia*, Science for Sustainable Societies, https://doi.org/10.1007/978-981-15-1133-2_3

Keywords Asian carp · Discrete choice model · Information provision · Public engagement

3.1 Introduction

A lack of human and financial resources represents a bottleneck to invasive alien species (IAS) management all over the world, although it is widely recognized that IAS causes biodiversity loss (Didham et al. 2005; Sala et al. 2000). IAS have substantially damaged natural resource-based industries, such as agriculture, forestry, and fishery (Pejchar and Mooney 2009; Pimentel et al. 2005). For some governments and environmental managers, access to human and financial resources in long-term represents one of the biggest challenges for effective IAS management (Gardener et al. 2010; Simberloff et al. 2005).

IAS management programs have considered that public involvement is an essential tool to succeed, since it could overcome the management resources shortage, such as a lack of human and financial resources (Dunn et al. 2018; Gaertner et al. 2016; McNeely 2001). For example, common sun skinks (*Eutropis multifasciata*) were removed by tourists on Green Island, leading to a decrease in skink numbers (Chao and Lin 2017). Based on these results, the Convention on Biological Diversity (CBD) mentioned that citizens were one of the most important players in IAS management (CBD 2014).

In spite of a general agreement on the importance of public involvement toward the success of IAS management, such involvement is still difficult to achieve. Previous literature noted that public apathy toward IAS management represents one of the biggest barriers to public involvement. For example, people who underestimate IAS impacts in Japan tended not to support IAS management (Akiba et al. 2012; Mameno et al. 2017). Thus, public education and information provision could be effective in engaging more people (Bremner and Park 2007; Marzano et al. 2015). Based on these suggestions, some governments have provided relevant information; however, public awareness and public involvement remains insufficient (Dunn et al. 2018). Recently, the focus shifted to indirect approaches, which comprise neither education nor information provision. For example, Morgan and Ho (2018) showed that good tasting carp meat encouraged invasive carp removal.

So far, many previous studies have addressed the public attitude concerning an IAS and the management thereof (Bremner and Park 2007; Mameno et al. 2017; Wald et al. 2018), as well as the estimation of social values from IAS management programs (Nunes and Van Den Bergh 2004; Roberts et al. 2018). However, little research has focused on how to encourage people to participate in IAS management activities. Thus, our study—which uses a tour that comprises carp removal activities—can provide new insights into public engagements in IAS management. This work also extends the knowledge of voluntary conservation approaches. A few studies have focused on such approaches (Durán-Medraño et al. 2017); however, to our knowledge, no studies have addressed tourists' attitudes concerning participation in conservation management.

The present study focuses on invasive common carp (*Cyprinus carpio*) management from the human dimension perspective. The invasive carp is one of the most invasive species, and is nominated as one of "100 of the world's worst invasive alien species" (Kopf et al. 2017; Lowe et al. 2000), since the carp damages the native ecosystem by consuming organisms that are a food resource for native species (Gilligan and Rayner 2007; Morgan and Hicks 2013). Thus, recent conservation literature paid attention to its management (Marshall et al. 2018; Thresher et al. 2014; Uchii et al. 2014); however, social science research on this issue is limited—for example, Morgan and Ho (2018). Interestingly, the carp is a domestic alien species in Japan—it is a native species on the main island, but non-native on some of the small islands (e.g., Amami Oshima Island, which is our research site). Since few people would recognize carp as an IAS in Japan, the sharing of ecological information could play an important role, as suggested by previous literature. Historically, IAS management, including invasive carp, was greatly dependent on chemical and biological methods (Zastrow 2018). Thus, our research contributes to the existing body of knowledge on effective invasive carp management through application of human dimension approaches (Jacobson and Duff 1998; McNeely 2001).

3.2 Study Background and Methods

3.2.1 Research Site

Our research site, Amami Oshima Island, Japan, is part of the Nansei Islands in the southern Japanese archipelago (28°19′N, 128°22′E). The island has the Japan's second largest mangrove forest, which plays an important role in biodiversity conservation (Lugo and Snedaker 1974; Polidoro et al. 2010). In particular, there are endangered and endemic species, such as Ryukyu Ayu (*Plecoglossus altivelis ryukyuensis*), around the mangrove forest (Kishino and Yonezawa 2013; Nishida 1988). Because of its rich biodiversity, the part of the island that includes the mangrove forest is a national park that is expected to become a Natural World Heritage Site. However, the island has substantial IAS concerns, and has been requested by UNESCO, through its designation process, to enhance its IAS management. Local government has attempted to remove common carp so as to improve its management in rivers (Fig. 3.1); however, the success has been limited because of resource constraints, among others.

Nature-based tourism is an important industry on the island. To date, most tourists have enjoyed nature-based and eco-friendly tours, such as canoeing in the mangrove forest and viewing wildlife, in spite of the potential invasive carp impacts on the ecosystem. The canoe tour attracts over 30,000 tourists annually (Kagoshima Prefecture 2019). It is the second most popular recreational activity in the island

Fig. 3.1 Invasive carp captured on Amami Oshima Island

(Ministry of the Environment 2017). Thus, balancing tourism development and biodiversity conservation represents a significant challenge for local government. Based on this background, the present study evaluates tourists' demand for carp removal options as a canoe tour attribute, and discusses the possibilities to compensate for management resource constraints in invasive carp management through nature-based tourism.

3.2.2 Questionnaire Design

In this study, we used a choice experiment (hereinafter, "CE") on canoe tours. The CE approach is one of methods for analyzing preferences through hypothetical choices in a questionnaire survey; it has been applied by many previous studies to nature-based tourism (Kubo et al. 2019; Kubo and Shoji 2016). We used this approach to evaluate tourists' willingness to pay (WTP) for tour options as a means of promoting canoe tours. Using the CE can elicit not only the level of demand for the option of carp removal, but also assess other tour options, such as tour time and fee.

Table 3.1 Attributes and levels for profile design using the choice experiment

Attribute	Levels
Carp removal option	Yes; No
Tour time (min)	60; 90; 120; 150; 180
Pick-up option	Yes; No
Tour fee (JPY)	1000; 2500; 5000; 7500; 10,000

A distributed questionnaire of six pages was used for the CE valuation exercise. Respondents were asked to choose their preferred option from alternative tour scenarios with different combinations of tour options.

In CE studies, it is important to select attributes and levels to create hypothetical scenarios. Based on current tours and discussions with managers on the Amami Oshima Island, this study selected the following attributes and levels to design profiles and choice sets: *Carp Removal option*, *Tour Time*, *Pick-up option*, and *Tour Fee*. *Carp Removal option* refers to catching carp using fishing nets before and/or after the canoe tour. *Pick-up option* refers to picking up tourists at their accommodations and taking them to recreation sites. In the island, recreational sites are located far from towns and the airport. Thus, tourists have to drive themselves to recreational areas or use a bus service, which only operates every few hours. These four characteristics, and possible choices for each, are listed in Table 3.1.

The respondents were asked to choose from three tour options under the hypothetical scenario. The scenario implied that new attributes of canoe tours (i.e., *Carp Removal option* and *Pick-up option*) could be implemented, and the levels of existing attributes (i.e., *Tour Time* and *Tour Fee*) could be changed to encourage the use of canoe tours.

Considering the scenario, we designed profiles and choice sets based on D-efficiency. The D-efficient design is able to minimize the distribution of estimated parameter, which contributes to efficient parameter estimations (Huber and Zwerina 1996). To mimic actual tour choice situations (Haaijer et al. 2001), we created choice sets that consist of "not attending tour" as well as two selected profiles (an example of choice set is shown as Fig. 3.2); we then created six patterns of a questionnaire with five choice sets each, and provided each respondent with one randomly selected questionnaire.

In addition, two types of questionnaires were used to assess the impact of information provision, namely, to understand differences between the preferences of respondents who recognized carp as an IAS, and those who did not. The information that "*Carp are an IAS and cause serious damage to the native unique ecosystem on Amami Oshima Island; this option contributes to the conservation of ecosystems*" was provided to some respondents only, and not to the rest. Respondents without this ecological information could have knowledge of invasive carp impacts. However, our study investigated the impact of information provision by focusing on the difference in attitude toward preference for tours between respondents with information and without information.

	Tour 1	Tour 2	Non-attend the tours
Carp Removal option	Yes	No	
Tour Time (minutes)	60	150	
Pick-up option	Yes	No	
Tour Fee (JPY)	5000	2500	
	↓	↓	↓
Please circle the answer ⇒	1	2	3

Fig. 3.2 Example of a choice set using a choice experiment. In the choice experiment, we showed three profiles (two profiles with different levels for the four attributes, while another profile is nonattendance) to each respondent, and repeated this task five times

3.2.3 Data Collection

The tourist questionnaire survey was conducted with randomized distribution at the Amami Airport on Amami Oshima Island in August 2017. Nine hundred and twenty-four questionnaires were distributed to tourists, of which 343 questionnaires were returned by mail (the response rate was 37.1%); of these, 12 contained no answers to any of the choice experiment questions and were thus omitted from analysis. We ultimately used data of 331 respondents, and 1608 choice sets contained answers to all relevant questions. Of the about half of respondents ($n = 175$) were provided ecological information, and 68.0% of respondents were female ($n = 217$). The most represented age group was between 40 and 49 years of age ($n = 92$), followed by respondents between 30 and 39 years of age ($n = 84$).

3.2.4 Econometric Model

To analyze the tourists' preferences, we used a model based on random utility theory (McFadden 1974), which comprises an observable deterministic component and an unobservable random component. According to this model, each individual's utility (U_i) of alternative i can be described as a function of an observable component (V_i) and an unobservable random (error) component (ε_i):

$$U_i = f\left(V_i, \varepsilon_i\right) = V_i + \varepsilon_i \tag{3.1}$$

The alternative i was chosen by the individual if $U_i > U_j$ for all $j \neq i$. Thus, the probability that the respondent chooses the alternative i from choice set C is:

$$P_i = \Pr\left[U_i > U_j\right] \quad \forall j \neq i, \quad \forall j \in C$$
$$= \Pr\left[V_i + \varepsilon_i > V_j + \varepsilon_j\right] = \Pr\left[V_i - V_j > \varepsilon_j - \varepsilon_i\right] \tag{3.2}$$

The probability of choosing alternative *i* is able to be written the following equation if each ε_i is assumed to distribute with a type I extreme value distribution,

$$P_i = \frac{\exp\left(V_i\right)}{\sum_{j \in C} \exp\left(V_j\right)} \tag{3.3}$$

While we estimated the results using both a conditional logit (CL) and a random parameter logit (RPL) models, in the present study, the results of only the RPL models were represented. That was why the results of the RPL models were superior to those of the CL as followers. First, RPL models do not require fulfilling the independence of irrelevant alternatives (IIA) condition, which is required by the conditional logit model. In addition, previous studies showed that tourists had preference heterogeneity (Kubo et al. 2019; Mejía and Brandt 2015) for nature-based tours, which is accommodated by RPL models.

According to Hensher et al. (2015), in RPL models, V_{nit} on the Eq. 3.3 is showed the following form using the individual *n*, choosing alternative *i* and period *t*:

$$V_{\text{nit}} = \beta_n' x_{\text{nit}}$$
$$\beta_n = \beta + \Delta Z_n + \Gamma \nu_n \tag{3.4}$$

where β indicates the population mean of the coefficient of random parameters; ΔZ_n indicate observed preference heterogeneity; on the other hand, unobserved preference heterogeneity is showed in $\Gamma\nu_n$; x_{nit} is the attributes in choice set which respondents are asked. This model can incorporate unobserved and observed preference heterogeneity through the random terms in the distributions of parameters (Hensher et al. 2015). We are able to calculate the expected probability using multivariate probability density function of β:

$$E_n = \int P_n(\beta) \cdot f\left(\beta | \Omega\right) d\beta = \int \left[\frac{\exp\left(\beta_n' x_{\text{nit}}\right)}{\sum_{j \in C} \exp\left(\beta_n' x_{\text{nit}}\right)} \cdot f\left(\beta\right) \right] d\beta \tag{3.5}$$

The parameter is estimated by simulated maximum likelihood techniques that maximize the log-likelihood function, because the integral of estimating this model does not have a closed form (McFadden and Train 2000; Train 2009).

In present study, we used *Carp Removal option*, *Pick-up option*, *Tour Time* and *Tour Time* squared (*Tour Time*^{2}), *Tour Fee*, and an alternative-specific constant (ASC) as explanatory variables: x_{nit}, and as observed preference heterogeneity, we incorporate the dummy variable of information provision that is if respondents were provided ecological information, the variable is set to 1. The dummy variable of information provision was incorporated as a cross-term with other attributes except for *Tour Fee* (i.e., *Carp Removal option*, *Pick-up option*, *Tour Time* and *Tour Time*^{2}). By following existing literature in applied economics, preference for the *Tour Fee* (i.e., money) was supposed not to be affected by the information (e.g., Das et al. 2009; Hole and Kolstad 2012; Layton and Brown 2000; Morey and Rossmann 2003; Revelt and Train 1998; Scarpa et al. 2008). The ASC variable was set to 1 if respondents chose not to attend the canoe tour (i.e., selected choice 3 in choice set), and the ASC variable was set to 0 if respondents selected to attend the canoe tour (i.e., selected choice 1 or 2 in choice set). This model needed to make assumptions about the distributional form of the coefficients of each attribute. Except for *Tour Fee*, all variables were assumed to be normally distributed.

In addition, the marginal willingness to pay (MWTP) is able to be calculated by using the estimates for each coefficient as following equation (Haab and McConnell 2003):

$$\text{MWTP} = \frac{\beta_{\text{attribute}}}{\beta_{\text{Tour Fee}}} \tag{3.6}$$

Note that the WTP for both *Carp Removal option* and *Pick-up option* attributes was calculated by doubling the MWTP since the attributes were effect-coded (Louviere et al. 2000).

3.3 Results

Table 3.2 presents the estimated results of the RPL model. We applied the effect code to the dummy variables concerning *Carp Removal option* and *Pick-up option*. Thus, the relative values of coefficient are important instead of the absolute values. Table 3.2 shows the mean of coefficients, standard deviations of the random coefficients, and the effect of ecological information on each random parameter variables in the RPL models, with their standard errors. The standard deviations for each of the random coefficients indicate the heterogeneity of individual preferences relative to the preference of the population.

Table 3.2 indicates that the mean of the *Carp Removal option* coefficient is significantly negative (Coefficient = −0.366; SE = 0.131) at the 99.9% level: *Carp Removal option* decreased the probability of choosing canoe tours. However, standard deviations for *Carp Removal option* are also statistically significant: there is preference heterogeneity for *Carp Removal option* (Fig. 3.3). The mean of the respondents' WTP for *Carp Removal option* was −988 JPY (100 JPY = about 0.9 USD and 0.8 EURO in November 2019). The other variables' coefficients are also significant at over 95% levels, except for ASC. The coefficient of *Pick-up option*

Table 3.2 Estimation results using the random parameter logit model

Variable	Random parameter model: Mean of coefficient (S.E)	Random parameter model: Standard deviation of coefficient (S.E)
Random and nonrandom parameters in utility function		
Carp removal option	−0.366 (0.131)***	1.01 (0.112)***
Tour time $*10^{-1}$	0.395 (0.136)***	0.00112 (0.0374)
Tour time^2 $*10^{-4}$	−1.52 (0.586)***	0.986 (0.117)***
Pick-up option	0.405 (0.110)***	0.719 (0.107)***
Tour fee $*10^{-3}$	−0.741 (0.0514)***	–
Non-attendance (alternative-specific constant)	−1.25 (0.818)	2.52 (0.329)***
The effect of ecological information on each random parameter variable		
Carp removal option	0.403 (0.176)**	
Tour time $*10^{-1}$	−0.0283 (0.177)	
Tour time^2 $*10^{-4}$	−0.324 (0.768)	
Pick-up option	0.0138 (0.146)	
Non-attendance (alternative-specific constant)	0.0273 (1.08)	
Number of observations	1608	
Log likelihood	−1243.10	

Simulated maximum likelihood was conducted using Halton draws with 1000 replications
Please, see Train 2003 for details on Halton draws
Carp Removal option: availability of options for carp capture; *Pick-up option*: collection and transport to the recreational site by guides; *Tour Time*: duration of tour (h); *Tour Time*^{2}: *Tour Time* squared; *Tour Fee* (JPY). *Carp Removal option* and *Pick-up option* were applied effect coding; *Tour Fee*, *Tour Time*, and *Tour Time*^{2} were normalized
$***p < 0.001$, $**p < 0.01$, $*p < 0.05$

and *Tour Time* is positive, on the other hand, the coefficients of *Tour Time*^{2}, *Tour Fee* are negative. While standard deviation of *Tour Time* coefficient is not significant, the other variables' standard deviation of coefficients is also significant: there is preference heterogeneity.

Table 3.2 also shows the effect of ecological information provision, and they are not significant except for *Carp Removal option*. The coefficient of the effect of ecological information on *Carp Removal option* is significantly positive (Coefficient = 0.403; SE = 0.176), namely, information provision dramatically increased the probability of choosing canoe tours including carp removal (Fig. 3.3). The coefficient of *Carp Removal option* for respondents who were provided with information could be calculated through addition of the coefficient of *Carp Removal option* and the effect of ecological information on *Carp Removal option*, which had a positive result (Coefficient = 0.0368). Therefore, the utility of respondents had ecological information became positive if the option for carp removal was added to canoe tours, and the mean WTP for *Carp Removal option* by respondents who had ecological information was estimated at 99.3 JPY.

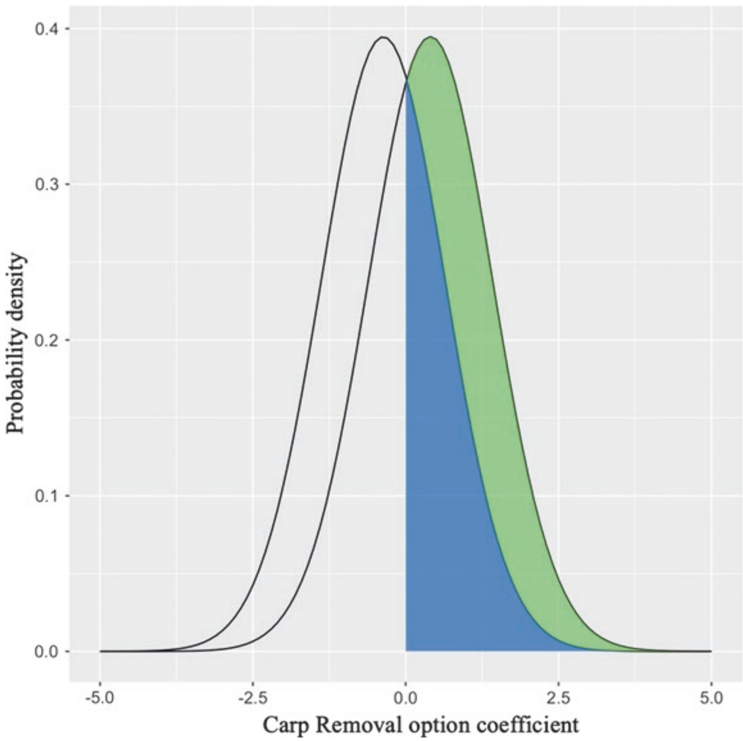

Fig. 3.3 Results of the random parameter logit model. The range of "Blue" indicates the probability density of respondents without ecological information that answered positive to *Carp Removal option*. On the other hand, the range of "Green" indicates that providing ecological information made the increasing probability density of respondents who answered positive to *Carp Removal option*. Even though respondents had no ecological information, a part of the respondents (Blue) answered positive to *Carp Removal option*. When respondents were provided ecological information, over half of the respondents (Blue and Green) answered positive to *Carp Removal option*

3.4 Discussion and Conclusion

Public participation is an essential enhancement to IAS management, since it can compensate for the shortages of human and financial resources (Jenkins 1999; Lepczyk 2005; Trumbull et al. 2000); however, few studies have addressed the potential roles of tourists, although most of them visit wilderness areas such as national parks. We applied a discrete choice model to invasive carp management on Amami Oshima Island, Japan, to quantify tourists' demand for participating in the carp removal program as a tour option. The results indicate that 64.2% of tourists who were not provided ecological information, about 100 tourists would avoid participating in carp removal activities as a tour option without any financial discounts when they have no ecological information (Table 3.2). In other words, on average, tourists with no information are indifferent to whether they participate in carp removal activities if they received a 988 JPY discount for a tour. This finding suggests that an additional IAS management option could decrease the number of tourists without any discounts, although preference heterogeneity should be discussed in more detail, which is described as follows. On the other hand, given the preference heterogeneity concerning the carp removal option by RPL models, 35.8% of tourists were willing to work for carp removal owing to their own motivations. Some tourists regarded carp removal as a tour activity, even when they were not provided with any ecological information (Fig. 3.3, Blue). This implies that a part of their preference heterogeneity could be derived from their original knowledge of and interests in nature and invasive management. This result also supports the view that tourist involvement could help to overcome the cost challenges of IAS management.

Although few studies have addressed IAS management as a tour activity, our finding is contrary to previous studies which have shown positive public support for IAS management. For example, Nishizawa et al. (2006) estimated the WTP for an eradication program of black bass (*Micropterus salmoides* and *Micropterus dolomieu*) as loading tax in Japan at about 2000 JPY. McIntosh et al. (2010) also showed that the WTP for invasive fish as a donation was about 50 USD. Mejía and Brandt (2015) showed that tourists had a positive WTP for a tour that enhanced IAS management. This contradiction indicates that the public, including tourists, has a motivation for financial support of IAS management; however, most of them are not willing to participate in IAS management, which suggests that human resources could become insufficient compared to financial resources in general.

How do we then engage the public in IAS management? The present study supports the views of previous literature by showing that the provision of ecological information affects tourists' preference for carp removal activities in a tour (Bremner and Park 2007; Marzano et al. 2015). Tourists who received ecological information have a positive WTP (99.3 JPY) for participation in carp removal activities, which is 1087 JPY more than tourist who had no ecological information. In other words, provision of ecological information enables tour operators to receive a tour premium for including IAS management opportunities. This suggests that information provision leads to a win-win situation by enhancing IAS management while satisfying tourists' demands and increasing tour operators' profits. Recent tourism literature highlights that balancing conservation and the local economy through nature-based tourism is becoming increasingly important (Kubo et al. 2019). We demonstrated that this approach can even succeed in IAS management by sharing ecological knowledge with the public, as described in conservation literature (Akiba et al. 2012; Bremner and Park 2007; Dunn et al. 2018; Mameno et al. 2017; Marzano et al. 2015).

The other attributes concerning canoe tour design are also important for tourists' decision-making and their involvement in carp removal activities. As shown in Table 3.2, tourists prefer to participate in tours of intermediate duration (i.e., about 120 min), and in tours that offer a pick-up option. These findings indicate that tourists are more encouraged to participate in a tour by adjusting the levels of the attributes of tour time and pick-up options, regardless of a carp removal option. Previous work by Morgan and Ho (2018) indicated that indirect approaches, which are not directly related with IAS management, are important. The present findings support their view of such indirect approaches, even in invasive carp removal management, and outline a new approach based on the use of nature-based tourism.

Our research site, Amami Oshima Island, is expected to be designated as a Natural World Heritage Site. Thus, IAS management has been paid more attention recently; however, a lack of resources has limited the implementation of IAS management. Our findings indicate that nature-based tourism which combined with the sharing of ecological knowledge with stakeholders, as well as indirect approaches, achieves sustainable IAS management.

Acknowledgement We acknowledge financial support from the Japan Society for the Promotion of Science (No. 16K00697), and the Ministry of the Environment, Japan (the Environmental Economics and Policy Study, and ERTDF (S-15: Predicting and Assessing Natural Capital and Ecosystem Services (PANCES)). We would like to express our gratitude to Oki, K, and the tourists who responded to the survey. We also thank an editor and reviewers for helpful comments on the previous manuscript.

References

Akiba H, Miller CA, Matsuda H (2012) Factor influencing public preference for raccoon eradication plan in Kanagawa, Japan. Hum Dimens Wildl 17:207–219

Bremner A, Park K (2007) Public attitudes to the management of invasive non-native species in Scotland. Biol Conserv 139:306–314

CBD (2014) Pathways of introduction of invasive species, their prioritization and management. Secretariat of the Convention on Biological Diversity, Montréal

Chao RF, Lin TE (2017) Effect of citizen action on suppression of invasive alien lizard population: a case of the removal of Eutropis multifasciata on Green Island, Taiwan. Appl Ecol Environ Res 15:1–13

Das C, Anderson CM, Swallow SK (2009) Estimating distributions of willingness to pay for heterogeneous populations. South Econ J 75:593–610

Didham RK, Tylianakis JM, Hutchison MA, Ewers RM, Gemmell NJ (2005) Are invasive species the drivers of ecological change? Trends Ecol Evol 20:470–474

Dunn M, Marzano M, Forster J, Gill RMA (2018) Public attitudes towards "pest" management: perceptions on squirrel management strategies in the UK. Biol Conserv 222:52–63

Durán-Medraño R, Varela E, Garza-Gil D, Prada A, Vázquez MX, Soliño M (2017) Valuation of terrestrial and marine biodiversity losses caused by forest wildfires. J Behav Exp Econ 71:88–95

Gaertner M, Larson BMH, Irlich UM, Holmes PM, Stafford L, van Wilgen BW, Richardson DM (2016) Managing invasive species in cities: a framework from Cape Town, South Africa. Landsc Urban Plan 151:1–9

Gardener MR, Atkinson R, Rentería JL (2010) Eradications and people: lessons from the plant eradication program in Galapagos. Restor Ecol 18:20–29

Gilligan DM, Rayner T (2007) The distribution, spread, ecological impacts and potential control of carp in the upper Murray River. NSW Department of Primary Industries, Cronulla

Haab T, McConnell K (2003) The econometrics of non-market valuation. Edward Elgar, Northampton

Haaijer R, Kamakura W, Wedel M (2001) The 'no-choice' alternative in conjoint choice experiments. Int J Mark Res 43:93–106

Hensher D, Rose JM, Greene W (2015) Applied choice analysis. Cambridge University Press, Cambridge
Hole AR, Kolstad JR (2012) Mixed logit estimation of willingness to pay distributions: a comparison of models in preference and WTP space using data from a health-related choice experiment. Empir Econ 42:445–469
Huber J, Zwerina K (1996) The importance of utility balance in efficient choice designs. J Mark Res 33:307–317
Jacobson SK, Duff MD (1998) Training idiot savants: the lack of human dimensions in conservation biology. Conserv Biol 12:263–267
Jenkins EW (1999) School science, citizenship and the public understanding of science. Int J Sci Educ 21:703–710
Kagoshima Prefecture (2019) Trends in Amami Islands Tourism 2018. http://www.pref.kagoshima.jp/aq01/chiiki/oshima/chiiki/zeniki/oshirase/documents/38010_20190422104935-1.pdf (In Japanese)
Kishino T, Yonezawa T (2013) Seasonal distribution of Ryukyu-ayu Plecoglossus altivelis ryukyuensis in the Katoku River, Amami-Oshima Island, southern Japan. Jpn J Ichthyol 60:91–101
Kopf RK, Nimmo DG, Humphries P, Baumgartner LJ, Bod M, Bond NR, Byrom AE, Cucherousset J, Keller RP, King AJ (2017) Confronting the risks of large-scale invasive species control. Nat Ecol Evol 1:172
Kubo T, Shoji Y (2016) Demand for bear viewing hikes: implications for balancing visitor satisfaction with safety in protected areas. J Outdoor Recreat Tour 16:44–49
Kubo T, Mieno T, Kuriyama K (2019) Wildlife viewing: the impact of money-back guarantees. Tour Manag 70:49–55
Layton DF, Brown G (2000) Heterogeneous preferences regarding global climate change. Rev Econ Stat 82:616–624
Lepczyk CA (2005) Integrating published data and citizen science to describe bird diversity across a landscape. J Appl Ecol 42:672–677
Louviere JJ, Hensher DA, Swait JD (2000) Stated choice methods: analysis and applications. Cambridge University Press, Cambridge
Lowe S, Browne M, Boudjelas S, De Poorter M (2000) 100 of the world's worst invasive alien species: a selection from the global invasive species database. Invasive Species Specialist Group, Auckland
Lugo AE, Snedaker SC (1974) The ecology of mangroves. Annu Rev Ecol Syst 5:39–64
Mameno K, Kubo T, Suzuki M (2017) Social challenges of spatial planning for outdoor cat management in Amami Oshima Island, Japan. Glob Ecol Conserv 10:184–193
Marshall J, Davison AJ, Kopf RK, Boutier M, Stevenson P, Vanderplasschen A (2018) Biocontrol of invasive carp: risks abound. Science 359:877–877
Marzano M, Dandy N, Bayliss HR, Porth E, Potter C (2015) Part of the solution? Stakeholder awareness, information and engagement in tree health issues. Biol Invasions 17:1961–1977
McFadden D (1974) The measurement of urban travel demand. J Public Econ 3:303–328
McFadden D, Train K (2000) Mixed MNL models for discrete response. J Appl Econ 15:447–470
McIntosh CR, Shogren JF, Finnoff DC (2010) Invasive species and delaying the inevitable: valuation evidence from a national survey. Ecol Econ 69:632–640
McNeely J (2001) The great reshuffling. Human dimensions of invasive alien species. IUCN, Gland/Cambridge
Mejía CV, Brandt S (2015) Managing tourism in the Galapagos Islands through price incentives: a choice experiment approach. Ecol Econ 117:1–11
Ministry of the Environment (2017) Amami Islands national park designation and construction plan. https://www.env.go.jp/park/amami/intro/files/plan_02.pdf (In Japanese)
Morey E, Rossmann KG (2003) Using stated-preference questions to investigate variations in willingness to pay for preserving marble monuments: classic heterogeneity, random parameters, and mixture models. J Cult Econ 27:215–229
Morgan DKJ, Hicks BJ (2013) A metabolic theory of ecology applied to temperature and mass dependence of N and P excretion by common carp. Hydrobiologia 705:135–145

Morgan M, Ho Y (2018) Perception of Asian carp as a possible food source among Missouri anglers. Hum Dimens Wildl 23:1–8
Nishida M (1988) A new subspecies of the ayu, Plecoglossus altivelis,(Plecoglossidae) from the Ryukyu Islands. Jpn J Ichthyol 35:236–242
Nishizawa E, Kurokawa T, Yabe M (2006) Policies and resident's willingness to pay for restoring the ecosystem damaged by alien fish in Lake Biwa, Japan. Environ Sci Pol 9:448–456
Nunes PALD, Van Den Bergh JC (2004) Can people value protection against invasive marine species? Evidence from a joint TC–CV survey in the Netherlands. Environ Resour Econ 28:517–532
Pejchar L, Mooney HA (2009) Invasive species, ecosystem services and human well-being. Trends Ecol Evol 24:497–504
Pimentel D, Zuniga R, Morrison D (2005) Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecol Econ 52:273–288
Polidoro BA, Carpenter KE, Collins L, Duke NC, Ellison AM, Ellison JC, Farnsworth EJ, Fernando ES, Kathiresan K, Koedam NE (2010) The loss of species: mangrove extinction risk and geographic areas of global concern. PLoS One 5:e10095
Revelt D, Train K (1998) Mixed logit with repeated choices: households' choices of appliance efficiency level. Rev Econ Stat 80:647–657
Roberts M, Cresswell W, Hanley N (2018) Prioritising invasive species control actions: evaluating effectiveness, costs, willingness to pay and social acceptance. Ecol Econ 152:1–8
Sala OE, Chapin FS, Armesto JJ, Berlow E, Bloomfield J, Dirzo R, Huber-Sanwald E, Huenneke LF, Jackson RB, Kinzig A (2000) Global biodiversity scenarios for the year 2100. Science 287:1770–1774
Scarpa R, Thiene M, Train K (2008) Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the Alps. Am J Agric Econ 90:994–1010
Simberloff D, Parker IM, Windle PN (2005) Introduced species policy, management, and future research needs. Front Ecol Environ 3:12–20
Thresher R, Van De Kamp J, Campbell G, Grewe P, Canning M, Barney M, Bax NJ, Dunham R, Su B, Fulton W (2014) Sex-ratio-biasing constructs for the control of invasive lower vertebrates. Nat Biotechnol 32:424
Train K (2003) Discrete choice methods with simulation. Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9780511753930 pp.137-147
Train KE (2009) Discrete choice methods with simulation. Cambridge University Press, Cambridge
Trumbull DJ, Bonney R, Bascom D, Cabral A (2000) Thinking scientifically during participation in a citizen-science project. Sci Educ 84:265–275
Uchii K, Minamoto T, Honjo MN, Kawabata Zi (2014) Seasonal reactivation enables cyprinid herpesvirus 3 to persist in a wild host population. FEMS Microbiol Ecol 87:536–542
Wald DM, Nelson KA, Gawel AM, Rogers HS (2018) The role of trust in public attitudes toward invasive species management on Guam: a case study. J Environ Manag 229:133–144
Zastrow M (2018) Doubts raised over Australia's plan to release herpes to wipe out carp. Nature, https://doi.org/10.1038/d41586-018-02315-4