ARTICLE IN PRESS

Ecosystem Services xxx (xxxx) xxxx

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Valuation of coral reefs in Japan: Willingness to pay for conservation and the effect of information

Kohei Imamura[a,b,1], Kohei Takenaka Takano[a,c,*], Naoki H. Kumagai[d], Yumi Yoshida[e,f], Hiroya Yamano[d], Masahiko Fujii[g], Tohru Nakashizuka[a,h,2], Shunsuke Managi[i]

[a] Graduate School of Life Sciences, Tohoku University, 6-3 Aoba, Aramaki, Aoba-ku, Sendai 980-8578, Japan
[b] Division of Natural Resource Economics, Forest Policy and Economics, Graduate School of Agriculture, Kyoto University, Kitashirakawa Oiwake-cho, Sakyo-ku, Kyoto 606-8502, Japan
[c] Natural Environment Division, Nagano Environmental Conservation Research Institute, Kitago 2054-120, Nagano-shi, Nagano 381-0075, Japan
[d] Centre for Environmental Biology and Ecosystem Studies, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba 305-8506, Japan
[e] Graduate School of Environmental Studies, Tohoku University, 468-1 Aoba, Aramaki, Aoba-ku, Sendai 980-8572 Japan
[f] Department of Management and Information Sciences, Faculty of Environmental and Information Sciences, Fukui University of Technology, 3-6-1 Gakuen, Fukui 910-8505, Japan
[g] Faculty of Environmental Earth Science, Hokkaido University, N10W5, Kita-ku, Sapporo 060-0810, Japan
[h] Research Institute for Humanity and Nature, 457-4 Motoyama, Kamigamo, Kita-ku, Kyoto 603-8047, Japan
[i] Urban Institute & Department of Civil Engineering, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka 819-0395, Japan

ARTICLE INFO

Keywords:
Discrete choice experiment
Latent class logit model
Textual information
Static image
Video
Climate change

ABSTRACT

In recent decades, despite their value, coral reefs have been endangered and are swiftly declining because of land overuse, rising sea temperatures, and increasing ocean acidification. This study assesses the willingness to pay (WTP) for coral reef conservation in Japan. We conducted an online discrete choice experiment with 10,573 respondents. A latent class logit model framework was used, and three respondent classes were recognized. The first, consisting of about 60% of respondents, had the highest income level and a willingness to pay 326,036–414,391 JPY (100 JPY ≒ 1 USD) over a lifetime. Individuals in the second class, comprising approximately 30% of the respondents, were willing to pay 9792–12,262 JPY. The third class, consisting of approximately 10% of the respondents, comprised individuals not willing to pay any amount. We also evaluated the relative preferences of respondents for different conservation scenarios. The most preferred conservation target was total coral reef area, followed by scenic beauty, and species richness. We further estimate the effect of the types and amount of information on the WTP. Concise or detailed information with text and static images about coral reefs increased WTP by 11.7–19.1%. Providing video information, however, decreased the WTP by 4.9–7.0%.

1. Introduction

1.1. Coral reefs under environmental changes and their poleward expansion

Coral reefs are three-dimensional shallow-water structures dominated by scleractinian corals and are found extensively in tropical and subtropical zones. They have important ecosystem functions with several benefits such as seafood, services such as coastal protection, as well as cultural, scientific, aesthetic, recreational, and spiritual benefits (Moberg and Folke, 1999). Coral reefs are also some of the most productive and biologically diverse ecosystems on earth (Connell, 1978): They serve as habitats for numerous organisms, such as fish and invertebrates; provide refuge from predators (Almany, 2004); act as food sources (Levin, 1994); and are an appropriate substrate for larvae to settle in (Williams and Sale, 1981).

Today, coral reefs face unprecedented degradation at both the global and local levels. State-of-the-art climate models project that global warming will cause a sharp decline in habitat suitability for many of the most significant and biodiverse tropical and subtropical coral regions (Couce et al., 2013). Local-scale threats include land-

* Corresponding author.
E-mail address: takano-kohei-r@pref.nagano.lg.jp (K.T. Takano).
[1] Current address: Asian Natural Environmental Science Center, The University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo 113-8657, Japan.
[2] Current address: Forestry and Forest Products Research Institute, 1 Matsunosato, Tsukuba, Ibaraki 305-8687, Japan.

https://doi.org/10.1016/j.ecoser.2020.101166
Received 3 May 2019; Received in revised form 7 July 2020; Accepted 24 July 2020

based pollution and the potential associated outbreak of coral-eating crown-of-thorns starfish, *Acanthaster solaris* (formerly *A. planci*) (Burke et al., 2011). A recent estimate shows that about 60% of reefs are endangered by local threats (Burke et al., 2011).

In addition, there is an expectation of potential poleward expansion to more favorable habitats (Yara et al., 2012; Couce et al., 2013; Yara et al. 2016). Couce et al. (2013) indicates that ocean acidification is less influential on future habitat suitability than global warming and its deleterious effects are centered evenly in both hemispheres between the 5° and 20° latitudes. Since coral reefs around Japan include poleward limits of tropical and subtropical coral habitats, it is important in any evaluation to look not only at the reefs degraded by climate change, but also at coral habitats that have expanded poleward. To address and manage such risks, prior studies (*e.g.*, Brander et al., 2007; Laurans et al., 2013) have focused on the economic valuation of coral reefs.

1.2. Valuing coral reefs

Economic valuation of coral reefs supports decision-making for sustainable management. The value of coral reefs may be divided into various components best described as different ecosystem services. Therefore, conservation plans for coral reefs can target different kinds and levels of attributes such as species richness, total preserved area, scenic beauty, and compensative poleward expansion of coral habitats.

Discrete choice experiments (DCE) are widely used to estimate citizen preferences regarding environmental valuation (see Supplementary Information S1). DCE present respondents with a choice set including a number of alternatives differentiated by their attributes. Then the respondents are asked to choose one of the alternatives (Louviere et al., 2010). DCE quantify the relative preferences of citizens to such options, which in turn help inform managers and justify the implementation of certain conservation policies.

Most of prior studies valuing preferences have focused on North America, Southeast Asia, and the Caribbean Sea (Brander et al., 2007), and a few studies have been conducted in the South Pacific Ocean (Laurans et al., 2013). In Japan, coral reefs have been valued in two locations: one in the Kerama Islands (Fujita, 2003), which are part of the Ryukyu Islands; the other around the Akashima Island (Tamura, 2009), which is one of the Kerama Islands. However, these studies have focused on specific local areas, so no study has tried to value coral reefs in Japan on a large scale.

1.3. Effects of information (and respondent attributes) on valuation

To ensure a fair evaluation of unfamiliar goods, researchers need to explain the goods to the respondents before conducting a DCE. This is because respondent familiarity with, or accuracy of knowledge about, a public good can dramatically affect their valuation of it (LaRiviere et al., 2014), and because people tend to assign a lower value to unfamiliar goods. This effect has also been noted in the case of the valuation of coral reefs (Laurans et al., 2013; Tseng et al., 2015; Rodrigues et al., 2016) and cold-water coral habitats (Jobstvogt et al., 2014).

Aanesen et al. (2015) indicate that explanations through workshops increase respondent willingness to pay (WTP) for cold-water corals in Norway (*i.e.*, unfamiliar goods). Sandorf et al. (2016) also indicate that explanations aided by video material increase WTP. Grafeld et al. (2016) indicate that improved knowledge of divers about land-based pollution is associated with increased WTP for investments that may improve fish biomass, diversity, and charismatic species.

The type and amount of information play an important role in stated preference surveys (Mathews et al., 2006). Static images and texts help respondents to evaluate targets (Shr et al., 2019). Moreover, video format can increase advertising recognition than pictures or other formats (Chen et al., 2020). However, too much information can make respondents be tired, leading to impairment of the reliability of the results (Mathews et al., 2006).

To the best of our knowledge, there is no study that examines the effects of the difference in the types and amount of information (*i.e.*, how and how much information was provided) on the valuation of coral reefs, especially on a broader scale such as the case of Japan as a whole. Moreover, as respondent attributes (*e.g.*, gender, age, educational and income levels, etc.) would also affect their WTP and their relative preferences to different targets of conservation, we take these variables into account. Such quantification would be useful for devising strategic campaigns for the conservation of coral reefs and to effectively raise awareness of this type of public goods.

1.4. Aims of the study

The aims of this study are to estimate the following aspects involved in conservation of coral reefs in Okinawa threatened by global and local environmental changes: (1) WTP of approximately 10,000 Japanese citizens for hypothetical conservation initiatives by a nationwide survey; (2) relative preferences of respondents for different conservation targets, namely, scenic beauty, coral species richness, the total area of coral reefs in Okinawa, and the compensative poleward expansion of coral habitats; (3) the effect of the difference in types and amount of information about coral reefs provided prior to the discrete choice experiment.

For the third aim, we prepared four kinds of information provision: (i) static images + short textual explanations, (ii) static images + long textual explanations, (iii) static images + short textual explanations edited into a video format with background music, and (iv) no prior explanation. Our hypotheses are as follows: (a) information provision increases the WTP for coral reefs (i, ii, iii > iv), (b) but too long information can be less effective (i ≥ ii), and (c) information provision through a video format is more effective (iii > i, ii).

Such evaluation based on nationwide survey is informative for prioritization in conservation planning and in public relations.

2. Materials and methods

2.1. Coral reefs in Japan

In Japan, there are many coral species (Fujikura et al., 2010), including about 400 (Veron, 1992) of the 845 hermatypic (zooxanthellate) coral species in the world (Carpenter et al., 2008). Furthermore, a very long latitudinal range is covered by the distribution of the Japanese reef hermatypic coral species, from the southern Ryukyu and Ogasawara Islands (24°N) to Tsushima Island (34°N) (Yamano et al., 2012). Non-reef hermatypic coral communities exist beyond Sado Island (38°N) (Yoshihara and Takehiko, 1978) and along the Pacific coast up to the Kanagawa (Eguchi, 1968) and Chiba prefectures (35°N) (Shimoike, 2004; Yamano et al., 2011, 2012). This wide latitudinal range of coral habitats is an appropriate system for detecting a change in coral communities induced by climate change (Yamano et al., 2011).

Mass coral bleaching has increased in the southern islands of Japan, while the northward expansion of coral habitats is considered a consequence of global warming (Yamano et al., 2011). Recent studies have projected that mass coral bleaching is increasing in the southern part of Japan (Yara et al., 2012, 2014, 2016) but the poleward expansion of coral habitats is more likely a temperature-driven shift triggered by rising surface water temperatures. Yet this poleward expansion is projected to be restricted by the southward expansion of ocean acidification (Yara et al., 2012, 2016). If global temperatures rise in the range of 2.0 °C to 5.4 °C by the end of this century, the spatial extent of the habitats suitable for tropical and subtropical corals around Japan may be reduced by half by 2020–2030 and may disappear completely by 2030–2040 (Yara et al., 2012, 2016).

In the Ryukyu Islands of southern Japan, in addition to coral bleaching, soil run-off may be another major cause of coral reef degradation. Although the Okinawa prefecture has enacted an ordinance for preventing heavy run-off sedimentation from land development and agricultural construction in 1995, run-off has continued from small-scale farmlands during heavy rains (Omijya, 2004), thereby reducing coral resilience against severe bleaching by 1998 (Hongo and Yamano, 2013). A few effective methods to prevent soil run-off from farmlands have been developed, but the actual application of these methods needs significant funding.

2.2. Discrete choice experiment

The DCE was developed originally for marketing research by Louviere and Woodworth (1983). Since then, the DCE has been widely used not only in marketing research, but also in transportation, psychometrics, and environmental valuation. In environmental valuation, earlier studies using the DCE focused on recreation (Adamowicz et al., 1994), hunting (Adamowicz et al., 1997), and habitat protection (Adamowicz et al., 1998). Many recent studies have used the DCE for environmental valuation as well (Hoyos, 2010; de Ayala et al., 2015).

This study also uses a DCE to value the Japanese coral reefs. The choice set is comprised of three potential scenarios for coral reef management: two extended conservation scenarios (ECS) and one normal conservation scenario (NCS). ECS is defined as increased conservation effort compared with current coral management, whereas NCS represents the status quo.

2.2.1. Establishing attributes

The scenarios are characterized by five attributes: coral reefs scenery in Okinawa (SCENERY), coral species richness in Okinawa (currently 400 species) (SPECIES), coral reef area in Okinawa (AREA), abundance of coral in Kyushu (KYUSHU), and donation amount for increasing conservation efforts of coral reefs (DONATION). Kyushu lies to the north of Okinawa and there is a possibility that climate change can induce the enlargement or the new establishment of coral reefs in that area.

The following payment vehicles are generally used for DCEs in environmental valuation: Enactment of a special-purpose tax, an increase of an existing tax, setting fees for public services, setting entrance fee, rise in product price, and foundation of funds and donation to it (Kuriyama, 2008). Kuriyama (2008) points out that protest response (*i.e.*, choosing status quo scenario because the respondent protests against some component of the valuation scenario, but see Meyerhoff and Liebe (2008) for various types of protest responses) tend to increase in Japan when a coercive payment vehicle is used and that therefore ambiguous payment vehicles such as “contribution” or “charge” are often used. In the present study, we set up a voluntary payment vehicle (*i.e.*, DONATION).

2.2.2. Assigning attribute levels

The different options in the ECS and the NCS were determined based on expert opinions of coral reef researchers, assuming the conditions set forth under the Representative Concentration Pathway (RCP) 8.5 scenario (IPCC, 2013) for the year 2100 are met. As a consequence of environmental changes, the attribute levels in the NCS were fixed as follows (*c.f.*, right column of Fig. 1): SCENERY—10% maintain—meaning that 10% of the beautiful scenery of the current coral reefs would remain (*c.f.* Yara et al., 2012, 2016). SPECIES—30% maintain—meaning that 30% of the current 400 species would remain (*c.f.* Yara et al., 2012, 2016; Muko et al., 2019). AREA —5% maintain—meaning that 5% or the current coral reef area would remain (Yara et al. 2012, 2016). KYUSHU—10-fold increase—meaning that the new reef growth in Kyushu would be 10-fold (Yara et al., 2012, 2016; Makino et al., 2014). DONATION — 0 Japanese Yen (JPY, 100 JPY ≒ 1 USD)—meaning that the donation required from the respondent is zero.

Each of the ECS (*i.e.*, ECS1 and ECS2) presents different options for the above attributes (*c.f.*, left and middle column of Fig. 1). The four attributes (*i.e.*, SCENERY, SPECIES, AREA, and KYUSHU) were presented with the targeted conditions for the year 2100 in the ECS.

We referred to previous DCE studies of ecosystem management in Japan (Fujino et al., 2017; Murakami et al., 2018; Ohdoko and Yoshida, 2012; Sakata, 2007; Senzaki et al., 2017; Shah et al., 2019; Wakamatsu et al., 2018; Wakita et al., 2019; Yamaura et al., 2016; Zhai et al., 2007; *c.f.*, Supplementary Information S2) instead of conducting pre-test. Payment frequency of DONATION was set to once referring to Mitani et al. (2008). The levels of DONATION was set to 100, 500, 1000, 5000, 10,000, 50,000 JPY, which are almost equivalent to those of Shoyama et al. (2013) (*i.e.*, 10, 50, 100, 500, 1000, 2000, 5000 JPY per year for 10 years).

2.2.3. Designing the choice sets

The next step is to generate hypothetical alternatives and combine them to create choice sets (Fig. 1 represents a choice set). Among choice sets, the options in the NCS were always the same; however, the options in each of the ECS changed. Using the Choice-based conjoint system (Sawtooth Software Inc, 2013), this study developed 20 combinations comprising the eight different choice sets (Supplementary Information S3). Respondents were randomly assigned to one of the 20 choice set combinations, and each respondent answered eight choice sets.

2.3. Survey design and data collection

The questionnaire developed for the study had four sections. The first section asked respondents to provide their perspectives on coral reefs. The questions were focused on their level of interest in and knowledge of coral reefs and the number of times they had visited a reef.

2.3.1. Providing different types and amount of information

The second section explained the valuable ecosystem services the coral reefs offer, along with the chronic threats to them, such as climate change, land-based pollution (*i.e.*, land-based sedimentation and eutrophication by domestic, agricultural, and livestock wastewater (Fabricius, 2005), and the outbreak of coral-eating crown-of-thorns starfish *A. solaris*). To investigate the impact of the communication method, the respondents were divided into four groups.

The first group (SHORT) was provided an explanation using short text and photos (Supplementary Information S4; 15 static images and 728 letters in Japanese, equivalent to 303 words in English). The second group (LONG) received the explanation via long text and photos (Supplementary Information S5: 20 static images and 1777 letters in Japanese, equivalent to 714 words in English). The third group (VIDEO) received it through video content composed of short text and photos (Supplementary Information S6: 19 images and 473 letters in Japanese, equivalent to 186 words in English). The fourth group (NoInfo) was not provided any explanation. Each respondent was assigned to one of the four groups randomly.

The flows of information were basically the same among the short, long and video explanations (Supplementary Information S7). However, several elements were included only in the short and long explanations (*e.g.*, element IDs 26–28 of Supplementary Information S8) or vice versa (IDs 29–31). Several photos (IDs 58, 59, and 67) were used only in the video but not in the short and long explanations to avoid duplication of the same photograph among the slides in the video.

2.3.2. Providing hypotheticals and applying DCE

The third section applied the discrete choice experiment. The following hypotheticals were provided to each respondent before the discrete choice experiment:

1. Coral reefs are, and could be, threatened by problems such as bleaching, land-based pollution, global warming, and ocean acidification.
2. To increase conservation efforts in Okinawa, several scenarios for

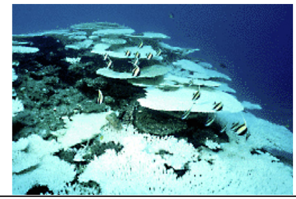
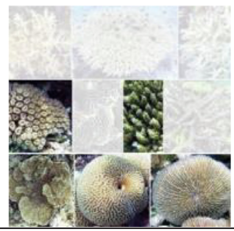
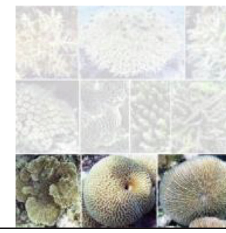
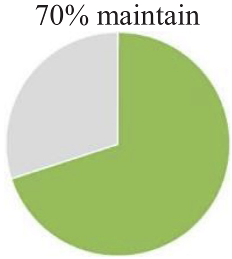
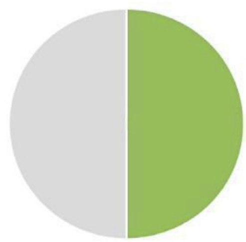
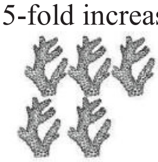
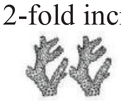
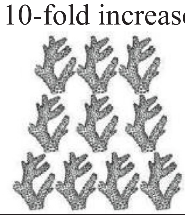
	Extended conservation scenario (ECS) 1	Extended conservation scenario (ECS) 2	Normal conservation scenario (NCS: status-quo)
Scenery of coral reefs in Okinawa	70% maintain 	40% maintain 	10% maintain 
Number of coral species in Okinawa (currently 400 species)	70% maintain 	50% maintain 	30% maintain 
Area of coral reefs in Okinawa	70% maintain 	50% maintain 	5% maintain 
Amount of corals in Kyushu	5-fold increase 	2-fold increase 	10-fold increase 
Amount of donation for increasing conservation of coral reefs (one-time payment only)	50000 Japanese Yen (JPY)	1000 JPY	0 JPY
	↓	↓	↓
Please choose your most preferred scenario	□	□	□

Fig. 1. Example of a choice set. Targeting (in ECSs 1 and 2) or assumed (in NCS) conditions in year 2100, followed by the donation amount and respondent preference. Each respondent answered eight choice sets like this example. Among the eight choice sets, the options in the NCS were always the same as status quo; however, the options in each of the ECS changed. This study developed 20 choice set combinations comprising the eight different choice sets. Respondents were randomly assigned to one of the 20 choice set combinations.

long-term management of coral reefs are under consideration.

3. Each scenario differs in the level of conservation for different objectives (*i.e.*, scenery or seascape-landscape of coral reefs in Okinawa, species richness of corals in Okinawa, preserved area of coral reefs in Okinawa, and abundance of corals in the Kyushu region) and the amount in donations are required from the public.
4. Respondents are asked to choose their most preferred scenario from each choice set eight times. Donation for the management of coral reefs is a one-time payment only. Respondents are asked to assume as if they lose their own money by the donation.

2.3.3. Capturing respondent attributes and conducting the online survey

The fourth section captured respondent attributes. This study gathered respondent gender, age, marital status, household size, household income, education, and whether the respondent job was related to coral reefs or not.

The survey, "Questionnaire about coral reefs in Okinawa," was distributed online on February 20–27, 2014 by Nikkei Research. The

Table 1
Attributes and levels of scenario-conserving coral reefs.

Attributes	Levels
SCENERY	10% maintain, 40% maintain, 70% maintain
SPECIES	30% maintain, 50% maintain, 70% maintain
AREA	5% maintain, 10% maintain, 30% maintain, 50% maintain, 70% maintain
KYUSHU	two-fold increase, five-fold increase, ten-fold increase
DONATION	100, 500, 1000, 5000, 10000, 50,000 (JPY)

questionnaire was sent to 86,149 potential respondents both men and women aged between 20 and 69 years-old from all prefectures in Japan registered with the research company and its cooperative companies. The potential respondents were randomly sampled to fit ratios for gender, age (*i.e.*, 20 s, 30 s, 40 s, 50 s, and 60 s), and the population of six broad geographic areas in order to generalize to the larger Japanese population. As a result, 13,304 people responded, and 10,577 completed the survey. Four respondents were removed because they did not validly state their educational attainment. Consequently, we obtained 10,573 valid responses (response rate = 12.3%). The number of respondents of SHORT, LONG, VIDEO, and NoInfo were 2715, 2695, 2650, and 2513, respectively. The respondent characteristics are summarized in Table 2.

2.4. Analysis methods

This study estimated respondent relative preferences for each attribute of, or different target for, coral management using the latent class logit (LCL) model, currently the most common used methodology to investigate heterogeneity in choice data (Næs et al., 2018). The LCL model assumes that a discrete number of classes are sufficient to account for preference heterogeneity across classes (Greene and Hensher, 2003; Shen, 2009). Within each class, the respondents are assumed to have a similar choice profile. The LCL was first introduced by Kamakura and Russell (1989), and Boxall and Adamowicz (2002) used it in environmental economics. Train (2008) further improved on the LCL methodology. Since then, the LCL has become a widely used method in environmental valuation. In this study, we applied the LCL following Train (2008) (see Supplementary Information S9 for the corresponding theoretical basis).

We conducted LCL analyses for each group: SHORT, LONG, VIDEO, and NoInfo. A total of 201 respondents of the VIDEO group were excluded from the analysis because they answered that they could not watch the video information in the internet survey (consequently, sample size of VIDEO was 2449). The dependent variable was a dummy variable corresponding to the answer to the discrete choice experiment. The explanatory variables were SCENERY, SPECIES, AREA, KYUSHU, DONATION, and a dummy variable that represented the NCS (*i.e.*, the alternative specific constant [ASC]). SCENERY, SPECIES, AREA, and KYUSHU were coded as follows: 5% maintain = 5, 10% maintain = 10, 30% maintain = 30, 40% maintain = 40, 50% maintain = 50, 70% maintain = 70, two-fold increase = 2, five-fold increase = 5, and ten-fold increase = 10. The unit of DONATION was set to 10,000 Japanese Yen to fit the digits with coefficients of the other attributes. The class membership variables, which account for class heterogeneity among members, were GENDER, AGE, marital status (MARRIED), number of children (CHILDREN), household income (INCOME), educational attainment (EDUCATION), and whether their professions were related to coral reefs (JOB). We used the statistical software STATA, version 14.0 by StataCorp LP, for the LCL analysis. This study used the default settings for LCL analysis in STATA 14.0.

2.5. Considering the time for a respondent spent on the survey

The research company also recorded time of each respondent to click "to the next" button of each page throughout the online survey. Then duration time, in which the respondent is assumed to have spent browsing information and/or responding to a question, was calculated for each page. Seven respondents (one, three, one, and two respondents of the SHORT, LONG, VIDEO, and NoInfo groups, respectively) were excluded from the following analyses because the values of the duration times were zero in the row data provided from the research company presumably because of respondents' environment such as respondents' devices (specific smartphones or game machines), disabled Javascript, and going back and forth through the Web pages. Consequently, the sample sizes of SHORT, LONG, VIDEO, NoInfo were 2714, 2692, 2448,

Table 2
Socio-economic characteristics of respondents.

Characteristics	Status	Number	Percentage (%)
GENDER	0 = Man	5356	50.7%
	1 = Woman	5217	49.3%
AGE	Integer from 20 to 69	Average = 46.49	standard deviation = 11.37
MARRIED	0 = Not married	3327	31.5%
	1 = Married	7246	68.5%
CHILDREN	Integer from 0 to 9	average = 2.17	standard deviation = 1.16
INCOME	1 = under 3 million JPY (Japanese Yen)	1829	17.3%
	2 = 3–5 million JPY	2620	24.8%
	3 = 5–7.5 million JPY	2687	25.4%
	4 = 7.5–10 million JPY	1916	18.1%
	5 = 10–15 million JPY	1123	10.6%
	6 = 15–30 million JPY	344	3.3%
	7 = over 30 million JPY	54	0.5%
EDUCATION	1 = Junior high school	1	0.0%
	2 = High school	112	1.1%
	3 = Vocational school	2340	22.1%
	4 = Junior college	2420	22.9%
	5 = University	4976	47.1%
	6 = Graduate school of master course	539	5.1%
	7 = Graduate school of doctoral course	185	1.7%
JOB	0 = Not related to coral reefs	10,132	95.8%
	1 = Related to coral reefs	441	4.2%

Note. CHILDREN: number of children, INCOME: household income.

and 2511, respectively, in the following analyses.

The duration times were summed up for each of the following three steps: (1) T_{info}, time to go through the information in Section 2.3.1; (2) T_{exp}, time to go through the explanation about the DCE (*i.e.*, hypotheticals 1–4 in Section 2.3.2); and (3) T_{cho}, time to choose a scenario from each choice set (Fig. 1) eight times. T_{info}, T_{exp}, and T_{cho} were log-transformed (hereafter lnT_{info}, lnT_{exp}, and lnT_{cho}), and we checked that their correlation coefficients are not high (0.43–0.51) with the *ggpairs* function of the package *GGally* version 1.4.0 (Emerson et al., 2013) in *R* version 3.6.2 (R Core Team, 2019) (Supplementary Information S10).

Then we conducted additional analyses incorporating lnT_{info} and lnT_{exp} as interaction terms into the LCL model for each group-class (see Section 3.1) to consider the relation between the evaluation and time spent on the survey by each respondent. Although the response or completion time is reported to have a significant bearing on estimates of utility coefficients and error variance (Holmes et al., 1998; Malhotra, 2008; Campbell et al., 2018), T_{cho} was not incorporated because the models become too complicated and because it was beyond the scope of the present study.

3. Results

In the LCL analysis, the decision on the number of classes is typically based on information criteria for model selection, but may also be chosen by the researcher (Greene and Hensher, 2003). In our case, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) became smaller as the number increased from two to five (Table 3). However, the larger these numbers, the more complicated their interpretation. Thus, to achieve a balance between model fit and interpretability, we set the number of the classes to three in our LCL models.

3.1. Latent class analyses to investigate relative preference for attributes of conservation scenarios and respondent attributes

Tables 4a–d summarize the results of the LCL analyses for the groups SHORT, LONG, VIDEO, and NoInfo, respectively. The parameters for choice attribute variables (the upper halves of Tables 4a–d) are associated with relative preferences for each attribute in the DCE in each class (*i.e.*, classes C1, C2, or C3), which are posteriorly determined by the LCL models. Because LCL analyses were conducted independently for the four groups, the respondents classified into the class C1 of the SHORT group are independent from those in C1 of the other groups, and so on. However, in the preliminary analyses, we found common tendencies and therefore assigned the class names throughout the groups as follows: C1, respondents classified into this group preferred extended conservation scenarios (ECS) and were relatively tolerant to an increase in the donation amount; C2, respondents also preferred ECS but were more sensitive to an increase in the donation amount; C3, respondents tended to avoid ECS and therefore preferred the normal conservation scenario (NCS). Throughout the groups, class share probabilities (*i.e.*, proportions) were approximately 60%, 30%, and 10% for C1, C2, and C3, respectively. The class membership parameters (the lower halves of Tables 4a–d) represent differences in respondent attributes between the reference class (C3) and the respective target class (*i.e.*, C1 or C2).

Table 3
Log likelihood, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC) of latent class logit models with different class numbers.

Group	Class number	Log likelihood	AIC	BIC
SHORT	2	−16029.977	32099.954	32218.085
SHORT	3	−14783.047	29634.093	29834.916
SHORT	4	−14503.748	29103.496	29387.010
SHORT	5	−14237.445	28598.890	28965.096
LONG	2	−15933.892	31907.784	32025.767
LONG	3	−14838.776	29745.552	29946.123
LONG	4	−14534.845	29165.689	29448.849
LONG	5	−14156.565	28437.130	28802.878
VIDEO	2	−14301.693	28643.386	28759.454
VIDEO	3	−13246.667	26561.334	26758.651
VIDEO	4	−13026.391	26148.781	26427.346
VIDEO	5	−12904.305	25932.610	26292.423
NoInfo	2	−15125.515	30291.031	30407.615
NoInfo	3	−14070.132	28208.263	28406.457
NoInfo	4	−13815.303	27726.606	28006.409
Noinfo	5	−13648.914	27421.827	27783.240

3.1.1. LCL analysis for respondents provided with short explanation

In the SHORT group, the values of coefficient of ASC were significantly negative in C1 and C2 (Table 4a), meaning that those classified into these classes preferred the extended conservation scenarios (ECSs). On the other hand, the ASC was positive in C3, indicating that those preferred normal conservation scenarios (NCS) were classified into C3.

The coefficients of SCENERY, SPECIES, and AREA were all significantly positive in C1 and C2 (Table 4a), indicating that those individuals prefer enhancing conservation efforts related to these aspects. The coefficient of KYUSHU was not significantly different from zero in C1 and C2 but was significantly positive in C3, meaning that respondents in C3 favor efforts designed to increase coral size in Kyushu. The coefficients of DONATION were significantly negative for classes C1, C2, and C3 (Table 4a), indicating that larger donation amounts are less preferred. The absolute value of the coefficient of DONATION was much larger in C2 than in C1 and C3, suggesting that individuals classified into C2 were more sensitive to donation size.

The coefficients of GENDER, AGE, JOB, EDUCATION, and INCOME were significantly positive for C1 (Table 4a). So, individuals classified into C1 were more likely to be a woman (dummy variable = 1) than a man, older, have a job related with coral reefs, have more years of education, and have the higher household income in comparison with those in the reference class C3. The coefficients of GENDER, AGE, and EDUCATION were significantly positive for C2, meaning that those classified into C2 were more likely to be a woman, older, and have more years of education as well. The average class share probabilities were 0.573, 0.329, and 0.099 for C1, C2, and C3, respectively (Table 4a).

3.1.2. LCL analysis for respondents provided with long explanation

The coefficients of ASC, SCENERY, SPECIES, AREA, and DONATION showed similar tendencies to those in the SHORT group. The coefficient of KYUSHU was significantly positive in C1 and C3, indicating a preference for efforts leading to coral growth in Kyushu. On the other hand, the coefficients of KYUSHU in C2 were significantly negative, representing the opposite preference.

The coefficients of GENDER, AGE, CHILDREN, EDUCATION, and INCOME were significantly positive in C1, so individuals in C1 were more likely to be a woman, older, have more children, have more years of education, and have higher household income. In C2, the coefficients of GENDER and CHILDREN were significantly positive, and the average class share probabilities were 0.582, 0.327, and 0.091 for C1, C2, and C3, respectively (Table 4b).

3.1.3. LCL analysis for respondents provided with video explanation

The coefficients of ASC, SPECIES, and DONATION showed similar tendencies relative to those in the SHORT group. The coefficients of SCENERY and AREA were significantly positive in C1, C2, and C3, indicating a preference for higher levels of conservation in all the classes. The coefficient of KYUSHU was significantly positive in C2 and C3, representing a preference for choices including the growth of corals in Kyushu (Table 4c).

The coefficients of GENDER, AGE, and INCOME were significantly positive in C1, whereas that of GENDER was positive in C2. The class shares were 0.621, 0.292, and 0.087 for C1, C2, and C3, respectively.

Table 4a
Estimation result of latent class logit model for SHORT group.

Group-Class (Class share)	SHORT-C1 (0.573)			SHORT-C2 (0.329)			SHORT-C3 (0.099)		
	Co-efficient	Standard error	*p*-value	Co-efficient	Standard error	*p*-value	Co-efficient	Standard error	*p*-value
Choice attribute variables									
DONATION	−0.131	0.009	0.000***	−3.526	0.108	0.000***	−0.214	0.044	0.000***
ASC	−2.834	0.111	0.000***	−2.508	0.085	0.000***	1.789	0.155	0.000***
SCENERY	0.013	0.001	0.000***	0.010	0.001	0.000***	0.002	0.002	0.384
SPECIES	0.011	0.001	0.000***	0.007	0.002	0.000***	−0.003	0.004	0.354
AREA	0.017	0.001	0.000***	0.013	0.001	0.000***	0.002	0.002	0.465
KYUSHU	−0.001	0.004	0.728	−0.009	0.008	0.228	0.054	0.017	0.002**
Class membership variables									
GENDER	0.467	0.146	0.001**	0.717	0.156	0.000***	0		
AGE	0.021	0.007	0.002**	0.014	0.007	0.047*	0		
MARRIED	0.146	0.175	0.403	0.238	0.188	0.205	0		
CHILDREN	0.081	0.074	0.278	0.110	0.078	0.160	0		
JOB	1.440	0.586	0.014*	0.756	0.620	0.223	0		
EDUCATION	0.246	0.073	0.001**	0.208	0.079	0.008**	0		
INCOME	0.113	0.057	0.049*	0.058	0.061	0.343	0		
Intercept	−0.990	0.460	0.031*	−1.130	0.499	0.024*	0		

Note: For definitions of choice attribute variables, see Sections 2.2.1, 2.2.2, and 2.4.
For class membership variables, see Table 2.
The legend *, **, *** means p < 0.05, 0.01, 0.001, respectively.

3.1.4. LCL analysis for respondents provided without explanation

The coefficients of ASC, SCENERY, SPECIES, KYUSHU, and DONATION showed similar tendencies relative to those in the SHORT group. The coefficients of AREA were significantly positive in C1, C2, and C3. The coefficients of GENDER, AGE, MARRIED, and INCOME were significantly positive in C1, meaning that those classified into C1 were more likely to be a woman, be married, and have higher household income than those in the reference class C3. The coefficient of GENDER was significantly positive in C2 as well. The class shares were 0.598, 0.296, and 0.106 for C1, C2, and C3, respectively (Table 4d).

3.2. Relative preference for attributes of conservation scenarios in terms of WTPs

3.2.1. Calculating marginal WTP and potentially maximum WTP

WTP per person for an ECS with arbitrary attribute levels can be estimated from the results of the LCL analyses. First, the marginal WTP of a class g member for each one of the choice attribute variables (*i.e.*, ASC, SCENERY, SPECIES, AREA, and KYUSHU) per unit of donation was calculated by the following formulae:

$$MW_{ASC,g} = \frac{-\beta_{ASC,g}}{\beta_{DONATION,g}}, \tag{1}$$

$$MW_{SCENERY,g} = \frac{-\beta_{SCENERY,g}}{\beta_{DONATION,g}}, \tag{2}$$

$$MW_{SPECIES,g} = \frac{-\beta_{SPECIES,g}}{\beta_{DONATION,g}}, \tag{3}$$

Table 4b
Estimation result of latent class logit model for LONG group.

Group-Class (Class share)	LONG-C1 (0.582)			LONG-C2 (0.327)			LONG-C3 (0.091)		
	Co-efficient	Standard error	*p*-value	Co-efficient	Standard error	*p*-value	Co-efficient	Standard error	*p*-value
Choice attribute variables									
DONATION	−0.116	0.010	0.000***	−3.662	0.112	0.000***	−0.955	0.229	0.000***
ASC	−2.633	0.090	0.000***	−2.286	0.081	0.000***	2.010	0.168	0.000***
SCENERY	0.013	0.001	0.000***	0.007	0.001	0.000***	0.002	0.003	0.430
SPECIES	0.010	0.001	0.000***	0.010	0.002	0.000***	0.003	0.004	0.542
AREA	0.016	0.001	0.000***	0.014	0.001	0.000***	0.003	0.003	0.317
KYUSHU	0.008	0.004	0.031*	−0.024	0.008	0.002**	0.053	0.021	0.013*
Class membership variables									
GENDER	0.531	0.151	0.000***	0.760	0.162	0.000***	0		
AGE	0.017	0.007	0.010*	0.001	0.007	0.841	0		
MARRIED	−0.036	0.185	0.845	0.096	0.201	0.632	0		
CHILDREN	0.161	0.082	0.048*	0.255	0.086	0.003**	0		
JOB	0.184	0.327	0.573	−0.548	0.396	0.166	0		
EDUCATION	0.158	0.075	0.035*	0.100	0.082	0.221	0		
INCOME	0.148	0.058	0.010*	0.071	0.062	0.258	0		
Intercept	−0.443	0.480	0.355	−0.090	0.518	0.862	0		

Note: For definitions of choice attribute variables, see Sections 2.2.1, 2.2.2, and 2.4.
For class membership variables, see Table 2.
The legend *, **, *** means p < 0.05, 0.01, 0.001, respectively

Table 4c
Estimation result of latent class logit model for VIDEO group.

Group-Class (Class share)	VIDEO-C1 (0.621) Co-efficient	Standard error	p-value	VIDEO-C2 (0.292) Co-efficient	Standard error	p-value	VIDEO-C3 (0.087) Co-efficient	Standard error	p-value
Choice attribute variables									
DONATION	−0.158	0.011	0.000***	−3.997	0.147	0.000***	−0.207	0.062	0.001**
ASC	−2.876	0.105	0.000***	−2.112	0.088	0.000***	2.561	0.195	0.000***
SCENERY	0.013	0.001	0.000***	0.011	0.001	0.000***	0.008	0.004	0.019*
SPECIES	0.010	0.001	0.000***	0.007	0.002	0.000***	−0.008	0.005	0.106
AREA	0.017	0.001	0.000***	0.016	0.001	0.000***	0.009	0.004	0.012*
KYUSHU	−0.005	0.004	0.186	0.022	0.009	0.017*	0.094	0.026	0.000***
Class membership variables									
GENDER	0.733	0.169	0.000***	0.918	0.182	0.000***	0		
AGE	0.018	0.007	0.015*	−0.002	0.008	0.815	0		
MARRIED	0.133	0.197	0.500	0.324	0.217	0.135	0		
CHILDREN	0.082	0.084	0.332	0.125	0.091	0.166	0		
JOB	0.315	0.376	0.401	−0.914	0.503	0.069	0		
EDUCATION	−0.016	0.079	0.843	−0.036	0.086	0.675	0		
INCOME	0.227	0.063	0.000***	0.066	0.069	0.333	0		
Intercept	0.077	0.525	0.883	0.578	0.573	0.313	0		

Note: For definitions of choice attribute variables, see Sections 2.2.1, 2.2.2, and 2.4.
For class membership variables, see Table 2.
The legend *, **, *** means $p < 0.05, 0.01, 0.001$, respectively.

$$MW_{AREA,g} = \frac{-\beta_{AREA,g}}{\beta_{DONATION,g}}, \tag{4}$$

$$MW_{KYUSHU,g} = \frac{-\beta_{KYUSHU,g}}{\beta_{DONATION,g}}, \tag{5}$$

where $\beta_{ASC,g}$, $\beta_{SCENERY,g}$, $\beta_{SPECIES,g}$, $\beta_{AREA,g}$, $\beta_{KYUSHU,g}$, and $\beta_{DONATION,g}$ are the coefficients of the choice attribute variables in Tables 4a–d. Using Eqs. (1)–(5), the WTP of a class *g* member for ECS was calculated as follows:

$$\begin{aligned} WTP_{ECS,g} &= MW_{ASC,g}(ASC_{ECS} - ASC_{NCS}) + MW_{SCENERY,g} \\ &(SCENERY_{ECS} - SCENERY_{NCS}) + MW_{SPECIES,g} \\ &(SPECIES_{ECS} - SPECIES_{NCS}) + MW_{AREA,g} \\ &(AREA_{ECS} - AREA_{NCS}) + MW_{KYUSHU,g} \\ &(KYUSHU_{ECS} - KYUSHU_{NCS}), \end{aligned} \tag{6}$$

where $SCENERY_{ECS}$, $SPECIES_{ECS}$, $AREA_{ECS}$, and $KYUSHU_{ECS}$ may be the values in Table 1, whereas ASC_{ECS}, ASC_{NCS}, $SCENERY_{NCS}$, $SPECIES_{NCS}$, $AREA_{NCS}$, and $KYUSHU_{NCS}$ were zero, one, 10%, 30%, 5%, and 10-fold, respectively (see Section 2.2.2). By substituting $SCENERY_{ECS}$, $SPECIES_{ECS}$, $AREA_{ECS}$, and $KYUSHU_{ECS}$ into Eq. (6) with the most mitigated levels of each attribute in Table 1 (*i.e.*, 70%, 70%, 70%, and 2-fold, respectively), the potentially maximum WTP (hereafter pm-WTP) of a class *g* member is represented by the Eq. (7) below:

Table 4d
Estimation result of latent class logit model for NoInfo group.

Group-Class (Class share)	NoInfo-C1 (0.598) Co-efficient	Standard error	p-value	NoInfo-C2 (0.296) Co-efficient	Standard error	p-alue	NoInfo-C3 (0.106) Co-efficient	Standard error	p-value
Choice attribute variables									
DONATION	−0.141	0.010	0.000***	−3.931	0.130	0.000***	−0.271	0.047	0.000***
ASC	−2.708	0.097	0.000***	−2.366	0.089	0.000***	1.787	0.138	0.000***
SCENERY	0.014	0.001	0.000***	0.008	0.001	0.000***	0.002	0.002	0.509
SPECIES	0.009	0.001	0.000***	0.009	0.002	0.000***	0.006	0.004	0.080
AREA	0.016	0.001	0.000***	0.013	0.001	0.000***	0.006	0.002	0.012*
KYUSHU	0.007	0.004	0.083	−0.007	0.008	0.433	0.094	0.017	0.000***
Class membership variables									
GENDER	0.521	0.149	0.000***	0.551	0.162	0.001**	0		
AGE	0.018	0.007	0.007**	0.011	0.007	0.123	0		
MARRIED	0.381	0.176	0.031*	0.305	0.193	0.115	0		
CHILDREN	−0.110	0.072	0.127	−0.121	0.080	0.130	0		
JOB	0.265	0.396	0.503	−0.182	0.463	0.694	0		
EDUCATION	0.089	0.074	0.230	−0.023	0.081	0.778	0		
INCOME	0.200	0.057	0.000***	0.074	0.063	0.239	0		
Intercept	−0.427	0.465	0.358	0.110	0.503	0.827	0		

Note: For definitions of choice attribute variables, see Sections 2.2.1, 2.2.2, and 2.4.
For class membership variables, see Table 2.
The legend *, **, *** means $p < 0.05, 0.01, 0.001$, respectively.

Table 5
Marginal WTPs (MW) for each attribute and potentially maximum WTP (pm-WTP) of each group-class.

Group-Class	MW_{ASC} (JPY)	(SE)	$MW_{SCENERY}$ (JPY/%)	(SE)	$MW_{SPECIES}$ (JPY/%)	(SE)	MW_{AREA} (JPY/%)	(SE)	MW_{KYUSHU} (JPY/fold)	(SE)	pm-WTP (JPY)	(SE)
SHORT-C1	−216,748	(17,437)	1020	(83)	842	(86)	1337	(107)	−105	(302)	399,407	(19,865)
LONG-C1	−227,901	(19,749)	1083	(103)	880	(101)	1417	(132)	724	(349)	414,391	(22,933)
VIDEO-C1	−182,415	(13,614)	795	(66)	615	(66)	1057	(86)	−328	(248)	326,036	(15,584)
NoInfo-C1	−192,651	(14,577)	1010	(82)	652	(74)	1159	(96)	493	(289)	350,724	(17,015)
SHORT-C2	−7112	(229)	28	(3)	21	(5)	37	(3)	−26	(21)	12,262	(451)
LONG-C2	−6242	(243)	20	(3)	27	(5)	38	(3)	−66	(21)	11,497	(448)
VIDEO-C2	−5283	(280)	27	(3)	18	(5)	40	(3)	54	(22)	9792	(481)
NoInfo-C2	−6018	(252)	19	(3)	22	(5)	32	(3)	−17	(21)	10,295	(460)
SHORT-C3	83,422	(20,152)	99	(116)	−157	(172)	82	(114)	2534	(984)	−98,648	(24,868)
LONG-C3	21,039	(5681)	24	(31)	28	(45)	31	(30)	551	(261)	−20,881	(6882)
VIDEO-C3	123,837	(40,671)	400	(203)	−409	(281)	426	(211)	4560	(1888)	−124,988	(48,419)
NoInfo-C3	66,041	(13,619)	59	(89)	232	(138)	221	(96)	3483	(899)	−66,762	(18,308)

Note: For definitions of ASC, SCENERY, SPECIES, AREA, and KYUSHU, see Sections 2.2.1, 2.2.2, and 2.4.
SE: Standard error. For details of the calculation method of a standard error, refer to Hole (2007).

$$pmWTP_g = MW_{ASC,g}(0-1) + MW_{SCENERY,g}(70-10) + MW_{SPECIES,g}(70-30) + MW_{AREA,g}(70-5) + MW_{KYUSHU,g}(2-10). \tag{7}$$

pm-WTP expresses WTP for the “most” extended conservation scenario, which targets to conserve 70% of scenic beauty, 70% of species diversity, and 70% of the total area of coral reefs in Okinawa, and to keep the increase of corals in Kyushu to 2-fold, at the end of the 21st century.

Marginal WTPs and pm-WTPs were estimated for each group and class (Table 5). The pm-WTPs for class C1 for the SHORT, LONG, VIDEO, and NoInfo groups were 399,407, 414,391, 326,036, and 350,724 JPY, respectively. Those for class C2 were 12,262, 11,497, 9792, and 10,295, whereas those for C3 were −98,648, −20,881, −124,988, and −66,762 JPY, respectively (see Supplementary Information S11).

MW_{ASC}, accounted for 54.3% (=216,748/399,407) of pm-WTP of class C1 in the SHORT group (Table 5). Likewise, MW_{ASC} accounted for 54.0–100.8% of pm-WTP throughout classes and groups (see Supplementary Information S11).

Marginal WTPs for different conservation targets were estimated as MW_{AREA} > $MW_{SCENERY}$ > $MW_{SPECIES}$ in C1 for all groups (Table 5). As formulae (6) and (7) indicate that MW_{AREA}, $MW_{SCENERY}$, and $MW_{SPECIES}$ are multiplied by 65, 60, and 40, respectively, and therefore AREA had the largest impact on the estimation of pm-WTP, followed by SCENERY and SPECIES in C1. The values of MW_{AREA} were also highest in C2 and C3, except for groups SHORT-C3 and NoInfo-C3.

3.2.2. Effects of information on potentially maximum WTPs

For C1, pm-WTPs were estimated as LONG-C1 > SHORT-C1 > NoInfo-C1 > VIDEO-C1 (see Table 5 and Supplementary Information S11). Specifically, this is equivalent to a 18.2% and 13.9% increase in LONG-C1 and SHORT-C1, respectively, compared to NoInfo-C1. On the other hand, pm-WTP of VIDEO-C1 decreased by 7.0%.

For C2, pm-WTPs were estimated as SHORT-C2 > LONG-C2 > NoInfo-C2 > VIDEO-C2, implying that providing short and long explanations increased pm-WTP by 19.1% and 11.7%, respectively. Following the result for C1, the pm-WTP for VIDEO-C2 decreased by 4.9%.

For C3, pm-WTPs were estimated as LONG-C3 > NoInfo-C3 > SHORT-C3 > VIDEO-C3 (see Table 5 and Supplementary Information S11).

3.3. Relation between duration time and preferences for attributes of conservation scenarios

3.3.1. Summary statistics

The median duration to complete the whole survey was 11 minutes and 25 seconds for available data ($N = 10{,}365$). The medians of T_{info} were 47, 61, 169, and *NA* seconds for SHORT, LONG, VIDEO, and NoInfo, respectively (Supplementary Information S12). Likewise, the medians were 17, 14, 18, and 18 seconds for T_{exp} and 165, 162, 171, and 162 seconds for T_{cho}, respectively.

T_{info} of 25.4% (621 out of 2448) respondents of VIDEO group were less than 157 seconds, the actual length of the video prepared, indicating that they have stopped watching the video before the end.

The duration times (*i.e.*, lnT_{info}, lnT_{exp}, and lnT_{cho}) were significantly shorter in C3 compared to C1 and C2 throughout SHORT, LONG, VIDEO, and NoInfo groups (Supplementary Information S13–15), being consistent with Sandorf et al. (2016) in that respondents rushing through the survey are more likely to choose status quo scenario (*i.e.*, NCS in the present study).

3.3.2. Relation between duration time and preferences for attributes

To explore relationships between the duration time (*i.e.*, T_{info} and T_{exp}) and preferences, we posteriorly assigned each respondent to either of C1, C2, or C3 classes based on the probability predicted from the LCL model. Then we applied conditional logit models for each group-class incorporating lnT_{info} and lnT_{exp} as interaction terms with SCENERY, SPECIES, AREA, KYUSHU, and DONATION.

We selected the minimum-AIC model from the lnT_{info}-only, lnT_{exp}-only, and $lnT_{info} + lnT_{exp}$ models for each group-class (Supplementary Information S16). If incorporated, interaction terms lnT_{info}*SCENERY, lnT_{info}*SPECIES, and lnT_{info}*AREA tended to be significantly positive (Supplementary Information S17), indicating that respondents with longer T_{info} preferred scenarios with higher SCENERY, SPECIES, and AREA. Contrary, lnT_{info}*DONATION tended to be significantly negative, indicating that respondents with longer T_{info} preferred scenarios with lower DONATION. lnT_{inafo}*KYUSHU was significantly positive only in VIDEO-C3.

Except for LONG-C3, lnT_{exp} was selected for interaction terms in all the AIC-minimum models (Supplementary Information S17). As same as lnT_{info}, interaction terms lnT_{exp}*SCENERY, lnT_{exp}*SPECIES, and lnT_{exp}*AREA tended to be significantly positive, indicating that respondents with longer T_{exp} preferred scenarios with higher SCENERY, SPECIES, and AREA. Contrary, lnT_{exp}*KYUSHU and lnT_{exp}*DONATION tended to be significantly negative, indicating that respondents with longer T_{exp} preferred scenarios with lower KYUSHU and DONATION.

4. Discussion

4.1. WTPs of Japanese citizens for coral reef conservation

Although the four different groups (SHORT, LONG, VIDEO, and NoInfo) are independent from each other (see Section 3.1), the class share of C1 was about 60% for all groups (Tables 4a–d). The values of pm-WTP for C1 were also similar irrespective of the group, ranging from 326,036 to 414,391 JPY (Table 5). The class share of C2 was about 30% in all groups as well, with the pm-WTP of C2 relatively low for all groups, ranging from 9792 to 12,262 JPY. The class share of C3 was about 10% for all groups, and their pm-WTPs were negative ranging from −124,988 to −20,881 JPY, indicating a preference for NCS.

The difference in the pm-WTPs between class C1 and C2 accounts for the tolerance of C1 to an increase in the donation amount (*i.e.*, the smaller absolute values of the coefficients of DONATION in Tables 4a–d). It may be explained by the higher household income of class C1 for all groups (Tables 4a–d). The pm-WTP of C3 for all groups was negative, implying a preference for ASC and an avoidance of the highest level of ECS, which was assumed in the calculation of pm-WTP.

Although we set levels of DONATION to cover the range of previous studies, pm-WTPs of C1 were estimated to be much higher in our DCE, resulting in a kind of extrapolation. We might have observed that the pm-WTP reach plateau in between 50,000 and 414,391 JPY if the levels of DONATIONS have had ranged wide enough. We should have conducted pre-test especially in this regard.

The first possible reason for such high WTPs is that people have widely different preferences for wildlife (Barbier, 2011). Our respondents may have put much higher values on coral reefs compared to other ecosystems studied previously. The second possible reason is hypothetical biases (see Section 4.4).

The third possible reason is that our DCE assumed a one-time payment for lifetime. So, if the estimated pm-WTPs were divided by 50 years, the yearly payments would range between 6521 and 8288 JPY/year/person. These values are comparable to reported WTPs for conserving coral reefs in Okinawa (3955–5871 JPY/year/person (Fujita, 2003) and 8154 JPY/year/person (Tamura, 2009)) and Taiwan (35.75 USD/year/person) (Tseng et al., 2015), although that in South Korea is much lower (1763 Korean Won, or 1.5 USD/year/household) (Kwon et al., 2018). These computations imply that about 60% of Japanese citizens are willing to pay for conservation of coral reefs in Okinawa at roughly the same levels as local residents of and visitors to Okinawa.

4.2. Relative preference for different conservation targets

MW_{ASC} accounted for 54.0–100.8% of pm-WTP throughout classes and groups (Tables 4a–d & 5 and Supplementary Information S11). It is reasonable that ECS to conserve larger area of coral reefs were preferred the most. For example, Target 11 of the Aichi Target of the Convention on Biological Diversity states as follows (SCBD, 2010): “By 2020, at least 17 percent of terrestrial and inland water areas and 10 percent of coastal and marine areas, …, are conserved…”

Conserving scenic beauty is also essential to tourism, which is also a source of income for sustainable development (UNWTO and UNDP, 2017). It is possible, however, that the outstanding colors (pink) in the photograph used for the level of “70% maintain” in SCENERY (*c.f.* Fig. 1) may have drawn a lot of attention and created an unrealistic bias.

Species richness is important from a conservation perspective as well (Waheed et al., 2015). Managers and experts of coral reefs would have to continue their efforts to promote public awareness of various aspects of coral reefs (McClanahan et al., 2011) under environmental changes.

The interpretation of the values of MW_{KYUSHU} was complicated. Although the authors assumed that an increase of corals in Kyushu is an unfavorable consequence of climate change, a certain amount of respondents may have recognized it as a favorable phenomenon in the DCE.

4.3. Effect of the difference in the types and amount of information on WTPs

For C1 (*i.e.*, “the high-WTP class”), pm-WTPs were estimated as LONG > SHORT > NoInfo > VIDEO, implying that providing detailed information about coral reefs with photos and texts is effective for those with higher household income. Contrary to a previous study (Sandorf et al., 2016) and our own expectation, however, showing video decreased the pm-WTP.

For C2 (*i.e.*, “the low-WTP class”), pm-WTPs were estimated as SHORT > LONG > NoInfo > VIDEO, implying that concise information is easier to understand and is a more effective way to increase the WTP of people who are more sensitive to an increase in the donation amount.

The respondents in class C3 (*i.e.*, “the negative-WTP class”) are regarded to be unwilling to pay for conservation. The pm-WTPs were estimated as LONG > NoInfo > SHORT > VIDEO, indicating that providing detailed information is also effective for such people to reduce negative attitudes toward conservation efforts. On the other hand, treatments of SHORT as well as VIDEO showed negative effects on pm-WTP, running contrary to our expectations.

These results partly support our hypotheses in that (a) information provision increases the WTP for coral reefs, and (b) longer information can be less effective. Contrary to previous studies (Sandorf et al., 2016; *c.f.*, Chen et al., 2020) and our expectation (hypothesis (c) in Section 1.4), however, the estimated pm-WTPs of VIDEO were lowest among groups throughout the classes. One of the possible reasons is that the amount of the information in the video was limited compared to the short and long explanations (Supplementary Information S8). Because the video progress automatically, we edited the video simplifying each slide. Consequently, the total numbers of the text and visual elements in the short, long, and video information were 64, 96, and 42, respectively (the bottom of Supplementary Information S8).

The second possible reason is the absence of a schema and a table in the video. Issues surrounding corals were summarized in a schema and/or a table in the short and long explanations whereas they were broken down into separate slides in the video (element IDs 32–59 in Supplementary Information S8). The schema and/or table may have been more efficient and played a significant role in understanding complex information such as local and global issues surrounding coral reefs. Information that coral reefs serve for education is only presented in the video (element IDs 29–31 in Supplementary Information S8). Contrary, information that coral reefs serve as a natural break water was missing in the video (element IDs 26–28). Such differences might have caused the lower pm-WTP of VIDEO group as well.

The third possible reason is that our video was much longer than attention spans (WISTIA, 2016). Respondents of the VIDEO group might have not been able to keep concentration and just waited until the video ends, whereas those of the SHORT and LONG groups had to click each slide to go through the information.

However, the pm-WTPs of VIDEO was even lower than those of NoInfo in all the classes. The possible reason is that the video was too long and made respondents irritated (Hegner et al., 2016). The length of our video was 157 seconds and was much longer than the medians of the time respondents went through the short (47 seconds) and long (61 seconds) explanations. Moreover, our video was played back in the normal speed and did not allow respondents to accelerate nor to compress to reduce time to go through.

Respondents of online research panels usually participate to surveys motivated by getting rewards (Ohsumi and Maeda, 2008; Hanibuchi et al., 2015). Longer duration periods would reduce the efficiencies and might have been perceived as a goal impediment (Cho and Cheon, 2004). The negative effect of being forced watching lengthy information might have exceeded the positive effect of being provided information in the VIDEO group.

Positive interactions between lnT_{info} and SCENARY, SPECIES, and AREA indicate correlations between longer engagement with information and preference to higher levels of coral reef conservation. Contrary, negative interactions between lnT_{info} and DONATION indicate longer engagement reduced DONATION. Provided information contained an explanation about complexed local and global issues (element IDs 32–56 in Supplementary Information S8). Longer engagement with such an explanation might have made respondents aware of limitation of conservation efforts against negative impacts such as global warming and ocean acidification.

4.4. Potential biases towards the high WTPs

Stated preference method (see Supplementary Information S1) are susceptible to various types of biases (Mitchell and Carson, 1989) such as strategic bias (*i.e.*, strategic misrepresentation of preferences where the respondent wants a specific outcome, *e.g.*, Meginnis et al. (2018)), hypothetical bias (Murphy et al., 2005; Hensher, 2010; Penn and Hu, 2018), and payment vehicle bias (Mitchell and Carson, 1989; see also Section 2.2.1).

Hypothetical bias is a tendency for stated WTPs to exceed actual WTPs because respondents do not have to pay from their own money (Kuriyama, 2008). It may partly explain the extremely high WTPs in class C1.

In our DCE, respondents were explained about a hypothetical to assume as if they lose their own money by the donation (the hypothetical 4 in Section 2.3.2). Enhanced awareness of this hypothetical by careful reading would reduce DONATION. Negative interactions between lnT_{exp} and DONATION support this expectation.

Another issue is that governments may use the collected tax, even a special-purpose tax, for other purposes. Such a worry could increase protest responses (Kuriyama, 2008) and a preference for status quo scenario, resulting in lower WTPs (*i.e.*, payment vehicle bias). Although the relationship between protest responses and WTPs are complexed (Meyerhoff and Liebe, 2008; Frey and Pirscher, 2019), this may partly explain the higher WTPs in the present study than in previous studies that used taxes as payment vehicles.

4.5. Limitations and challenges

In the preparation of the short, long, and video information, we failed to use exactly the same elements. It is unavoidable to some extent but made difficult to interpret the effect of the video information. Our results infer the effectiveness of using a schema or a table, which were not used in our video, in explaining complex environmental issues.

In reference to video contents, Guo et al. (2014) report that the median engagement time is at most six minutes in online learning. In fact 33.3% (815 out of 2448) of our respondents stopped watching the video before end. Lang et al. (2020) reports that students who watched online video contents in 1.25 speed are more likely to get better grades in a course, attempt more content, and obtain more certificates. Conciseness and accelerated playback function may improve the respondents' experience with videos.

Overall, we assume three potential reasons for the lowest WTPs in VIDEO group: 1) insufficiency of textual explanation, 2) lack of a schema and a table, and 3) too long duration time. It would be necessary to pursue effective and efficient amount and type of information to raise awareness of public goods and to reduce biases in DCEs as well.

Our results are suffered with various biases. For example, Ohsumi and Maeda (2008) and Hanibuchi et al. (2015) point out that "frivolous" or problematic responses may be in relation to shorter and/or longer response times. There are no standard or empirical thresholds of abnormally short or long response time (Hanibuchi et al., 2015), and thus we did not exclude respondents with short or long response time. Such examinations would be necessary in further analyses (*e.g.*, Campbell et al., 2018).

5. Conclusions

This study is the first to conduct a discrete choice experiment with approximately 10,000 respondents from all over Japan to quantify WTP for the conservation of coral reefs in Okinawa, which account for more than 90% of coral reefs in Japan (Ministry of the Environment and Japanese Coral Reef Society, 2004). We adopted the latent class logit models, and respondents were classified into three posteriorly-determined classes: (1) a class consisting of about 60% of respondents showing higher WTPs (pm-WTPs = 326,036–414,391 JPY over their lifetime); (2) a class consisting of about 30% of respondents showing lower WTPs (pm-WTPs = 9792–12,262 JPY); (3) a class of about 10% respondents unwilling to pay for conservation efforts (pm-WTPs = (−124,988) − (−20,881) JPY). A respondent of the first class is more likely to be a woman, older, and have a higher income level compared with the third class (reference class). A respondent of the second class is more likely to be a woman, compared to the reference class. The pm-WTPs of the first class were comparable to the reported WTPs in Okinawa (Fujita, 2003; Tamura, 2009) and Taiwan (Tseng et al., 2015). This implies that Japanese citizens, as a whole, are willing to pay for conservation of coral reefs in Okinawa at roughly the same levels as local residents and tourists visiting coral reef areas.

Next, we evaluated relative preferences of respondents for different attributes of conservation scenarios. The most preferred conservation target, which was associated with the highest marginal WTP, tended to be the total area of coral reefs, followed by scenic beauty, and species richness. Because tourism and biodiversity are also important components of coral reefs (Conservation International, 2008), managers toned to continue their efforts promoting public awareness of various and related aspects of coral reefs under environmental change (Duffy et al., 2016).

Finally, we estimated the effect of the types and amount of information on WTP. Providing concise and detailed information, which took 47 and 61 seconds on average to go through, with text (about 300–700 words) and static images (15–20 visuals) prior to the discrete choice experiment increased pm-WTP by 11.7–19.0%. Providing information with video (157 seconds in length with about 180 words and 19 visuals), however, decreased pm-WTPs. These results infer that the presentation of our short and long information were effective, whereas that of the video information was ineffective in that the amount of information was insufficient and/or the duration time was too long. Moreover, our results indicate that the optimal amount of information might differ depending on respondents (*e.g.*, age, gender, and income levels). Further studies would help effectively designing information to promote public awareness of ecosystem services.

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.

Acknowledgements

The authors thank Shintaro Takao for his support in the study design; the Biological Institute on Kuroshio and Yoshihisa Fujita, Naoko Namizaki, Takashi Nakamura, and Yoshikatsu Nakano of Sango 15 Project for providing the photographs used in the explanation of coral reefs in the questionnaire survey; Kohei Iwai for editing the video materials; and Koichi Kuriyama for his support with the statistical analysis.

Funding

This work was a part of the project “Precise Impact Assessments on Climate Change” of the Program for Risk Information on Climate Change (SOUSEI Program, JPMXD0712103606) supported by the Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and was partly supported by the Environment Research and Technology Development Fund (JPMEERF16S11520 and JPMEERF20192007) of the Ministry of the Environment and the Environmental Restoration and Conservation Agency of Japan.

Author contributions

S.M, T.N, H.Y, M.F, N.H.K, Y.Y, and K.T.T conceived the study. Y.Y, K.T.T, and S.M designed the questionnaire survey including the DCE. The levels of SPECIES, AREA, and KYUSHU in the DCE were set by N.H.K and H.Y. K.I conducted the statistical analyses and estimated the WTPs. K.I and K.T.T prepared the manuscript, and all authors revised it critically.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecoser.2020.101166.

References

Aanesen, M., Armstrong, C., Czajkowski, M., Falk-Petersen, J., Hanley, N., Navrud, S., 2015. Willingness to pay for unfamiliar public goods: Preserving cold-water coral in Norway. Ecol. Econ. 112, 53–67. https://doi.org/10.1016/j.ecolecon.2015.02.007.

Adamowicz, W., Louviere, J., Williams, M., 1994. Combining revealed and stated preference methods for valuing environmental amenities. J. Environ. Econ. Manag. 26, 271–292. https://doi.org/10.1006/jeem.1994.1017.

Adamowicz, W., Boxall, P., Williams, M., Louviere, J., 1998. Stated preference approaches for measuring passive use values: Choice experiment versus contingent valuation. Am. J. Agric. Econ. 80, 64–75. https://doi.org/10.2307/3180269.

Adamowicz, W., Swait, J., Boxall, P., Louviere, J., Williams, M., 1997. Perceptions versus objective measures of environmental quality in combined revealed and stated preference models of environmental valuation. J. Environ. Econ. Manag. 32, 65–84. https://doi.org/10.1006/jeem.1996.0957.

Almany, G.R., 2004. Differential effects of habitat complexity, predators and competitors on abundance of juvenile and adult coral reef fishes. Oecologia 141, 105–113. https://doi.org/10.1007/s00442-004-1617-0.

Barbier, E.B., 2011. Capitalizing on Nature: Ecosystems as Natural Assets. Cambridge University Press, New York.

Boxall, P.C., Adamowicz, W.L., 2002. Understanding heterogeneous preferences in random utility models: A latent class approach. Environ. Resour. Econ. 23, 421–446. https://doi.org/10.1023/a:1021351721619.

Brander, L.M., Van Beukering, P., Cesar, H.S.J., 2007. The recreational value of coral reefs: A meta-analysis. Ecol. Econ. 63, 209–218. https://doi.org/10.1016/j.ecolecon.2006.11.002.

Burke, L., Reytar, K., Spalding, M., Perry, A., 2011. Reefs at Risk Revisited. World Resources Institute, Washington DC.

Campbell, D., Mørkbak, M.R., Olsen, S.B., 2018. The link between response time and preference, variance and processing heterogeneity in stated choice experiments. J. Environ. Econ. Manag. 88, 18–34. https://doi.org/10.1016/j.jeem.2017.10.003.

Carpenter, K.E., Abrar, M., Aeby, G., Aronson, R.B., Banks, S., Bruckner, A., Chiriboga, A., Cortes, J., Delbeek, J.C., Devantier, L., Edgar, G.J., Edwards, A.J., Fenner, D., Guzman, H.M., Hoeksema, B.W., Hodgson, G., Johan, O., Licuanan, W.Y., Livingstone, S.R., Lovell, E.R., Moore, J.A., Obura, D.O., Ochavillo, D., Polidoro, B.A., Precht, W.F., Quibilan, M.C., Reboton, C., Richards, Z.T., Rogers, A.D., Sanciangco, J., Sheppard, A., Sheppard, C., Smith, J., Stuart, S., Turak, E., Veron, J.E., Wallace, C., Weil, E., Wood, E., 2008. One-third of reef-building corals face elevated extinction risk from climate change and local impacts. Science 321, 560–563. https://doi.org/10.1126/science.1159196.

Chen, T.-Y., Yeh, T.-L., Chang, C.-I., 2020. How different advertising formats and calls to action on videos affect advertising recognition and consequent behaviours. Serv. Ind. J. 40, 358–379. https://doi.org/10.1080/02642069.2018.1480724.

Cho, C.-H., Cheon, H.J., 2004. Why do people avoid advertising on the internet? J. Advert. 33, 89–97. https://doi.org/10.1080/00913367.2004.10639175.

Connell, J.H., 1978. Diversity in tropical rain forests and coral reefs. Science 199, 1302–1310. https://doi.org/10.1126/science.199.4335.1302.

Conservation International, 2008. Economic values of coral reefs, mangroves, and seagrasses: A global compilation. Center for Applied Biodiversity Science, Conservation International, Arlington, USA.

Couce, E., Ridgwell, A., Hendy, E.J., 2013. Future habitat suitability for coral reef ecosystems under global warming and ocean acidification. Glob. Change Biol. 19, 3592–3606. https://doi.org/10.1111/gcb.12335.

de Ayala, A., Hoyos, D., Mariel, P., 2015. Suitability of discrete choice experiments for landscape management under the European Landscape Convention. J. Forest Econ. 21, 79–96. https://doi.org/10.1016/j.jfe.2015.01.002.

Duffy, J.E., Lefcheck, J.S., Stuart-Smith, R.D., Navarrete, S.A., Edgar, G.J., 2016. Biodiversity enhances reef fish biomass and resistance to climate change. PNAS 113, 6230–6235. https://doi.org/10.1073/pnas.1524465113.

Eguchi, M., 1968. The Hydrocorals and Scleractinian Corals of Sagami Bay Collected by His Majesty the Emperor of Japan. Maruzen Co., Tokyo.

Emerson, J.W., Green, W.A., Schloerke, B., Crowley, J., Cook, D., Hofmann, H., Wickham, H., 2013. The generalized pairs plot. J. Comput. Graph. Stat. 22, 79–91. https://doi.org/10.1080/10618600.2012.694762.

Fabricius, K.E., 2005. Effects of terrestrial runoff on the ecology of corals and coral reefs: review and synthesis. Mar. Pollut. Bull. 50, 125–146. https://doi.org/10.1016/j.marpolbul.2004.11.028.

Frey, U.J., Pirscher, F., 2019. Distinguishing protest responses in contingent valuation: A conceptualization of motivations and attitudes behind them. PLoS ONE 14, e0209872. https://doi.org/10.1371/journal.pone.0209872.

Fujikura, K., Lindsay, D., Kitazato, H., Nishida, S., Shirayama, Y., 2010. Marine biodiversity in Japanese waters. PLoS ONE 5, e11836. https://doi.org/10.1371/journal.pone.0011836.

Fujino, M., Kuriyama, K., Yoshida, K., 2017. An evaluation of the natural environment ecosystem preservation policies in Japan. J. Forest Econ. 29, 62–67. https://doi.org/10.1016/j.jfe.2017.08.003.

Fujita, Y., 2003. Protest responses in contingent valuation method for coral reefs in Kerama islands. Stud. Region. Sci. 34, 367–378. https://doi.org/10.2457/srs.34.3_367.

Grafeld, S., Oleson, K., Barnes, M., Peng, M., Chan, C., Weijerman, M., 2016. Divers' willingness to pay for improved coral reef conditions in Guam: an untapped source of funding for management and conservation? Ecol. Econ. 128, 202–213. https://doi.org/10.1016/j.ecolecon.2016.05.005.

Greene, W.H., Hensher, D.A., 2003. A latent class model for discrete choice analysis: contrasts with mixed logit. Transport. Res. B-Meth. 37, 681–698. https://doi.org/10.1016/S0191-2615(02)00046-2.

Guo, P., Kim, J., Rubin, R., 2014. How video production affects student engagement: An empirical study of MOOC videos. In: Proceedings of the first ACM conference on Learning, pp. 41–50. doi: doi:10.1145/2556325.2566239.

Hanibuchi, T., Muranaka, A., Ando, M., 2015. Challenges of data collection through internet research: Analysis of “frivolous” responses, response time, and geographical pattern. E-j. GEO 10, 81–98. https://doi.org/10.4157/ejgeo.10.81.

Hegner, S.M., Kusse, D.C., Pruyn, A.T.H., 2016. Watch it! the influence of forced pre-roll video ads on consumer perceptions. In: Verlegh, P., Voorveld, H., Eisend, M. (Eds.), Advances in Advertising Research. European Advertising Academy. Gabler Verlag, Wiesbaden, Germany. https://doi.org/10.1007/978-3-658-10558-7_6.

Hensher, D.A., 2010. Hypothetical bias, choice experiments and willingness to pay. Transp. Res. Part B: Method. 44, 735–752. https://doi.org/10.1016/j.trb.2009.12.012.

Hole, A.R., 2007. A comparison of approaches to estimating confidence intervals for willingness to pay measures. Health Econ. 16, 827–840. https://doi.org/10.1002/hec.1197.

Holmes, T., Alger, K., Zinkhan, C., Mercer, E., 1998. The effect of response time on conjoint analysis estimates of rain forest protection values. J. Forest Econ. 4, 7–28.

Hongo, C., Yamano, H., 2013. Species-specific responses of corals to bleaching events on anthropogenically turbid reefs on Okinawa Island, Japan, over a 15-year period (1995–2009). PLoS ONE 8, e60952. https://doi.org/10.1371/journal.pone.0060952.

Hoyos, D., 2010. The state of the art of environmental valuation with discrete choice experiments. Ecol. Econ. 69, 1595–1603. https://doi.org/10.1016/j.ecolecon.2010.04.011.

IPCC, 2013. Climate change 2013: The physical science basis. In: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge and New York.

Jobstvogt, N., Hanley, N., Hynes, S., Kenter, J., Witte, U., 2014. Twenty thousand sterling under the sea: estimating the value of protecting deep-sea biodiversity. Ecol. Econ. 97, 10–19. https://doi.org/10.1016/j.ecolecon.2013.10.019.

Kamakura, W.A., Russell, G.J., 1989. A probabilistic choice model for market segmentation and elasticity structure. J. Market Res. 26, 379–390. https://doi.org/10.2307/3172759.

Kuriyama, K., 2008. Economic analysis of biases in the stated preference data. Rev. Environ. Econ. Policy Stud. 1, 51–63.

Kwon, Y.J., Kim, H.J., Yoo, S.H., 2018. Assessment of the conservation value of Munseom area in Jeju Island, South Korea. Int. J. Sustainable Dev. World 25, 739–746. https://doi.org/10.1080/13504509.2018.1457102.

Lang, D., Chen, G., Mirzaei, K., Paepcke, A., 2020. Is faster better?: A study of video playback speed. Proceedings of the Tenth International Conference on Learning Analytics & Knowledge 260–269. https://doi.org/10.1145/3375462.3375466.

LaRiviere, J., Czajkowski, M., Hanley, N., Aanesen, M., Falk-Petersen, J., Tinch, D., 2014. The value of familiarity: Effects of knowledge and objective signals on willingness to pay for a public good. J. Environ. Econ. Manag. 68, 376–389. https://doi.org/10.1016/j.jeem.2014.07.004.

Laurans, Y., Pascal, N., Binet, T., Brander, L., Clua, E., David, G., Rojat, D., Seidl, A., 2013. Economic valuation of ecosystem services from coral reefs in the South Pacific: Taking stock of recent experience. J. Environ. Manag. 116, 135–144. https://doi.org/10.1016/j.jenvman.2012.11.031.

Levin, P.S., 1994. Small-scale recruitment variation in a temperate fish: the roles of macrophytes and food supply. Environ. Biol. Fish. 40, 271–281. https://doi.org/10.1007/bf00002517.

Louviere, J.J., Woodworth, G., 1983. Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data. J. Market Res. 20, 350–367. https://doi.org/10.2307/3151440.

Louviere, J.J., Flynn, T.N., Carson, R.T., 2010. Discrete choice experiments are not conjoint analysis. J. Choice Model. 3, 57–72. https://doi.org/10.1016/S1755-5345(13)70014-9.

Makino, A., Yamano, H., Beger, M., Klein, C.J., Yara, Y., Possingham, H.P., Loyola, R., 2014. Spatio-temporal marine conservation planning to support high-latitude coral range expansion under climate change. Divers. Distrib. 20, 859–871. https://doi.org/10.1111/ddi.12184.

Malhotra, N., 2008. Completion time and response order effects in web surveys. Public Opin. Quart. 72, 914–934. https://doi.org/10.1093/poq/nfn050.

Mathews, K.E., Freeman, M.L., Desvousges, W.H., 2006. How and how much? The role of information in stated choice questionnaires. Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice. Springer.

McClanahan, T.R., Graham, N.A.J., MacNeil, M.A., Muthiga, N.A., Cinner, J.E., Bruggemann, J.H., Wilson, S.K., 2011. Critical thresholds and tangible targets for ecosystem-based management of coral reef fisheries. PNAS 108, 17230–17233. https://doi.org/10.1073/pnas.1106861108.

Meginnis, K., Burton, M., Chan, R., Rigby, D., 2018. Strategic bias in discrete choice experiments. J. Environ. Econ. Manag. https://doi.org/10.1016/j.jeem.2018.08.010.

Meyerhoff, J., Liebe, U., 2008. Do protest responses to a contingent valuation question and a choice experiment differ? Environ. Res. Econ. 39, 433–446. https://doi.org/10.1007/s10640-007-9134-3.

Ministry of the Environment, Japanese Coral Reef Society, 2004. In: Coral Reefs of Japan. Ministry of the Environment, Tokyo.

Mitani, Y., Shoji, Y., Kuriyama, K., 2008. Estimating economic values of vegetation restoration with choice experiments: a case study of an endangered species in Lake Kasumigaura, Japan. Landsc. Ecol. Eng. 4, 103–113. https://doi.org/10.1007/s11355-008-0049-0.

Mitchell, R.C., Carson, R.T., 1989. Using Surveys to Value Public Goods; The Contingent Valuation Method. Resources for the Future, Washington, D.C.

Moberg, F., Folke, C., 1999. Ecological goods and services of coral reef ecosystems. Ecol. Econ. 29, 215–233. https://doi.org/10.1016/S0921-8009(99)00009-9.

Muko, S., Suzuki, G., Saito, M., Nakamura, T., Nadaoka, K., 2019. Transitions in coral communities over 17 years in the Sekisei Lagoon and adjacent reef areas in Okinawa, Japan. Ecol. Res. 34, 524–534. https://doi.org/10.1111/1440-1703.12013.

Murakami, K., Itsubo, N., Kuriyama, K., Yoshida, K., Tokimatsu, K., 2018. Development of weighting factors for G20 countries. Part 2: estimation of willingness to pay and annual global damage cost. Int. J. Life Cycle Assess. 23, 2349–2364. https://doi.org/10.1007/s11367-017-1372-1.

Murphy, J.J., Allen, P.G., Stevens, T.H., Weatherhead, D., 2005. A meta-analysis of hypothetical bias in stated preference valuation. Environ. Res. Econ. 30, 313–325. https://doi.org/10.1007/s10640-004-3332-z.

Næs, T., Varela, P., Berget, I., 2018. Individual differences in choice and ranking experiments. In: Næs, T., Varela, P., Berget, I. (Eds.), Individual Differences in Sensory and Consumer Science. Woodhead Publishing, Cambridge, pp. 171–189. https://doi.org/10.1016/B978-0-08-101000-6.00008-1.

Ohdoko, T., Yoshida, K., 2012. Public preferences for forest ecosystem management in Japan with emphasis on species diversity. Environ. Policy Stud. 14, 147–169. https://doi.org/10.1007/s10018-011-0026-y.

Ohsumi, N., Maeda, T., 2008. Problems of online surveys (2) from experiment. J. Japan Assoc. Public Opin. Res. 101, 79–94. https://doi.org/10.18969/yoron.101.0_79. (in Japanese).

Omijya, T., 2004. Terrestrial inflow of soils and nutrients. In: Tsuchiya, M., Nadaoka, K., Kayanne, H., Yamano, H. (Eds.), Coral reefs of Japan. Ministry of the Environment and Japanese Coral Reef Society, Tokyo, pp. 64–68.

Penn, J.M., Hu, W., 2018. Understanding hypothetical bias: An enhanced meta-analysis. Am. J. Agric. Econ. 100, 1186–1206. https://doi.org/10.1093/ajae/aay021.

R Core Team, 2019. R: A language and environment for statistical computing. R foundation for statistical computing, Vienna, Austria. URL https://www.r-project.org/.

Rodrigues, L.C., van den Bergh, J.C.J.M., Loureiro, M.L., Nunes, P.A.L.D., Rossi, S., 2016. The cost of Mediterranean Sea warming and acidification: a choice experiment among scuba divers at Medes Islands, Spain. Environ. Resour. Econ. 63, 289–311. https://doi.org/10.1007/s10640-015-9935-8.

Sakata, Y., 2007. A choice experiment of the residential preference of waste management services – the example of Kagoshima City, Japan. Waste Manag. 27, 639–644. https://doi.org/10.1016/j.wasman.2006.03.007.

Sandorf, E.D., Aanesen, M., Navrud, S., 2016. Valuing unfamiliar and complex environmental goods: a comparison of valuation workshops and internet panel surveys with videos. Ecol. Econ. 129, 50–61. https://doi.org/10.1016/j.ecolecon.2016.06.008.

Senzaki, M., Yamaura, Y., Shoji, Y., Kubo, T., Nakamura, F., 2017. Citizens promote the conservation of flagship species more than ecosystem services in wetland restoration. Biol. Conserv. 214, 1–5. https://doi.org/10.1016/j.biocon.2017.07.025.

Shah, P., Dissanayake, S.T.M., Fujita, Y., Nunes, P.A.L.D., 2019. Impact of a local, coastal community based management regime when defining marine protected areas: Empirical results from a study in Okinawa, Japan. PLoS One 14 (3), e0213354. https://doi.org/10.1371/journal.pone.0213354.

Shen, J., 2009. Latent class model or mixed logit model? A comparison by transport mode choice data. Appl. Econ. 41, 2915–2924. https://doi.org/10.1080/00036840801964633.

Shimoike, K., 2004. Boso Peninsula. In: Tsuchiya, M., Nadaoka, K., Kayanne, H., Yamano, H. (Eds.), Coral reefs of Japan. Ministry of the Environment and Japanese Coral Reef Society, Tokyo, pp. 232–233.

Shoyama, K., Managi, S., Yamagata, Y., 2013. Public preferences for biodiversity conservation and climate-change mitigation: A choice experiment using ecosystem services indicators. Land Use Policy 34, 282–293. https://doi.org/10.1016/j.landusepol.2013.04.003.

Shr, Y.-H., Ready, R., Orland, B., Echols, S., 2019. How do visual representations influence survey responses? Evidence from a choice experiment on landscape attributes of green infrastructure. Ecol. Econ. 156, 375–386. https://doi.org/10.1016/j.ecolecon.2018.10.015.

Tamura, M., 2009. Management approaches toward the sustainable use of coral reefs: Questionnaire survey on socioeconomic value of coral reefs among Akajima community. J. Japan. Coral Reef Soc. 11, 9–22. https://doi.org/10.3755/jcrs.11.9.

Sawtooth Software Inc., 2013. The CBC System for Choice-Based Conjoint Analysis. Version 8, Sawtooth Software Technical Paper Series.

The Secretariat of the Convention on Biological Diversity (SCBD), 2010. Aichi Biodiversity Targets. Technical Rationale extended. Target 11. < https://www.cbd.int/sp/targets/rationale/target-11/ > . Accessed February 2020.

Train, K.E., 2008. EM algorithms for nonparametric estimation of mixing distributions. J. Choice Model. 1, 40–69. https://doi.org/10.1016/S1755-5345(13)70022-8.

Tseng, W.W.-C., Hsu, S.-H., Chen, C.-C., 2015. Estimating the willingness to pay to protect coral reefs from potential damage caused by climate change—the evidence from Taiwan. Mar. Pollut. Bull. 101, 556–565. https://doi.org/10.1016/j.marpolbul.2015.10.058.

Veron, J.E.N., 1992. Hermatypic corals of Japan. Aust. Inst. Mar. Sci. Monogr. Ser. 9, 234.

Waheed, Z., van Mil, H.G., Syed Hussein, M.A., Jumin, R., Golam Ahad, B., Hoeksema, B.W., 2015. Coral reefs at the northernmost tip of Borneo: An assessment of scleractinian species richness patterns and benthic reef assemblages. PLoS ONE 10, e0146006. https://doi.org/10.1371/journal.pone.0146006.

Wakamatsu, M., Shin, K.J., Wilson, C., Managi, S., 2018. Exploring a gap between Australia and Japan in the economic valuation of whale conservation. Ecol. Econ. 146, 397–407. https://doi.org/10.1016/j.ecolecon.2017.12.002.

Wakita, K., Kurokura, H., Oishi, T., Shen, Z., Furuya, K., 2019. Exploring the effect of psychometric variables on willingness to pay for marine ecosystem services: A survey in Japan. Ecosyst. Serv. 35, 130–138. https://doi.org/10.1016/j.ecoser.2018.12.003.

Williams, D.M., Sale, P.F., 1981. Spatial and temporal patterns of recruitment of juvenile coral reef fishes to coral habitats within "one tree lagoon", great barrier reef. Mar. Biol. 65, 245–253. https://doi.org/10.1007/bf00397118.

WISTIA, 2016. How Long Should Your Next Video Be? < https://wistia.com/learn/marketing/optimal-video-length > .

World Tourism Organization (UNWTO), United Nations Development Programme (UNDP), 2017. Tourism and the sustainable development goals – journey to 2030. UNWTO, Madrid. https://doi.org/10.18111/9789284419340.

Yamano, H., Sugihara, K., Nomura, K., 2011. Rapid poleward range expansion of tropical reef corals in response to rising sea surface temperatures. Geophys. Res. Lett. 38. https://doi.org/10.1029/2010GL046474.

Yamano, H., Sugihara, K., Watanabe, T., Shimamura, M., Hyeong, K., 2012. Coral reefs at 34°N, Japan: Exploring the end of environmental gradients. Geology 40, 835–838. https://doi.org/10.1130/g33293.1.

Yamaura, Y., Shoji, Y., Mitsuda, Y., Utsugi, H., Tsuge, T., Kuriyama, K., Nakamura, F., 2016. How many broadleaved trees are enough in conifer plantations? The economy of land sharing, land sparing and quantitative targets. J. Appl. Ecol. 53, 1117–1126. https://doi.org/10.1111/1365-2664.12642.

Yara, Y., Fujii, M., Yamano, H., Yamanaka, Y., 2014. Projected coral bleaching in response to future sea surface temperature rises and the uncertainties among climate models. Hydrobiologia 733, 19–29. https://doi.org/10.1007/s10750-014-1838-0.

Yara, Y., Vogt, M., Fujii, M., Yamano, H., Hauri, C., Steinacher, M., Gruber, N., Yamanaka, Y., 2012. Ocean acidification limits temperature-induced poleward expansion of coral habitats around Japan. Biogeosciences 9, 4955–4968. https://doi.org/10.5194/bg-9-4955-2012.

Yara, Y., Yamano, H., Steinacher, M., Fujii, M., Vogt, M., Gruber, N., Yamanaka, Y., 2016. Potential future coral habitats around Japan depend strongly on anthropogenic CO_2 emissions. In: Nakano, S., Yahara, T., Nakashizuka, T. (Eds.), Aquatic Biodiversity Conservation and Ecosystem Services. Springer, Tokyo, pp. 41–56. https://doi.org/10.1007/978-981-10-0780-4.

Yoshihara, H., Takehiko, K., 1978. Fauna and flora in the waters adjacent to the sado marine biological station, niigata university. In: Annual Report of the Sado Marine Biological Station. Niigata University, pp. 7–81.

Zhai, G., Fukuzono, T., Ikeda, S., 2007. Multi-attribute evaluation of flood management in Japan: a choice experiment approach. Water Environ. J. 21, 265–274. https://doi.org/10.1111/j.1747-6593.2007.00072.x.