[Revised Draft by Authors]

Public Preferences for Forest Ecosystem Management in Japan with Emphasis on Species Diversity

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Abstract

We carried out online choice experiments (CE) to investigate what value Japanese individuals assign to rare *vs*. familiar species in forest ecosystems, and to determine how preference heterogeneity arises. CE attributes comprised a forestry charge as the price attribute and rare *vs*. familiar species of animals or plants as the good to be valued. Species numbers in a 5 km mesh forest area were evaluated without the use of species names so as to focus purely on responses to numerical changes. In addition, attribute positional effects were tested to validate results regarding attributes other than the price attribute along with alternative positional influences.

A random parameter logit model was adopted to capture preferences for species diversity. We show that positional effects did not affect attributes other than the price attribute, and did not influence alternatives. We find that 1) rare animals are valued more highly than rare plants; 2) familiar plants are assigned a positive value, but familiar animals are not assigned significant value at the mean parameter estimate and 3) preference heterogeneities exist for all species.

The sources of preference heterogeneity were analyzed with a latent class model having principal components of attitudes toward the environment. The influence of such attitudes is shown to be significant, and suggests that attention should be paid to belief systems rather than solely demographics.

Keywords: forest ecosystem; species diversity; choice experiment; attribute positional effects; environmental attitudes

1. Introduction

Increasing attention has been paid to biodiversity and ecosystem services recently, particularly in the lead-up to the 10th Conference of the Parties (COP10) of the Convention on Biological Diversity, held in Nagoya City, Japan in October 2010. In addition, International Science Workshop was held in Tokyo, Japan in July 2011, on Assessments for Intergovernmental Platform on Biodiversity and Ecosystem. More research on biodiversity preservation has been called for in this context.

While biological and ecological knowledge is essential for practical management of ecosystems, an economic perspective has been increasingly required to confirm efficient management and to capture the preferences of local residents. Azqueta and Sotelsek (2007) pointed out that Geographic Information System (GIS) on environmental assets should be coupled with its economic values ideally in order to incorporate the values of natural capital into national accountings; "greening the national accounts (Bartelmus (2009); P.1850)". Dasgupta (2009) criticized current attempts of green national accounting and indicated the importance of estimating and utilizing shadow prices of environmental assets with national accounts. Engelbrecht (2009) demonstrated that the relationship is robust between macro-level subjective welfare and natural capital per capita. Especially on forestry accounting, Jobstl (2009) insisted it is necessary to highlight on the assessment of non-market benefits. Thus, we should simultaneously cumulate both natural and social scientific knowledge as soon as possible, where the latter must consist of market and non-market values of natural assets include biodiversity and ecosystem.

Though there are increasing calls for economic evaluation of biodiversity and ecosystem, its researches seem to be scarce especially in Japan. On biological and ecological knowledge, for example, Japan Integrated Biodiversity Information System has been trying to collect and cumulate information on the species diversity in Japan[1]. Japan Biodiversity Outlook Science Committee and the Ministry of the Environment (2010) conducted the natural scientific assessment of biodiversity. On the other hand to the extent of our knowledge, there are no economic researches on public preferences for biodiversity as a whole in Japan, which definitely includes the species diversity. It may lead to the situation that effective policies have been absent and opportunities have been missed. Thus, we in Japan should also try to collect and cumulate the information on the public preferences for the species diversity.

At present, there is a good deal of research being carried out on economic evaluations of biodiversity. The objectives in economic evaluations of species diversity are to clarify 1) whether species should be preserved, 2) how preservation should be carried out and 3) whether some strategies are more effective or efficient than others. Nunes and van den Bergh (2001) summarized existing case studies and described several conflicting or complementary structures relating to biodiversity values. Their approach emphasizes that it is important to 1) keep in mind that there exist both measurable and non-measurable values, 2) estimate not only use values but non-use

[1] http://www.biodic.go.jp/english/J-IBIS.html

values, 3) approach both natural and social science using appropriate macro and micro concepts, and 4) gather both expert and general opinion. Furthermore, they summarized connections between biodiversity and social welfare. When evaluating biodiversity, it should be kept in mind that four levels exist, which include 1) genetic/species diversity, 2) landscape diversity, 3) ecological functions/services, and 4) passive use values. In addition, it is possible to address several kinds of economic values and to estimate passive use values along with ecosystem services as use values. Christie et al. (2006) divided biodiversity concepts into two groups: ecological concepts and anthropocentric concepts. Choice experiments (CE) were carried out using four sub-concepts; 1) habitat quality and 2) ecosystem processes, based on ecological concepts; 3) rare or unfamiliar species of wildlife and 4) familiar species, based on anthropocentric concepts. Thus, we should conduct simultaneous multi-attribute evaluation of biodiversity.

Conjoint analysis is appropriate for simultaneous evaluation of the several kinds of characteristics possessed by biodiversity. This approach started with the concept of conjoint measurement (Luce and Tukey, 1964), although certain operational notions had previously been proposed by Thurston (1927). Practical methods were developed at Psychometrics and Marketing (Louviere et al., 2000). Conjoint analysis is carried out by choosing preferred types (CE) and ranking different types (Contingent Ranking) in such a way that one clarifies preferences for multi-attribute options. CE has become an increasingly reliable approach due to a range of methodological improvements.

Recent CE studies covering forest ecosystem biodiversity, along with the treatment of biodiversity used in each case, are summarized in Table 1[2]. Each study focused on site-specific species diversity. There do not appear to be any studies that evaluate biodiversity at a national level. However, in considering national strategies related to ecosystems, it is important to conduct evaluation studies at a national level.

<Table 1>

In considering biodiversity, it appears likely that members of the public may interpret this in terms of the species diversity. On animal species, Adamowicz et al. (1998) employed mountain caribou and moose population. Naidoo and Adamowicz (2005) adopted the number of bird species seen and chance of seeing large wildlife. Shapansky et al. (2008) used the numbers of certain representative species such as moose or woodland caribou. On plant species, Hanley et al. (1998) employed the mixture level of species of plant, while Nielsen et al. (2007) used broadleaves and conifers. Wang et al. (2007) utilized the number of plant species present. On the whole species, Horne et al. (2005) used the total number of species. On the rarity of species, Lehtonen et al. (2003) utilized the number of endangered species. Bienabe and Hearne (2006) and Carlsson et al. (2003)

[2] Ojea et al. (2010) also reviewed on the economic valuation studies on biodiversity in forests, including the other methodologies, such as a contingent valuation method.

used the number of area-conserving species, while Garber-Yonts et al. (2004) employed endangered species along with the protection of salmon habitat streams and the patch of land to reserve biodiversity as a whole. Some studies focused solely on the width of protected area; for example, Mallawaarachchi et al. (2001) adopted the width of conserving area of Teatree woodlands and vegetation. In addition, Siikamaki and Layton (2007) highlighted biodiversity hotspots. However, no previous studies have conducted some integrated research on numerical trade-off between animal and plant species with those rarities.

We have used CE to study whether one can state the preference for purely numerical definitions of species richness by focusing on the rarity of animal and plant species in Japanese forests at national level. Species were defined numerically without the use of names so as to avoid the effects of distribution, site-specific characteristics and so on, enabling us to investigate general tendencies in preferences for the species diversity within Japan. We employed a random parameter logit (RPL) in order to grasp overall features of the preference heterogeneity, and a latent class model (LCM) in order to investigate that heterogeneity in detail.

The remainder of the paper is organized as follows: Section 2 describes the online survey design in terms of contents, scheme scenarios, sample features and so on. The econometric method is explained in Section 3, and the results are given in Section 4. Section 5 is the discussion, with concluding remarks and topics for future research in Section 6.

2. Online Survey Design

With the intention of focusing on Japanese forest ecosystems as a whole, we developed an Internet questionnaire to gather respondents from across the country. We carried out the online survey from January 26-29th, 2009 in association with Macromill, Inc. Demographics are given in Table 2.

Some information on forest ecosystems was presented in the first part of the questionnaire, with the cooperation of the Forestry and Forest Products Research Institute (FFPRI), Japan. First, we described the species present in forest ecosystems, describing how mature forest ecosystems provide many species with habitats, with timbers as the dominant plants being supported by organisms living in the soil. Respondent comprehension was tested using questions on interspecies relationships in the forest ecosystem. Second, facts relating to the status quo of Japanese forest ecosystem were presented (see also Appendix A); the area covered by Japanese forests is 250,000 km^2 or two thirds of the country; there are about 150 animals, excluding immigrant species but including 42 species classified in the Japanese red (endangered) list; there are 200 birds, including 53 red-listed species; there are about 1,000 species of timber and 7,000 vascular plants, including 690 red-listed species. Third, the notion of endangered species was introduced using information from the Red Data Book. Finally, respondents were told that we are developing an improved management scheme for species richness, as the current management of forest ecosystems seems to be insufficient.

We took the unit of management to be in the range that members of the public travel on foot each day, which covers a radius of less than 3.0 km based on the results of Kunimitsu (2005) on the attraction range of rural parks beside irrigation canals in Japan (see also Appendix B)[34]. Targeted species comprised rare species defined as endangered species grade 1 and 2 in the Japanese red list, as compared with familiar species. The payment vehicle was a single annual payment of a forestry charge by each household to fund a management system. We presented CE questions with three attributes eight times as a practice exercise, followed by eight CE questions using the full five attributes. Possible correlation of the attributes was eliminated by the experimental design methodology, primarily using fractional factorial design. Sixteen profiles were created, and choice sets were created by randomly selecting 2 of 16 profiles.

Though a status quo option are frequently included in similar studies, we omitted such options because we hoped to concentrate on grasping overall trends of public preferences for the species diversity in Japan by using the same online survey across different Japanese local prefectures. Instead of setting such option, we described in detail about the status quo of Japanese forests with regard to the species diversity (see also Appendix A). Most of respondents answered they understood the description (Table 2). Thus, we assumed that respondents understood and perceived the status quo of Japanese forests in choosing an alternative from each choice set.

In addition, we omitted other opt-out options, such as “no choice”. The inclusion of the opt-out option enables to mimic real situation (Ryan and Skatun (2004)), while including various types of no-opinion options reduces the sample size of yes and no responses (Fenichel et al. (2009)). De Blaeij et al. (2007) pointed out that the inclusion of no-preference option is relevant for the analysis by utilizing a nested logit model. On the other hand, Carlsson et al. (2007) investigate the effect of inclusion of not-to-buy options in the context of the purchase of minced beef by utilizing a random parameter logit model (RPL) which is more flexible method than a nested logit model. They suggested that there are no such effects on the marginal willingness to pay. Thus, we decided to omit them in order to obtain large sample size, and to concentrate just on public preferences for the species diversity with just a marginal change[5].

We presented mathematical expressions for magnitude and units (species/yen) since the definitions of each attribute were found to confuse respondents (see also Appendix B). Focus groups and pre-testing are important to make CE more effective. We thus asked FFPRI and their colleagues in Japan to respond to preliminary CE questions to identify the levels of attributes.

We listed management contents before each CE question so that respondents could always

[3] Although Kunimitsu et al. (2005) focused on rural parks; their results can be used for our purposes, as forest ecosystems in Japan are mainly dispersed in rural areas. They conclude that a radius of 2.1-2.9 km is a credible estimate of the attraction range of rural parks (Kunimitsu et al. 2005: P.271).

[4] In the first place, we aimed to link social welfare with GIS such as Japan Integrated Biodiversity Information System. Thus, we tried to develop the estimation procedure for evaluating the species diversity in some geographic mesh. However, our design may have some limitation in the context of estimation of welfare measures. Thus, we set this issue of the linkage as the topic of future research.

[5] Thus, there may be some limitation on our estimates below in the context of unbiased welfare measures.

check the meaning of the listed attributes (see also Appendix B). The contents were defined as follows; 1) *Preserving Familiar Animals* refers to management of mammals and birds familiar in the forest. The more the number of species in this class increases, the more familiar animals will be present in the forest; 2) *Preserving Familiar Plants* refers to management of vascular plants familiar in the forest. The more the number of species in this class increases, the more familiar plants will be present in the forest; 3) *Preserving Rare Animals* refers to management of rare mammals and birds registered in the red list. The more the number of species in this class increases, the more rare animals can be seen in the forest; 4) *Preserving Rare Plants* refers to management of rare vascular plants registered in the red list. The more the number of species in this class increases, the more rare plants can be seen in the forest.

<Table 2>

<Table 3>

We created four split samples in which the order of rare and familiar species of animals and plants was varied in order to test whether there are non-monetary attribute positional biases and to obtain more rigorous estimated results (cf. Chrzan (1994), Scott and Vick (1999), Farrar and Ryan (1999), Kjær et al. (2006), among others). The price attribute was defined as an annual forestry charge to each household and was placed at the bottom of the choice set to allow conservative estimates. The split sample definition was as follows: 1) Group A (Basic Design) was ordered as preserving familiar animals (FA), familiar plants (FP), rare animals (RA) and rare plants (RP); 2) Group B: RA, RP, FA and FP; 3) Group C: RP, RA, FP and FA; and 4) Group D: FP, FA, RP and RA.

3. Econometric Method

To analyze CE data, we present a random utility model, where we define the utility of the respondent who chooses alternative i as being;

$$U_i=V_i+\varepsilon_i=\beta x_i+\varepsilon_i \qquad (1)$$

where V_i denotes the observable component, while ε_i describes the unobservable error component and x_i the attribute vector of alternative i, which has marginal utility vector β. Previous studies have employed an additive separated form for the observable component, which we also utilize.

McFadden (1974) showed that the choice probability of i among J alternatives becomes a conditional logit model (CL) with the first extreme value distribution assumed on the error component as follows:

$$P_i = \exp(V_i) / \sum \exp(V_j) \qquad (2)$$

Revelt and Train (1998) demonstrated that RPL with repeat data to estimate the choice probability with preference heterogeneities can relax the assumptions of CL: preference homogeneity and independence of irrelevant alternatives. The choice probability of respondent n (n = 1…N) is given as follows within the parameter space Ω:

$$\pi_{ni} = \int \prod P_{nit} f(\beta|\Omega) d\beta \qquad (3)$$

where t (t = 1…T) denotes the number of times the respondent answers, and P_{nit} is in the form of CL.

Greene and Hensher (2003) compared RPL with LCM. Assuming that c (c = 1…C) denotes the number of probabilistic segments to which respondents belong. The choice probability becomes:

$$\pi_{ni} = \sum [\exp(M(z_n)) / \sum \exp(M(z_n)) \prod P_{nit|c}] \qquad (4)$$

$M(z_n)$ is referred to as a “membership function”, showing why the respondent can belong to the unobservable segments c (c = 1…C) with psychological attitudes z_n (see also Kontoleon and Yabe 2006).

When conducting LCM, one should determine the number of classes exogenously. Though previous researchers have employed several kinds of information criterion to determine the number of classes, it seems that deciding on a model requires the discretion of the researcher. There are many criteria employed by previous studies: Log Likelihood (LL), McFadden’s ρ, AIC, crAIC, AIC3 and BIC (Andrews and Currim 2003, Birol et al. 2009, Kuriyama et al. 2010, among others) We employed several criteria in determining the number of classes in order to validate our estimated result; LL, McFadden’s ρ, AIC3 and BIC.

We used Equation (3) to capture overall preference heterogeneities, and Equation (4) to seek for sources of heterogeneous preferences in detail. In defining a membership function, we conducted a principal component analysis (PCA) of psychological attitudes with rotation in order to obtain efficient results, and used the scores of the principal components along with other demographics.

An implicit price (IP) is estimated as follows, where bid denotes the price attribute and q denotes the other attributes.

$$IP_q = -\beta_q / \beta_{bid} \qquad (5)$$

We utilized Limdep 9.0 + NLOGIT 4.0 (Econometric Software, Inc.) when estimating RPL and LCM, while R 2.13.0 when PCA in order to use varimax rotation[6][7]. We used 1,000-time Monte Carlo simulations with the mean and the variance matrix of mean parameters to estimate confidence intervals of IP (Krinsky and Robb (1986)). In addition, we set an alternative specific constant to the left option in the choice set in order to test some alternative positional bias, which Chrzan (1994) pointed out.

In searching the best fit model on RPL, we put high priority on the significance of standard deviation parameters in order to grasp the structure of preference heterogeneities, then, on fit measures above; LL, McFadden's ρ, AIC3 and BIC. On LCM, we did on that at least one covariate in the membership function, except a constant term, is significantly estimated in order to interpret the result in detail, then, on fit measures above in estimating with each number of class, which ranges from two to five.

4. Results

4.1. RPL Result

When estimating with RPL, the forestry charge parameter was assumed to be fixed in order to estimate IP much simply, while the other marginal utility parameters had normal distributions.

Before conducting full sample analysis, we applied Complete Combinatorial (CC; Poe et al. (2005)) with IP to the result of RPL with every combination of split samples: FA, FP, RA, and RP. The results suggested that our econometric valuation results are statistically robust to attribute positional biases. In addition, we tried to estimate an alternative specific constant set to the left option in the choice set. However, it was not statistically significant in any instance. Thus, we concluded that there is no alternative positional bias, and omitted the constant.

Then, each split sample was pooled and reanalyzed (Table 4). Every standard deviation parameter could be estimated significantly at 0.1%, meaning that every attribute has preference heterogeneity. Only the attribute of FA could not be estimated significantly. However, we were able to identify certain distributions of the FA parameter with a zero mean, as the standard deviation parameter of FA was estimated significantly. The sign of each significant parameter is intuitively interpretable. Again, more species richness corresponds to a more preferred management scheme, in contrast to forestry charges.

We estimated IP for each attribute as for species richness. It has been assumed that the management scheme is carried out in each 25 km^2 cell and the forestry charges are paid by the household once per year. Thus, IP is considered as the household's willingness to pay for the

[6] In order to conduct PCA with varimax rotation, we modified the R program "princomp2" in Shigenobu Aoki website (retrieved on Oct. 4th 2011): http://aoki2.si.gunma-u.ac.jp/R/princomp2.html (In Japanese only)

[7] For example, Nunes et al. (2009) employed varimax rotation to factor analysis in order to interpret factors easily. In addition, we appreciate the anonymous reviewers recommended we should conduct PCA with some rotation procedure in order to obtain more rigorous results.

scheme per cell per year. The mean IP estimate for FA is 0 yen / (cell*year), but it differs across respondents. An average of around 3 yen / (cell*year) for FP with a 95% confidence interval (CI) ranges from 2.405 to 3.771; around 73 for RA with CI ranges from 66.352 to 85.332; around 32 for RP with CI ranges from 29.009 to 39.210. Therefore, the relative dominance of the IPs is estimated as $IP_{RA} > IP_{RP} > IP_{FP}$ ($> IP_{FA}$), meaning that: 1) rare species are preferred to familiar species as a whole, 2) rare animals are preferred to rare plants, and 3) familiar plants are preferred to familiar animals.

<Table 4>

4.2. LCM Result

Preference heterogeneities were demonstrated to exist with each attribute for species richness by the results of RPL. Therefore, we analyzed using LCM to clarify the sources of preference heterogeneity. In estimating these, we addressed membership functions of 1) psychological attitudes to the whole environment, 2) those of forest richness and 3) other characteristics of respondents. In estimating principal components, we decided to distinguish between attitudes toward the environment as a whole and attitudes towards forest-specific richness specifically. In addition, we adopted those with an eigenvalue greater than unity and interpreted the data by concentrating on component loadings greater than 0.5. Principal components of psychological attitudes toward the environment or nature as a whole are interpreted as follows: PC1 means *conscious of environmental issues*; PC2 means *believes influences on environment are caused by human due to the limitation of the knowledge*; PC3 means *aware of current limitations in human knowledge* (Table 5). Then, those attitudes specifically related to forest richness are interpreted as follows: PC4 means *negative toward total forest species diversity management* (Table 6).

<Table 5>

<Table 6>

The fit measures of LCM are presented in Table 7 with various combinations of covariates, while estimated results are given in Table 8[8]. According to Table 7, it was possible to employ a 3-class model. We obtained the estimated results with PC2, PC3 and PC4 as membership functions, while no demographic distinctions were supported (Table 8)[9]. Firstly, quantitative interpretations were conducted as follows; PC3 is significantly estimated in the membership function with a negative sign in class 1, while PC4 with a positive sign. Thus, those respondents are more likely to

[8] We tried to estimate LCM with various numbers of classes, which ranges from two to five. Though we obtained estimated results on 4-class and 5-class model, the both of covariates, even of some of constant terms in the membership function could not be significantly estimated. Thus, we interpreted 4 and 5 classes were redundant.

[9] We employed demographics in Table 2 as covariates. However, no demographics were significantly estimated.

belong to this class who are less *aware of current limitations in human knowledge* and more *negative toward total forest species diversity management*. People in this class are more likely to evaluate management for rare animal and familiar species in this order, but not for familiar animal species. PC2 is significantly estimated with a negative sign in class 2. Thus, respondents are more likely to fall into this class, those who are less *believes influences on environment are caused by human due to the limitation of the knowledge*. People in this class seems to have the most extreme features of the preference, and to take it for granted that management for familiar plants and rare animals is taken as positive, and individuals are extremely willing to pay forestry charges even when the amount increases. Compared to the other classes, those respondents are more likely to incorporate into class 3 who are more *believes influences on environment are caused by human due to the limitation of the knowledge*, more *aware of current limitations in human knowledge*, and less *negative toward total forest species diversity management*. They consider that management must be paid for or don't perceive the payment as burdensome, as the parameter of forestry charges is not significantly estimated. On the other hand, they prefer certain management for rare species, while dislike that for familiar species.

<Table 7>

<Table 8>

5. Discussion

By using results from RPL with full samples, we suggest certain conclusions as follows: 1) the number of species is adequate as a sole measure for evaluation; 2) as a mean value estimate, the value of preserving rare animals is twice than that of rare plants; 3) preserving familiar plants is economically evaluated to a certain degree; 4) there may be positive and negative opinions in terms of preserving familiar animals, with the mean value being neutral; 5) every species is heterogeneously preferred. Prior studies have not been able to consider purely numerical trade-off structures along with the rarity and the kind of species at national level, as they addressed site-specific species. In contrast, we can conclude that members of the public can attribute value to the number of species in the absence of site specificity, geographical distribution, charismatic features, etc. The value attributed to rare species is different between animals and plants, which suggests that one should take into account residents' opinions when carrying out environmental evaluations and policy development. As the numbers of registered mammals and birds are much fewer than those of vascular plants, it seems from our results that members of the public accept mammals and birds as targets of environmental policy, while they may ignore vascular plants even though these are numerically dominant in the forest ecosystem. In aiming for preservation of vascular plants, it is important to have not only economic justifications but also ecological and biological justifications. There may be two influences on the positive evaluation of familiar plants:

there are plenty of familiar plants which have market value; familiar plants form a large part of the landscape in the forest ecosystem. Aspects of scenic beauty or landscape diversity, including mosaic colonies and corridors to enable birds to transfer between plant colonies, may merit more attention. In addition, preserving familiar animals may be difficult as there may be positive and negative opinions that tend to neutralize each other. Members of the public may see them either as beneficial or harmful, depending on agricultural influences because most of Japanese forest disperses in rural area.

There are influences of residential characteristics on preference as suggested by LCM. Psychological attitudes influence notions of species richness; while socioeconomic characteristics do not seem to play a role. Class 1 comprises individuals who are more likely to consider rare animal and familiar plant species diversity as something to be protected. They appear to consider that current human knowledge is well enough to conduct certain management for forest species diversity, but that it is not desirable to implement the management for *total* species diversity. They show some willingness to pay for preserving rare animal and familiar plant species. On the other hand, members of this class may see familiar animals as harmful. Members of class 2 are unlikely to be conscious of influences of human on environment and of current limitations of science. They are extremely willing to pay for management, especially that of familiar plants and rare animals. Familiar plants appear to be the dominant species in forests, and this can serve as a visual symbol of forest management. Rare animals tend to be treated as clear targets via documents such as the red list. Class 3 is made up of members of the public who are conscious of the influences of human on environment, and of current limitation of science. Then, they like *totally* managing forest species diversity as the attitudes. However on the preference, members of this class seem to prefer management for rare species, not for familiar ones, and are insensitive to paying for that outcome. Thus, it appears that there are certain numbers of people who may be committed to preventing loss of species.

We can interpret the LCM result as topics of “warm glow”; for example, “when people make donations to privately provided public goods, they may not gain utility from increasing its total supply, but they may also gain utility from the act of giving (Andreoni (1990); P.473).” On environmental issues, for example, Nunes et al. (2009) demonstrated two components of warm glow; material or project-specific one, which relates to the satisfaction from specific sites and means the project involves; immaterial or moral one, which is independent from material one and relates to ethics of playing roles on the total provision of environmental quality. Our LCM results suggest some possibility of warm glow and policy implications. Firstly, members of class 2 indicates that people can extremely prefer for, and perceive as burdensome, management for species diversity that contains both the visual symbol, such as familiar plants, and the clear target, such as rare animals. This type of warm glow can be classified as moral one, and seems to be mainly attributable for forest charges and their ignorance of current limitation of science. It suggests that solely some obligation such as forest charges may cause moral warm glow, thus, we should consider policy mix with other mechanism design, such as payment for ecosystem services (Millennium Ecosystem Assessment (2005), Engel et al. (2008) among others). Moreover, it indicates that current limitation of science should be told carefully in conducting some forest management. Secondly, members of class 3 suggests that people, those who are likely to be committed to preventing loss of species, do not perceive payment for rare species management as burdensome. This type of warm glow can be categorized as project-specific one. It indicates that we should not conduct management with emphasis only endangered species, and that we should put targets some environmental scheme on *total* management.

6. Conclusion

In summary, we conducted an online survey with CE questions on species richness in Japanese forest ecosystems. It is suggested that rare animals are evaluated more positively than rare plants, while familiar plants are also positively evaluated, and there exist both positive and negative opinions on preserving familiar animals, with a neutral attitude as an averaged opinion. We conclude that preserving rare species should be justified not just by economics but also by ecology and biology, that forest ecosystem landscapes should be more of a focus of attention, and that familiar species should be handled with care due to the existence of many positive and negative notions. On the whole, there is no doubt that we should draw on a much broader range of residential opinions, perceptions and emotions when carrying out environmental management on biodiversity in forest ecosystems. Taking RPL and LCM results together, it appears that members of the public tend to take it for granted that rare species should be preserved, a perception that may need to be carefully handled. On the perception, it may be useful to analyze the trends and changes of Japanese psychological attitudes for environment with certain database for those covariates, such as Japanese General Social Surveys[10]. Furthermore, we should pay attention to project-specific and moral warm glow that is responsible for the management scenario.

On the other hand, there is indeed certain circumstance with in-situ management schemes; for example, charismatic species should be preserved from the local context. Our conclusion is rather general perspective on management for the species diversity, and we do not intend to criticize the local context. However, we indicate that we seem to have to pay more attention to the harmony of *total* environment by employing ecological perspective in conducting every in-situ management.

In our analysis, we tested for attribute and alternative positional effects. We found no evidence of such effects, which supports a high reliability for our estimated results. On the other hand, we have not carried out analyses of lexicographic preferences or dominant preferences, variance comparisons of values that attributes possess, or considerations of more advanced choice models. Especially, dominant preferences may be treated by models such as the heuristic choice model of Gilbride and Allenby (2006). Attribute positional effects can be avoided using many

[10] http://jgss.daishodai.ac.jp/english/index.html

factors; a common definitions of attributes, the position of the price attribute or the checkboxes for choices, and so on. In addition, it has been said that IP estimates become conservative when the price attribute is placed at the bottom of the alternative, which has not been demonstrated to be the true preference. Finally, though we firstly aimed to link social welfare with GIS database, our design may have some limitation in the context of estimation of unbiased welfare measures and that of linkage with GIS database, which seems to be more useful for decision makers. These topics remain in the future research.

Acknowledgement

This article represents one part of a research project entitled “Developing Integrated Evaluation of Forest Ecosystem Services Contributing to a Sustainable Rural Society in Harmony with Nature” granted by the Global Environment Research Fund. This article was also supported by Japan Society for the Promotion of Science, Grant-in-Aid for Scientific Research (B), KAKENHI: 23310031. Helpful comments and advice were provided by Kenji Takeuchi, Graduate School of Economics, Kobe University, participants in the Rokko Forum at Kobe University on November 12th 2009, Takahiro Tsuge, Faculty of Economics, Konan University, Yohei Mitani, Colorado University, who was the discussant at the Society for Environmental Economics and Policy Studies on September 27th 2009 with including participants, Toru Murayama, Toyonaka Institute for Urban Management. We greatly appreciate all comment and advice from colleagues, the cooperation of FFPRI and their colleagues, Macromill, Inc., and many correspondents.

Table 1: Choice Experiment on Biodiversity of Forest Ecosystem

Studies	Treatment of Biodiversity (Levels of Attribute)
Adamowicz et al. (1998)	Mountain caribou population (50, 400, 600, 1,600), Mouse population (2,000, 6,000, 8,000, 14,000)
Hanley et al. (1998)	Species mix (evergreen only, evergreen/larch/ broadleaves mixture)
Mallawaarachchi et al. (2001)	Teatree woodlands in 2005 (12,000ha, 15,000ha, 23,000ha, 30,000ha), Vegetation along rivers and in wetlands in 2005 (700ha, 1,000ha, 2,300ha, 5,000ha)
Carlsson et al. (2003)	The design of the wetland area can promote plant, animal and insect life so that the wetland contains different numbers of both rare and more common species (low, medium, high)
Lehtonen et al. (2003)	Number of endangered species (650, 300, 200, 100, 90)
Garber-Yonts etal. (2004)	Salmon Streams (5%, 15%, 40%, 90%), Biodiversity Reserves (5%, 10%, 20%, 40%), Endangered Species (5%, 15%, 25%, 75%)
Horne et al. (2005)	Species richness at each site (15, 40, 70, 100) Average species richness (Calculated on the basis of site-specific species richness at the five study sites), Variance of species richness (Calculated from the species richness at the five study sites)
Naidoo and Adamowicz (2005)	Number of bird species seen (20, 40, 60, 80), Chance of seeing large wildlife (Very slim chance, Very good chance)
Bienabe and Hearne (2006)	Number of conservation-focused zones (0, 2, 5)
Nielsen et al. (2007)	Species (broadleaves: 100% broadleaves, mixed: 50% broadleaves and 50% conifers, conifers 100% conifers)
Siikamaki and Layton (2007)	The protected percentage of all biodiversity hotspots (10%, 25%, 50%, 75%)
Wang et al. (2007)	Plant species present (1,600, 1,900, 2,200, 2,400)
Shapansky et al. (2008)	Moose population size (2,000, 6,000, 7,500 (current level), 14,000), Woodland caribou population size (50, 300 to 500 (current level), 600, 1600)

Table 2: Demographics

Items	Sub items	Answer	Items	Sub items	Answers
Gender	Male	515	Awareness of Description of Species and Landscape in Forests (Appendix A)	Already Know	378
	Female	442		Have Heard	456
Age	10+	7		Do Not Know	123
	20+	185	Perception of Description of Status Quo in Japanese Forest (Appendix B)	Highly Understandable	243
	30+	357		Partly Understandable	639
	40+	254		Slightly Understandable	73
	50+	109		Incomprehensible	2
	60+	41	Visualized Forest Form When Schemes are Considered	Primeval Forest Deep in the Mountain	310
	over 70	4		Artificial Forest Deep in the Mountain	59
Marital Status	Married	338		"Satoyama" Forest near People	520
	Unmarrie	619		City Forest	66
Children	Yes	436		Others	2
	No	521	Features of Forests Close to Residential Location (Multi-Answer)	Primeval Forest	100
Annual Household Income	-2	58		Well Managed Forest	124
	-4	167		Lightly Managed Forest	189
	-6	250		Artificial Forest (e.g. Cedar or Hinoki)	161
	-8	160		Near Park with Forest	461
per	-10	102		No Forest	283
1 million yen	-12	43		Others	6
	-14	27	Residential Location	Urban	402
	-16	11		Suburban	455
	16+	21		Rural	93
	Unknown	118		Others	7

Table 3: Attribute Level

Attributes	Level 1	Level 2	Level 3	Level 4
Preserving Familiar Animals (FA)	20 species	35 species	50 species	65 species
Preserving Familiar Plants (FP)	100 species	250 species	400 species	550 species
Preserving Rare Animals (RA)	8 species	16 species	24 species	32 species
Preserving Rare Plants (RP)	10 species	25 species	40 species	55 species
Hypothetical Forestry Charges	500 Yen	1,500 Yen	2,500 Yen	3,500 Yen

Table 4: RPL Result with Pooled Data

Utility Function	mean parameter	standard deviation parameter	mean IP (yen)
Familiar Animals	-3.191E-02 (-1.626)	2.552E-02*** (10.672)	0 [N.A.]
Familiar Plants	1.947E-03*** (6.503)	4.533E-03*** (16.986)	2.786 [2.405; 3.771]
Rare Animals	4.649E-02*** (10.984)	7.949E-02*** (19.077)	72.536 [66.352; 85.332]
Rare Plants	2.062E-02*** (8.162)	2.269E-02*** (7.476)	31.676 [29.009; 39.210]
Forestry Charges	-6.454E-04*** (-25.486)	N.A. (N.A.)	N.A [N.A.]
No. of Observations	7,656		
No. of Samples	957		
Log Likelihood	-4,661.942		
McFadden's ρ			
No coefficients	0.12		
Constants only	0.12		

Note: ***, significant at 0.1%; t value is in parenthesis; 95% confidence interval of IP is given in brackets; N.A. = not applicable.

Table 5: Psychological Attitude and Principal Component as for Whole Environment (After Varimax Rotation)

Contents	Strongly Disagree	←	Neutral	→	Strongly Agree	PC1	PC2	PC3	Contribution
World Population Will Decrease with Current Natural Environment	46	153	332	327	99	0.27	-0.29	0.46	1.02
Humans Have Rights to Change Environment	475	300	137	33	12	-0.39	0.31	-0.01	0.83
Increasing Natural Disasters are Caused by Human Destruction of Environment	59	65	89	273	471	0.75	0.62	-0.36	1.41
Current Human Knowledge is Unable to Maintain Environment Properly	38	187	337	284	111	0.39	0.52	0.64	1.05
Humans Abuse Environment	17	65	175	440	260	0.67	0.16	0.09	0.88
Natural Environment Will Be Properly Used as Science Develops	52	171	432	248	54	-0.02	0.16	-0.44	0.87
Other Animals and Plants Have a Right to Exist	23	36	94	280	524	0.65	-0.12	-0.10	0.92
Natural Environment Recovers by Itself When Destroyed	300	353	224	64	16	-0.47	0.37	0.19	0.96
Human Lives Depend on Natural Environment	17	75	253	374	238	0.50	-0.06	-0.07	0.94
Current Ecosystems are Confronting a Crisis	17	54	169	388	329	0.72	-0.11	0.02	0.91
The Earth is Like a Space Ship for Humans	26	61	254	377	239	0.60	-0.10	-0.16	0.96
Humans Thought They Could Control Nature, but Failed	16	47	177	399	318	0.68	-0.06	0.09	0.86
Harmony of Natural Environment is Very Fragile	18	66	169	402	302	0.66	-0.16	0.05	0.93
Eigenvalues						4.22	1.10	1.07	
Proportion						32.49	8.47	8.21	
Cumulative. Prop.						32.49	40.96	49.17	

Note: New Ecological Paradigm (c.f. Aldrich et al. (2007)) is modified so as to be suitable for Japanese situations; Principal components are presented with eigenvalues exceeding 1.00; data in mesh cell is interpreted.

Table 6: Psychological Attitude and Principal Component as for Forest Richness (After Varimax Rotation)

Contents	Strongly Disagree	←	Neutral	→	Strongly Agree	PC4	Contribution
Forest Diversity Should be Protected Even If It Costs a Lot	16	41	243	464	193	-0.64	0.74
I Understand the meaning of Biodiversity	49	165	444	227	72	-0.43	0.90
I Think Forest Diversity Means Plenty of Animals	9	46	168	450	284	-0.75	0.75
I Think Forest Diversity Means Plenty of Plants	7	42	146	436	326	-0.73	0.73
Animal and Plants Cannot Be Prevented from Dying Out	265	323	250	103	16	0.62	1.06
Animal and Plants are the Only Criteria of Natural Diversity	92	297	425	107	36	0.11	0.86
Eigenvalues						2.09	
Proportion						41.4	
Cumulative. Prop.						41.4	

Table 7: Fit Measures of LCM

	Log Likelihood	McFadden' ρ	AIC3	BIC	DF	No. of Observations
2 classes	-4345.987	0.180	8730.974	4365.363	13	957
3 classes	**-4244.123**	**0.198**	**8557.246**	**4278.403**	23	957

Note: The figures in bold mean the selected model.

Table 8: LCM Result

		Class1		Class2		Class3	
		Coeff.	IP	Coeff.	IP	Coeff.	IP
Utility Function	Familiar Animals	-1.095E-02*	-4.945	8.119E-04	0	-1.184E-02***	N.A.
		(-2.482)	[-1.125; -9.169]	(0.325)	[N.A.]	(-6.698)	[N.A.]
	Familiar Plants	1.888E-03***	0.834	4.812E-03***	-15.869	-6.920E-04**	N.A.
		(5.862)	[0.555; 1.104]	(14.480)	[-10.833; -23.669]	(-2.849)	[N.A.]
	Rare Animals	3.958E-02***	17.569	1.903E-02***	-63.758	6.388E-02***	N.A.
		(8.011)	[13.823; 21.286]	(4.777)	[-30.718; -111.111]	(19.845)	[N.A.]
	Rare Plants	1.080E-02	0	-3.408E-03	0	1.821E-02***	N.A.
		(1.936)	[N.A.]	(-0.999)	[N.A.]	(7.840)	[N.A.]
	Forest Charges	-2.248E-03***	N.A.	3.122E-04***	N.A.	-3.679E-05	N.A.
		(-16.910)	[N.A.]	(6.710)	[N.A.]	(-1.04)	[N.A.]
Membership Function	Constant	0.233*		-0.592***		0.000	
		(2.321)		(-4.388)		(fixed parameter)	
	PC2	-8.532E-02		-0.214*		0.000	
		(-0.100)		(-2.030)		(fixed parameter)	
	PC3	-0.189*		-0.139		0.000	
		(-2.178)		(-1.258)		(fixed parameter)	
	PC4	0.333***		-3.516E-02		0.000	
		(4.972)		(-0.354)		(fixed parameter)	
Average Class Probability		0.449		0.200		0.351	
No. of Observations		7656					
No. of Samples		957					
Log Likelihood		-4244.123					
McFadden's rho							
No Coefficients		0.198					
Constants only		0.198					

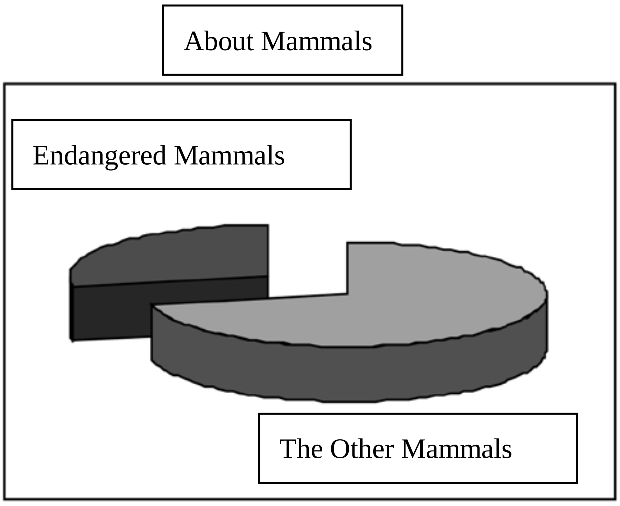
Note: ***, **, *; significant at 0.1%, 1%, 5%, respectively; t value is in parenthesis; 95% confidence interval of IP is given in brackets; N.A. = not applicable.

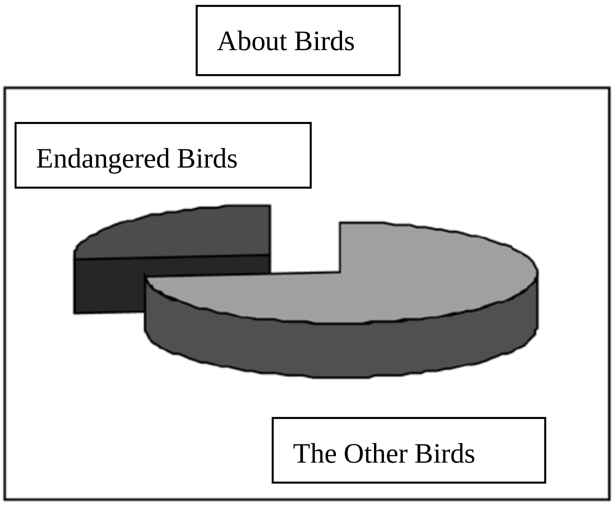
Appendix A: Description of Status Quo in Japanese Forest in Questionnaire

>The Japanese forest area spreads around two thirds (around 0.25 million km^2) of the nation.

>There are around 150 species of mammal living in Japanese forests except invasive ones, which includes endangered ones. The number of endangered species is larger than one fourth (42 species) of total mammals in Japan.

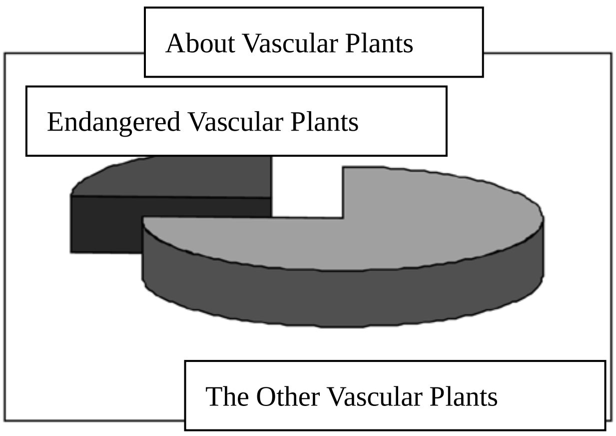
> There are around 200 species of bird requisite for Japanese forests to live on, which includes endangered birds. The number of endangered birds is larger than one fourth (53 species) of total birds in Japan.



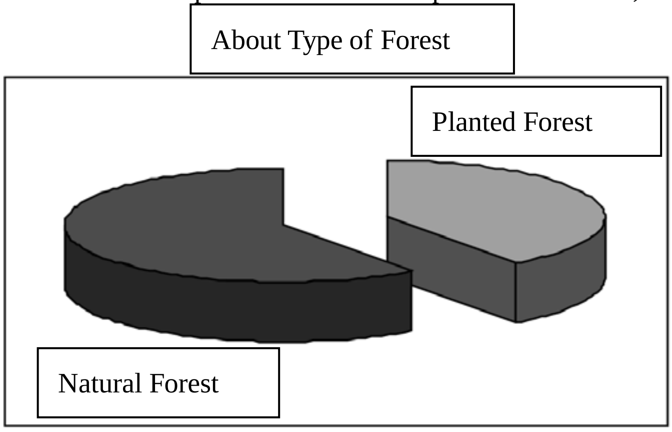


> There are around 1,000 species of timber living in Japanese forests except invasive species. In addition, there are around 7,000 species of vascular plants, which includes timbers, grasses, flowers, etc.

>The number of endangered species of vascular plant is larger than one fourth (1,690 species) of total vascular plants in Japan.



>Planted forests spread 40% of total Japanese forest area, and the rest is occupied by natural forests.



>Recent years, the number of endangered species is increasing on earth, which is the same situation in Japan.

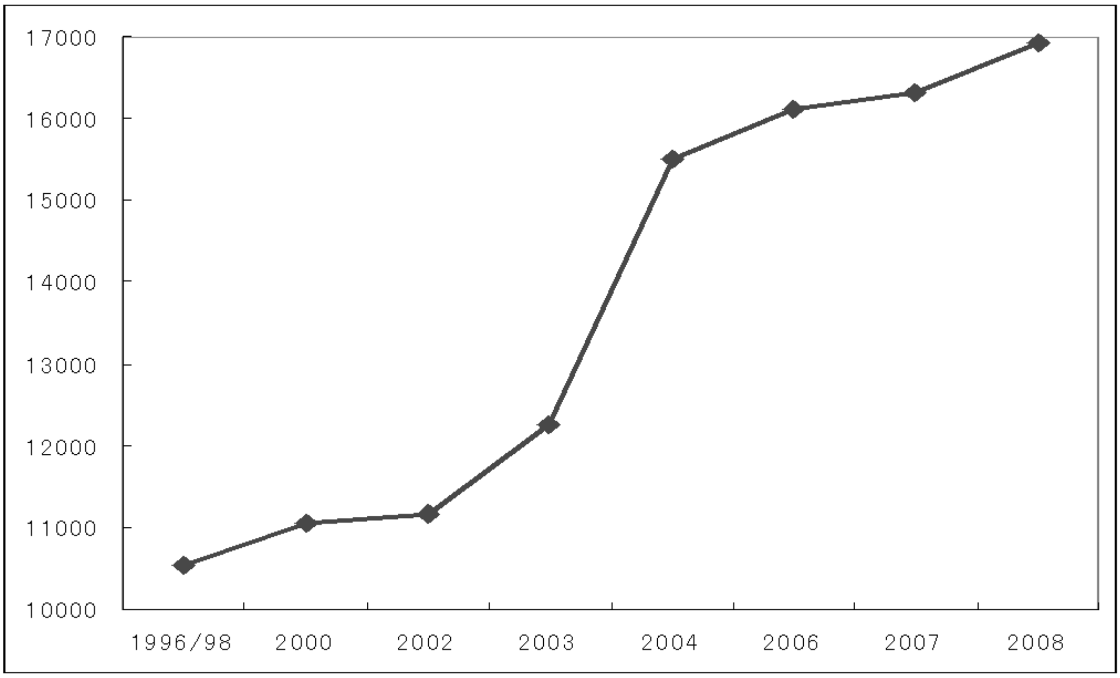


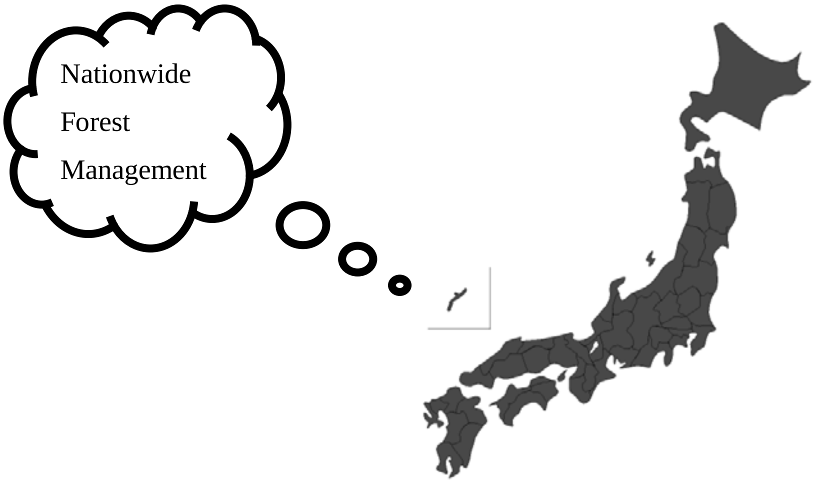
Figure: The number of endangered animal and plants in the world (vertical axis: the number of species, lateral axis: the year registered in Red Data Book)

Source: Created by Authors from data in International Union for Conservation of Nature and Natural Resources (http://www.iucnredlist.org/).

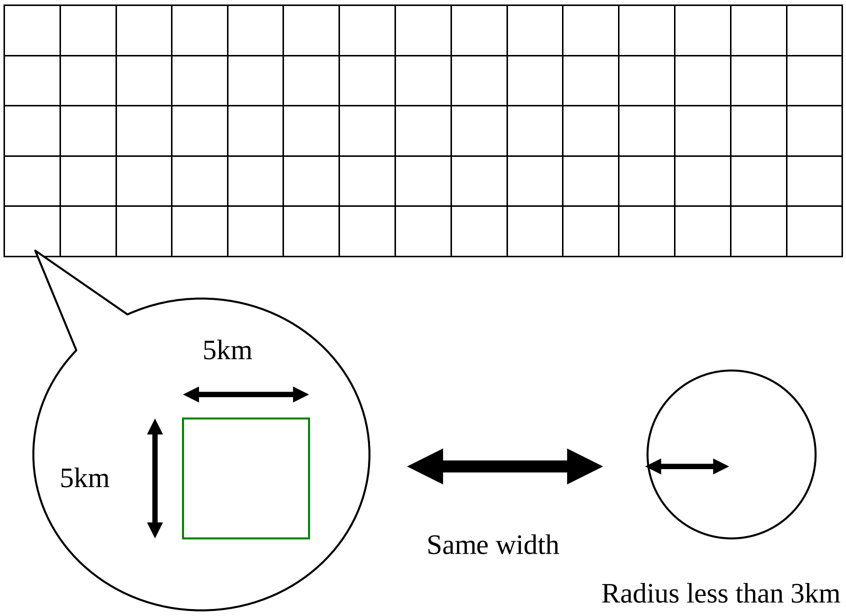
>This situation relates to the loss of rich forests. However, we should improve the scheme of the forest management because the current one seems to be imperfect.

Appendix B: CE Scenario

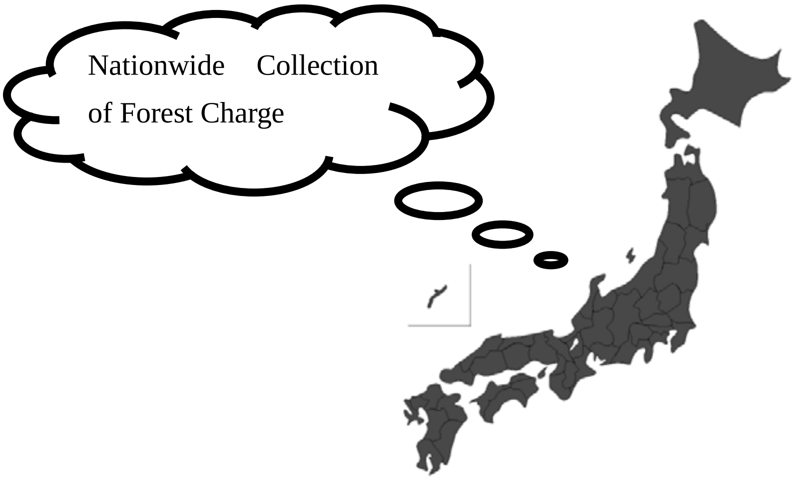
>Suppose that there is some forest management scheme targeting on species and landscape in Japanese forest. This scheme is nationwide; thus, please answer the questions below with the forest image of your own.



>This scheme is conducted by units; an area of a unit is $25km^2$ (~radius of less than 3km). Suppose the width of the unit as wide as the area of your dairy life.



>However, the scheme costs. Thus, suppose a forest fund is organized in order to create some framework which enables to preserve Japanese forests in the long term. And, suppose one-time forest charge is collected in the first year in order to manage the fund.



>Please note that your disposable money decreases if you donate to the fund. Then, please choose what you are most desirable from schemes presented below.

>Questions will proceed 14 times. Please choose the best scheme considering carefully. In the next section, we provide the details of the scheme.

Contents of Scheme

Contents	Descriptions of Contents
Preserving Familiar Animals	Management on the species of mammal and bird which we can usually observe. The increase of the number denotes that more animal species can live in the forest.
Preserving Rare Animals	Management on the endangered species of mammal and bird which is registered in Red Data Book. The increase of the number denotes that we can more frequently observe the registered.
Preserving Familiar Plants	Management on the species of timber which we can usually observe. The increase of the number denotes that forests become richer where more animal and plant species can live in.
Preserving Rare Plants	Management on the endangered species of plant which is registered in Red Data Book. The increase of the number denotes that we can more frequently observe the registered.

The Scheme is also conducted in your neighborhood.

Please consider and choose along with Forestry Charge.

Choice Set Example (If you prefer Scheme 1 to Scheme 2)

	Scheme 1		Scheme 2
Preserving Familiar Animals	20 species	<	35 species
Preserving Familiar Plants	250 species	<	400 species
Preserving Rare Animals	32 species	>	8 species
Preserving Rare Plants	55 species	>	10 species
Forestry Charges (yen/year*household)	1,500 Yen	>	500 Yen

The mark denotes which number is larger.

<: The right is larger   >: The left is larger   =: equivalent

Choose the Most Preferable Scheme	☑		□

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