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SPECIAL FEATURE: ORIGINAL PAPER

Conservation of Satoyama Endangered Species in the Era of Depopulation and Aging

Designing participatory green area management and biodiversity conservation strategies in the era of population shrinkage: empirical analysis of multi-generational perceptions on Satoyama rare species in central Japan

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Abstract
Underuse, instead of overuse, is a potential threat to biodiversity in semi-natural areas, particularly in East Asia. Due to serious depopulation and aging trends in East Asia, including Japan, few people are being involved in managing green areas and conserving biodiversity. Depending on specific events and age groups that contribute to the experience, knowledge, and preferences of citizens, green area management and biodiversity conservation activities can be effectively conducted through strong collaborations between various stakeholders and generations. We aimed to understand the differences in the perceptions of citizens, belonging to different generations in the metropolitan Nagoya City, towards the Satoyama areas in Japan through an online survey. The status of Satoyama areas is reflected by the rare species of endangered category II in the Act on Conservation of Endangered Species of Wild Fauna and Flora. Analyzing the perceptions revealed gaps in the experience, knowledge, and preference between different age groups for various management and conservation activities. In addition to the intergenerational gaps, gaps between different household income levels and the duration of the activities were identified. The results indicated that reflecting upon the diverse interests among citizens and addressing the causes of the differences is necessary by integrating the differences for consensus building among different stakeholders belonging to different age and socio-economic groups.

Keywords Green area · Depopulation · Multi-Generations · Satoyama · Endangered category II species

Introduction

With depopulation of societies increasing, more human and financial resources are required for green area management and biodiversity conservation. In East Asia, including Japan, serious depopulation and aging trends are being observed, thus, calling for effective management of green areas and conservation of biodiversity through the collaboration of various stakeholders and citizens belonging to different generations (Young et al. 2013; Sterling et al. 2017).

Historically, the Satoyama landscape is known as an agricultural landscape in Japan, with paddy fields, secondary forests, meadows, and irrigation ponds forming a mosaic landscape (Takeuchi 2010; Kadoya and Washitani 2011; Kohsaka et al. 2019). Although it is a manmade semi-natural area, several studies have demonstrated that Satoyama provides various ecosystem services (Natsuhara 2013; Osawa

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2011, 2015) and opportunities for participatory conservation activities (Shimpo 2022). Alarmingly, aquatic organisms in Satoyama are rapidly declining due to changes in agricultural practices and habitat destruction, mainly due to the underuse of the landscape, including abandonment (Sala et al. 2000; Foley et al. 2011; Krebs et al. 1999). Habitat protection for aquatic organisms has conventionally been a follow-up protection strategy for development and land improvement projects (Nishida et al. 2006). Although efforts to conserve species have been undertaken in the Satoyama landscape, inappropriate management of agricultural lands, use of excessive fertilizers and pesticides, and other related factors in or near the species habitats have negatively influenced the habitat environment (Tilman et al. 2001). Moreover, constructing roads and cement-walled rivers promote the loss of genetic diversity of species due to habitat fragmentation (Kobayashi et al. 2018).

Considering the statutory perspective, the Law for the Conservation of Endangered Species of Wild Fauna and Flora was amended to include certain Satoyama species in 2017 (cf. Act on Conservation of Endangered Species of Wild Fauna and Flora Article 4 (6) endangered category II [vulnerable]) that were previously not categorized as endangered species because their population size recovered rapidly. Species were designated in 2020. The designated species mostly included those that lived in a Satoyama-like landscape, with rapidly degrading habitats, and those that could recover speedily, but a collection of these species for commercial purposes could result in serious consequences. Accordingly, three species were added, namely, giant water bug *(Kirkaldyia deyrollis*; Goodwyn 2006*)*, golden venus chub *(Hemigrammocypris rasborella)*, and Tokyo salamander *(Hynobius tokyoensis)*. The latter two species are endemic to Japan. The newly established endangered category II species are commonly called as "Satoyama rare species" to increase awareness. In the broader context of public participation in conservation efforts, the Amendment Act on the Promotion of Environmental Conservation Activities through Environmental Education was promulgated by the Ministry of the Environment in 2012 (partially went into effect in 2011 and completely in 2012). It stated that conservation and environmental education activities should be promoted through cooperation and collaboration with multiple stakeholders, such as schools, residents, environmental non-profit organizations, industries, and local and national governments. In addition, conserving a single localized habitat, and establishing and networking multiple ex situ conservation sites with different characteristics in a watershed area is necessary to reduce species extinction risk and avoid the loss of genetic diversity (Yuewei et al. 2019). In addition to the conservation of original natural habitats, safeguarding multiple ex situ conservation areas, such as parks and green spaces that have restored natural environments, artificial biotopes in school playgrounds, and indoor breeding aquariums, is necessary. By connecting multiple sites and including the watershed region of populated areas, the species extinction risk can be significantly reduced in areas, even if there is a local extinction every 10 years (Sean 2019; Yoshimura et al. 2014a). Furthermore, setting bases in various public facilities, such as elementary schools, promotes environmental education by improving the understanding of students regarding the conservation of rare species (Yoshimura et al 2014b). Thus, rare species can be conserved through multi-stakeholder cooperation in watershed networks. To effectively conserve rare species and manage their habitats, collaboration among various stakeholders and generations is necessary, which can be achieved by promoting increased understanding among them and utilizing their expertise, preferences, and participation (Yoshimura et al. 2014a).

Transmission of knowledge between generations to implement effective collaboration is a challenging issue. Despite rigorous efforts by official intuitions and civil societies, the loss of knowledge and experience of the elderly citizens on managing green areas is continuing and has become a critical issue in different regions worldwide (Parrotta et al. 2016; Ens et al. 2016). The awareness, preference, and actions of individuals vary from generation to generation (Martín-López et al. 2007; Clark et al. 2017; Uchiyama and Kohsaka 2020), and the difference can be a cause of miscommunication and misunderstanding between them. To avoid such problems and facilitate effective intergenerational communication, understanding the type of differences is the first step. Although the necessity of identifying such differences is acknowledged in academic research and practices, empirical data to verify intergenerational awareness and preferences are still limited.

In addition to stakeholder collaborations, there are several strategies to simplify or visualize the status and trends of intergenerational knowledge transmission. One method to share information and facilitate policy-making in a logical manner is to use relevant indicators (Kohsaka 2010; Uchiyama et al. 2015; Kohsaka and Uchiyama 2017; Uchiyama and Kohsaka 2019). Thus, intergenerational communication using indicators, without compromising scientific rigor, is a key to address this issue.

Furthermore, indicator-based practices, technical solutions, and institutional measures can be implemented. For example, the citizen science approach is a technical solution for collecting data and knowledge through online platforms (Schuttler et al. 2018; Peter et al. 2019; MacPhail and Colla 2020). Digitized data can be easily shared among generations and across national boundaries. Older generations, who have observed natural areas over the years, tend to have essential local ecological knowledge, which can be, however, lost easily in the subsequent years if a successor in the family or community that also possesses the knowledge is absent. In such cases, digitization of data and knowledge can assist in sharing and transmitting the knowledge to the next generations even outside of local communities. There have been extensive discussions on the transmission of traditional ecological knowledge in academia and international policy processes (Joa et al. 2018; Biró et al. 2019; McElwee et al. 2020). Recently, the International Partnership for Satoyama Initiative and Globally Important Agricultural Heritage Systems have been actively promoting the transmission of traditional knowledge by identifying interactions between knowledge and local landscape and sharing the resultant interaction information internationally. While implementing these technical solutions and institutional measures, proper communication is required to facilitate intergenerational collaborations.

There are ongoing discussions on whether "extinction of experience" influences conservation activities (Gaston and Soga 2020; Oh et al. 2020; Novotný et al. 2020; Imai et al. 2018). In this study, we have not addressed this question or focused on the impact of experiences of early generations and subsequently, their impact on conservation efforts and action in the later generations. However, we considered the discussions as relevant factors for addressing the needs of inter or multigenerational collaborations.

To provide a reference for developing inter or multigenerational collaborations and communications, this study provided significant insights into the different awareness and preferences of different generations regarding green area management and biodiversity conservation. Specifically, a large-scale online survey was conducted to obtain empirical data to comprehensively analyze the differences between the generations, focusing on the Satoyama areas. The results of the survey analysis were used to verify our hypothesis, which stated that, "There are gaps in knowledge, experience, and preferences on Satoyama species conservation and green area management between different socioeconomic groups, which have different experiences of nature and species." The findings of this study can serve as a basis to promote and implement multi-generational collaborations that are required in regions facing depopulation trends wherein few stakeholders are present to manage the local environment. By understanding the gaps and similarities between generations, constructive communication towards designing schemes and policies to achieve common goals for green area management and biodiversity conservation can be facilitated.

Methods

Analytical methods

To understand the awareness and preferences of individual generations, we conducted a large-scale online questionnaire survey from July 31 to August 1, 2020 in Aichi Prefecture, Japan. The survey was conducted after the first emergency period (April 16–May 14, 2020) of COVID-19 in Japan. Although the Japanese government discouraged residents from moving and visiting different areas in different prefectures, no penalties were assigned if they did not follow the instructions of the government during the emergency period. However, there were relatively large impacts on the behavior of residents possibly because Japanese society experiences a relatively high peer pressure for following social norms and showing unified behavior. A study on the behavior of residents during the emergency period revealed that 37% of the residents in Aichi did not visit green areas during this period (Uchiyama and Kohsaka 2020).

The survey was conducted among citizens residing in Aichi Prefecture, which is the central prefecture of the third-largest metropolitan area in Japan. The capital city is Nagoya City, which is considered a megacity from international perspectives, has a population of more than 10 million people in its metropolitan area. The study area is surrounded by mountains and bays and has a Satoyama landscape with mixed land-use patterns.

In total, 1244 residents participated in the questionnaire survey. The proportion of female and male respondents was 47.6% and 52.4%, respectively. Moreover, the proportion of elderly respondents (over 60 years old) was 36.6% and that of all other five-year age groups was relatively similar (7–11%), except for the youngest age group (20–24 years, 2.9%).

The questionnaire survey included topics, such as their knowledge and experience of rare species, management methods, preference for management activities, duration of conservation and management activities, and distance of the areas for activities from the residential areas. These have been enlisted comprehensively. The variable types of the socioeconomic attributes of gender, age, and annual household income were binary, continuous, and ordinal (median of each category of income was used for the analysis as a continuous variable), respectively. Detailed descriptive statistics are presented in the appendix table. We collected the following data from the respondents during the questionnaire survey:

1. Socioeconomic attributes: Gender, age, and annual household income

2. Knowledge and experience on specific rare species: Giant water bug (*Kirkaldyia deyrollis*), golden venus chub (*Hemigrammocypris rasborella*), and Tokyo salamander (*Hynobius tokyoensis*), all of which are registered as Satoyama rare species by the Ministry of Environment in 2020
3. Knowledge of general rare species: Question: Do you know that rare species, including endangered species, live in natural lands near your residential place?
4. Methods of green area (agricultural land) management: Question: Which factor is essential for agricultural land management, if biodiversity conservation, including rare species conservation and productivity of agricultural lands, are considered from a holistic perspective?
5. Preference for green area management and biodiversity conservation activities: Question: What type of activities would you participate in for green area management and biodiversity conservation?
6. Preference for the duration of the management and conservation activities: Question: For how long would you like to participate in green area management activities in a day?
7. Preference for the distance from a residential area to place of the activities: Question: What is the maximum distance from residential areas to the place of green area management activities that you would prefer for participation in the activities?

Logistic regression analysis was used to identify the relationships between the attributes and the corresponding answers of the respondents using Jamovi software which is a R statistical language-based open-source software (version 1.6.23.0). This analysis method was used for the answers to Questions 2–7. The formats of answers to these questions were in the ordinal or nominal format. Multiple answers were not permitted for any of the questions, except Question 5. The overall trends of the answers to the individual questions were analyzed using bar charts. We conducted ordinal logistic regression analysis for the answers to Questions 2, 6, and 7, binomial logistic regression analysis for those to Questions 3 and 5, and polytomous logistic regression analysis for that of Question 4. The Akaike information criterion (AIC) was used to select the logistic regression analysis models. After applying all possible combinations of socioeconomic attributes, the models with the lowest AIC values were selected for analyzing the individual questions. Further, the AIC was used to select the models to interpret the survey results, and the p value was used to check the probability of the coefficients of the independent variables in each model to be 0. If the coefficients of the independent variables were not statistically significant ($p > 0.1$), the models were not selected, even if their AIC values were relatively low than those of other models. If the AIC values of the models with statistically significant coefficients of independent variables were the same, the model with the highest R^2 value was selected.

Target species

Giant water bug (*Kirkaldyia deyrollis*), golden venus chub (*Hemigrammocypris rasborella*), and Tokyo salamander (*Hynobius tokyoensis*) were selected as the target species in this study. Natsuhara (2021) comprehensively provides the species characteristics and the factors that should be considered for their conservation. The following subsections provide an overview of their characteristics and conservation-related actions.

Giant water bug (*Kirkaldyia deyrollis*)

Kirkaldyia deyrolli was earlier known as *Lethocerus deyrollei* or *Lethocerus deyrolli* (Goodwyn 2006). It lives in freshwater habitats, such as ponds, rivers, and paddy fields, and is widely distributed in Southeast Asia, China, Taiwan, South Korea, and Japan (Nakasako et al. 2020). The Japanese population is distributed from the central Honshu region to the Ryukyu Islands (Ohba 2011). However, it has decreased rapidly because of the loss of suitable habitats, water pollution, excessive pesticide use, increased street lighting, and invasive predator species (Ohba 2011).

To conserve this species in Japan, utilizing abandoned paddy fields can be an effective measure (Ichikawa 2004, 2015). The paddy fields, which have habitats similar to wetlands or ponds can thus, be restored. Such an environment can also serve as a habitat for other aquatic animals, thereby contributing to their conservation as well (Utsunomiya et al. 2017).

Golden venus chub (*Hemigrammocypris rasborella*)

This species is distributed mainly in western Japan, ranging from the Pacific side and Seto Inland Sea side of Honshu (west of Shizuoka Prefecture) to the Seto Inland Sea side of Shikoku, and the northwestern part of Kyushu. The study area, Aichi Prefecture, includes natural habitats for this species. The golden venus chub inhabits shallow lakes, ponds, and slow-flowing rivers in plains (Hoshino 1998). Its population has decreased in recent years because of environmental changes, such as a decrease in ponds and excessive predation by carnivorous exotic fish, namely, largemouth bass (*Micropterus salmoides*) and bluegill sunfish (*Lepomis macrochirus*) (Takahisa and Hoshiya 2008).

As an example of multi-sectoral and multi-generational collaborations, various groups related to the conservation of golden venus chub have been collaborating to coordinate conservation activities in the Ishikawa-river basin, including extraterritorial conservation, through the cooperation and sharing of knowledge and technology. In 2011, the "Waterside Conservation Network" was formed to design and implement suitable conservation policies for this species (Yoshimura et al. 2014a, b).

Tokyo salamander (*Hynobius tokyoensis*)

This species is mainly distributed in the Kanto region, except Gunma Prefecture, along with a part of Fukushima Prefecture (Sugawara et al. 2016). Previously, the Yamato salamander (*Hynobius vandenburghi*) (Matsui et al. 2019) in Aichi Prefecture was considered as the Tokyo salamander. The species is terrestrial during the non-breeding season and aquatic during the breeding season in early spring (Kusano 1980). It breeds mainly in stagnant water bodies, such as small ponds or rice fields. The adult individuals inhabit the forest floor near breeding areas (Kusano 1980; Takagi and Miyashita 2019).

This species can be used as an example in environmental education to understand the species and conservation of the Satoyama landscape (Hayakawa 2006). To implement precautionary approaches for its conservation, species distribution models have been developed for consensus building in urban and regional management processes (Abe 2017).

Results

The survey results revealed different patterns of responses regarding the target species. The knowledge and experience of the giant water bug were correlated with the age of the respondents (Fig. 1, Table 1). Although giant water bug was widely familiar among the respondents of different generations, actual visual experience was less in younger generations.

Further, most respondents were not familiar with the golden venus chub, with the proportion of respondents having knowledge and experience being limited (Fig. 1). However, compared with all the age groups, the proportion of respondents in the older age group who had known and had seen the golden venus chub was more (Table 2).

Regarding the Tokyo salamander, the proportion of respondents who had seen the species was limited in all age groups (Fig. 1). However, compared with the golden venus chub, the Tokyo salamander was relatively more familiar among the respondents, although the species was not present in the Aichi Prefecture.

The results of the ordinal logistic regression analysis indicated that the models of the individual species were statistically significant ($p < 0.001$ or $p < 0.05$) (Tables 1, 2, 3), although the R^2 values of the models were relatively low. Moreover, all individual independent variables (age, household income, and gender) of the models were statistically significant ($p < 0.05$) in the giant water bug and golden venus chub models (Tables 1 and 2). The Tokyo salamander model had the lowest R^2 value among the models, and only household income was a significant variable ($p < 0.05$) (Table 3). Overall, age and household income were positively correlated with the knowledge and experience regarding the species, although the influence of income per unit was relatively weak, as shown by their odds ratios. Specifically, respondents with older age or higher household income were more familiar with or had seen the species. Furthermore, male respondents had more knowledge and experience of seeing the giant water bug and the golden venus chub compared to female respondents.

Moreover, we asked the respondents if they knew that rare species, including endangered species, live in natural habitats near their residences. The responses revealed that older respondents were more aware of the existence of rare species near their residence (Fig. 2). T-test was applied to understand the difference in the average ages of two respondent groups who knew or did not know about the species existence (Table 4). The difference in the average age between the two groups was statistically significant ($p < 0.001$), with the average age of the respondents who knew about the species existence belonging to the older group. This result was consistent with results on the knowledge and experience of the giant water bug and golden venus chub (Fig. 1), thus, implying that the elderly were more aware of the existence of rare species in general than other age groups.

In addition to the *t*-test, we conducted a binomial logistic regression analysis to understand the knowledge of rare species in general. Consequently, the regression model was statistically significant, although the R^2 value was low (Table 5). Among the independent variables, age and household income were significant ($p < 0.001$ and $p < 0.1$, respectively). This implied that general knowledge of rare species was also correlated with age and household income; however, the difference in the knowledge between males and females was not significant. The odds ratio of household income showed that its influence per unit on general knowledge was relatively weak.

Regarding the essential factors necessary to manage agricultural land as green areas, the survey results showed a correlation between the responses and the ages of the respondents. Specifically, the location was an essential factor in relatively younger age groups, and water and green area connectivity with the surrounding area was an essential factor in older age groups (Fig. 3, Tables 6, 7). Although the location of agricultural land is considered an essential factor, understanding the importance of water and green area connectivity at the landscape level cannot be ignored. Thus, these results showed that intergenerational sharing

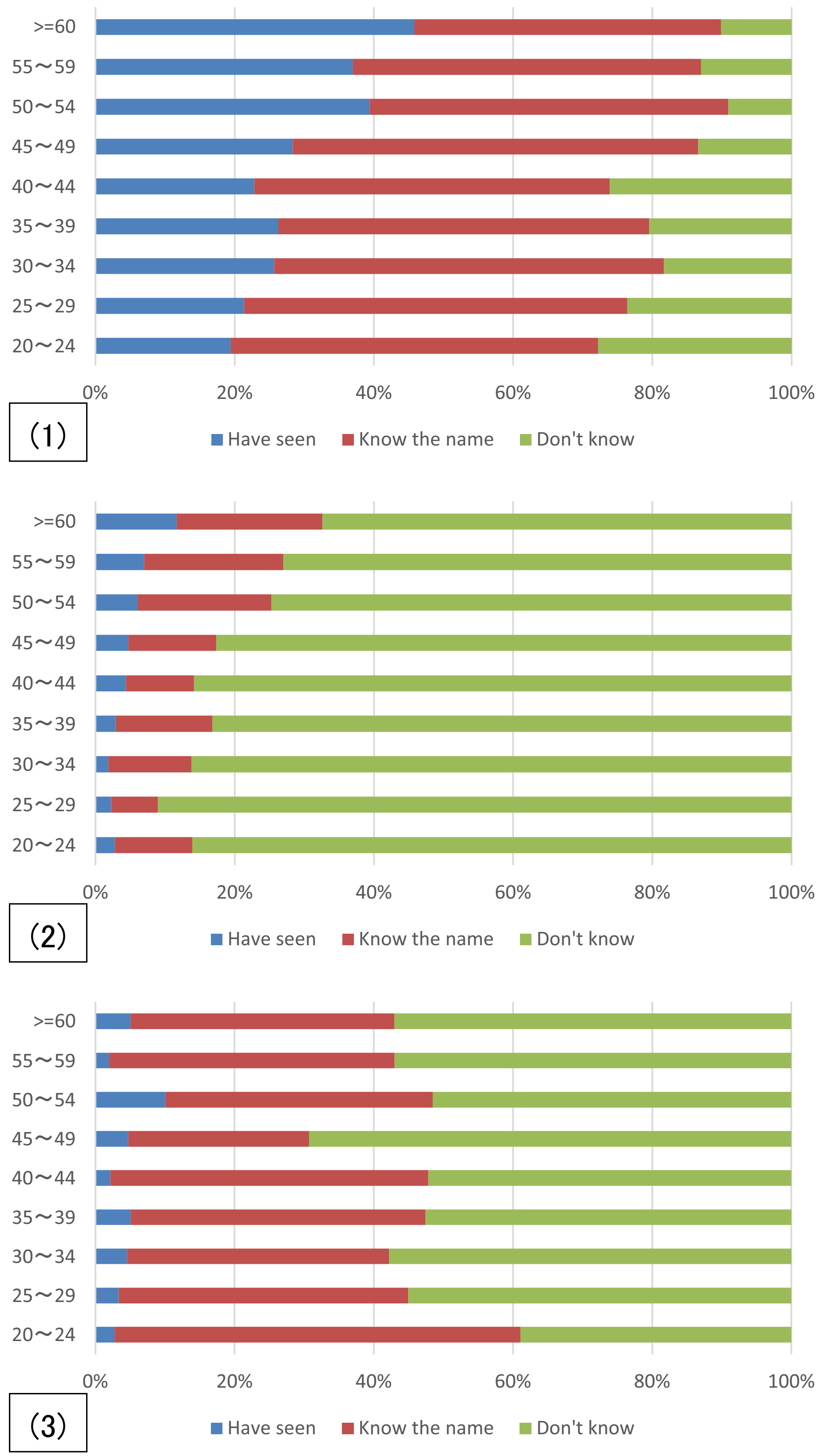


Fig. 1 Knowledge and experience on (1) giant water bug (*Lethocerus deyrolli*), (2) golden venus chub (*Hemigrammocypris rasborella*), and (3) Tokyo salamander (*Hynobius tokyoensis*) by age groups

Table 1 Results of logistic regression analysis on knowledge and experience on the three species: Giant water bug

Giant water bug	Income					Gender				
	Estimate	SE	*Z*	*p*	Odds ratio	Estimate	SE	*Z*	*p*	Odds ratio
I	0.00043	0.00020	2.14	0.032	1.000					
G						− 1.0800	0.1310	− 8.23	< 0.001	0.339
A										
IG	0.00033	0.00020	1.65	0.1	1.000	− 1.0700	0.1320	− 8.12	< 0.001	0.344
GA						− 0.9115	0.1371	− 6.65	< 0.001	0.402
IA	0.00052	0.00020	2.59	0.009	1.000					
IGA	**0.00042**	**0.00020**	**2.06**	**0.04**	**1.000**	**− 0.8867**	**0.1375**	**− 6.45**	**< 0.001**	**0.412**

Giant water bug	Age					AIC	Deviance	R^2McF	R^2N	Overall model test			Number of analyzed samples
	Estimate	SE	*Z*	*p*	Odds ratio					χ^2	*df*	*p*	
I						1887	1881	0.0027	0.0036	5.03	1	0.025	946
G						1821	1815	0.0375	0.0507	70.8	1	< 0.001	946
A	0.0281	0.0043	6.53	< 0.001	1.030	1848	1842	0.0233	0.0317	44	1	< 0.001	946
IG						1820	1812	0.0391	0.0528	73.7	2	< 0.001	946
GA	0.0194	0.00451	4.3	< 0.001	1.020	1804	1796	0.0474	0.0639	89.5	2	< 0.001	946
IA	0.029	0.00433	6.71	< 0.001	1.030	1842	1834	0.0273	0.037	51.4	2	< 0.001	946
IGA	**0.0204**	**0.00454**	**4.48**	**< 0.001**	**1.021**	**1802**	**1792**	**0.0499**	**0.0672**	**94.1**	**3**	**< 0.001**	**946**

R^2McF: McFadden's R^2, R^2N: Nagelkerke's R^2. The categories of the dependent variable are; the respondents do not know (1), know the names (2), and, have seen (3). The model shown by bold numbers and characters is the selected model based on AIC and p-value. The most left column shows the model names based on the independent variables used in the analysis; *I* Income, *G* Gender, *A* Age. As for the independent variable for gender, it is a categorical variable, and its categories are; male (1) and female (2). A positive estimated value of its coefficient indicates that females tend to have higher dependent values than males

Table 2 Results of logistic regression analysis on knowledge and experience on the three species: Golden venus chub

Golden venus chub	Income					Gender				
	Estimate	SE	*Z*	*p*	Odds ratio	Estimate	SE	*Z*	*p*	Odds ratio
I	0.00059	0.00023	2.54	0.011	1.000					
G						− 1.3	0.1760	− 7.42	< 0.001	0.272
A										
IG	0.00047	0.00024	2	0.045	1.000	− 1.28	0.1760	− 7.29	< 0.001	0.278
GA						− 1.095	0.1821	− 6.01	< 0.001	0.335
IA	0.00074	0.00024	3.17	0.002	1.000					
IGA	**0.00061**	**0.00024**	**2.57**	**0.01**	**1.001**	**− 1.0509**	**0.1829**	**− 5.75**	**< 0.001**	**0.350**

Golden venus chub	Age					AIC	Deviance	R^2McF	R^2N	Overall model test			Number of analyzed samples
	Estimate	SE	*Z*	*p*	Odds ratio					χ^2	*df*	*p*	
I						1345	1339	0.0051	0.0064	6.89	1	0.009	946
G						1289	1283	0.0469	0.0583	63.1	1	< 0.001	946
A	0.0337	0.0054	6.24	< 0.001	1.03	1310	1304	0.0309	0.0385	41.5	1	< 0.001	946
IG						1286	1278	0.0501	0.0622	67.4	2	< 0.001	946
GA	0.0238	0.00569	4.19	< 0.001	1.024	1272	1264	0.0604	0.0747	81.2	2	< 0.001	946
IA	0.0359	0.00555	6.48	< 0.001	1.04	1301	1293	0.039	0.0485	52.4	2	< 0.001	946
IGA	**0.0261**	**0.00582**	**4.48**	**< 0.001**	**1.026**	**1267**	**1257**	**0.0657**	**0.0812**	**88.4**	**3**	**< 0.001**	**946**

R^2McF: McFadden's R^2, R^2N: Nagelkerke's R^2. The categories of the dependent variable are; the respondents do not know (1), know the names (2), and, have seen (3). The model shown by bold numbers and characters is the selected model based on AIC and *p* value. The most left column shows the model names based on the independent variables used in the analysis; *I* Income, *G* Gender, *A* Age. As for the independent variable for gender, it is a categorical variable, and its categories are; male (1) and female (2). A positive estimated value of its coefficient indicates that females tend to have higher dependent values than males

Table 3 Results of logistic regression analysis on knowledge and experience on the three species: Tokyo salamander

Tokyo salamander	Income					Gender				
	Estimate	SE	*Z*	*p*	Odds ratio	Estimate	SE	*Z*	*p*	Odds ratio
I	**0.00049**	**0.00021**	**2.34**	**0.019**	**1.000**					
G						−0.0516	0.1300	−0.396	0.692	0.950
A										
IG	0.00049	0.00021	2.32	0.02	1.000	−0.0244	0.1310	−0.187	0.852	0.976
GA						−0.1199	0.1388	−0.864	0.388	0.887
IA	0.00048	0.00021	2.28	0.023	1.000					
IGA	0.00046	0.00021	2.202	0.028	1.000	−0.0837	0.1399	−0.598	0.55	0.920

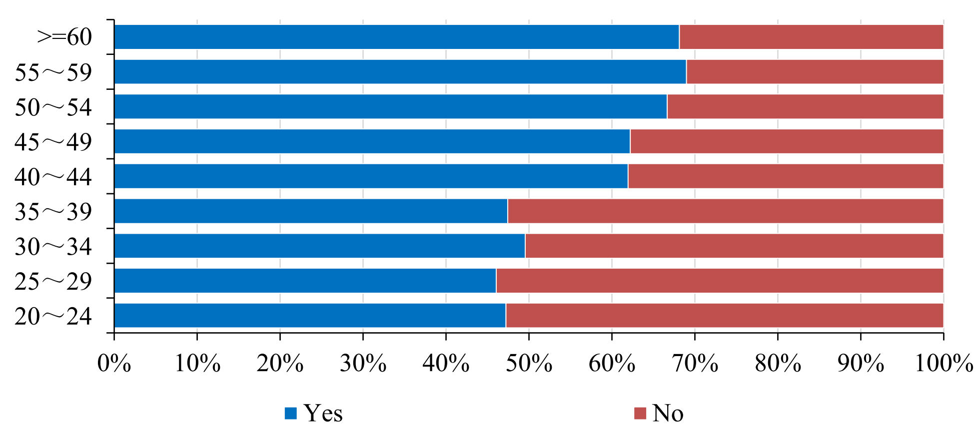
Tokyo salamander	Age					AIC	Deviance	R^2McF	R^2N	Overall model test			Number of analyzed samples
	Estimate	SE	*Z*	*p*	Odds ratio					χ^2	*df*	*p*	
I						**1590**	**1584**	**0.0039**	**0.0051**	**6.16**	**1**	**0.013**	**946**
G						1596	1590	0.0001	0.0001	0.157	1	0.692	946
A	−0.00527	0.00434	−1.21	0.225	0.995	1588	1594	0.0009	0.0012	1.48	1	0.224	946
IG						1592	1584	0.0039	0.0051	6.19	2	0.045	946
GA	−0.00664	0.00463	−1.436	0.151	0.993	1596	1588	0.0014	0.0018	2.22	2	0.329	946
IA	−0.00467	0.00437	−1.07	0.284	0.995	1590	1582	0.0046	0.0060	7.31	2	0.026	946
IGA	−0.00565	0.00466	−1.212	0.226	0.994	1592	1582	0.0048	0.0063	7.67	3	0.053	946

R^2McF: McFadden's R^2, R^2N: Nagelkerke's R^2. The categories of the dependent variable are; the respondents do not know (1), know the names (2), and, have seen (3). The model shown by bold numbers and characters is the selected model based on AIC and *p* value. The most left column shows the model names based on the independent variables used in the analysis; *I* Income, *G* Gender, *A* Age. As for the independent variable for gender, it is a categorical variable, and its categories are; male (1) and female (2). A positive estimated value of its coefficient indicates that females tend to have higher dependent values than males

of experience should be implemented to enhance mutual understanding of all relevant essential factors. Regarding other essential factors for green area management, the trends of responses by household income levels showed that the methods for management and production, and shape of agricultural lands were selected by respondents having relatively high-income levels (Fig. 4, Tables 6 and 7). Moreover, in the selected model with the lowest AIC value, gender was not included as an independent variable.

Other gaps existed between respondents belonging to different age groups. To determine the preferred activities for management and conservation, we conducted a binomial logistic regression analysis on the individual responses related to the activities. Consequently, statistically significant models were not found for two activities, namely, weeding and cleaning, and monitoring and surveying nature; additionally, only one respondent selected "other." The results of the analysis for the other activities are shown in Tables 8, 9, 10 and 11. Younger respondents preferred

Fig. 2 Answer (Yes/No) to the question; do you know that rare species, including endangered species, live in natural lands near your residential place?



education and caring for children, and working with others in a team (Fig. 5, Tables 8 and 9). The question was answered by respondents who were willing to participate in management and conservation activities. Figures 5, 6, 7, 8, 9 show the responses to the question ($n = 204$). The results suggested that younger generations preferred educational activities, whereas older generations preferred more direct management and conservation activities, such as logging and managing invasive species (Fig. 5); however, the correlation between the preference for these activities and age was not statistically significant (Tables 10 and 11). Moreover, male respondents preferred logging and managing invasive species (Tables 10 and 11), possibly based on the physical strength of the respondents.

Further, the respondents with relatively high income preferred to work with others in a team (Fig. 6, Table 9). The preference for weeding, cleaning, and monitoring and surveying nature, did not show a statistically significant correlation with basic socioeconomic attributes, such as household income, gender, and age. The results implied that the abovementioned activities could be accepted across a wider range of age groups and different socioeconomic groups.

In addition to the preferred activities, the duration of the activities and the distance of the place of green area management activities from residential areas are considered as the fundamental factors that should be considered to encourage the participation of the citizens in management and conservation activities. Accordingly, we conducted an ordinal logistic regression analysis on the responses associated with these two factors. However, the resultant models were not statistically significant. This suggested that the models did not show a good fit with the trends of the responses because of complex response patterns of individual age groups and income groups. The overall trends of the answers are shown in Figs. 7, 8, and 9.

Regarding the preferred activity duration, the overall trend showed that older generations preferred a relatively longer duration to participate in the activities (Fig. 7).

Table 4 *t*-test of average year of respondents who know/don't know that rare species including endangered species are living in natural lands near their residential places

	Know	Don't know
Average (year)	52.5	47.2
Variance	216.9	227.3
Number of respondents	757	486
Degree of freedom	1241	
t value	6.19	
p value	$p < 0.001$	

Table 5 Results of logistic regression analysis on the knowledge on general rare species

Knowledge on general rare species	Income					Gender				
	Estimate	SE	*Z*	*p*	Odds ratio	Estimate	SE	*Z*	*p*	Odds ratio
I	0.00028	0.00021	1.34	0.181	1.000					
G						−0.153	0.1348	−1.14	0.255	0.858
A										
IG	0.00026	0.00021	1.25	0.21	1.000	−0.14	0.1350	−1.04	0.3	0.869
GA						0.0658	0.1447	0.455	0.649	1.068
IA	**0.00035**	**0.00021**	**1.67**	**0.095**	**1.000**					
IGA	0.00037	0.00021	1.728	0.084	1.000	0.0936	0.1459	0.642	0.521	1.098

Knowledge on general rare species	Age					AIC	Deviance	R^2McF	R^2N	Overall model test			Number of analyzed samples
	Estimate	SE	*Z*	*p*	Odds ratio					χ^2	*df*	*p*	
I						1266	1262	0.0014	0.0026	1.81	1	0.179	946
G						1266	1262	0.001	0.0019	1.29	1	0.255	946
A	0.0213	0.00459	4.65	< 0.001	1.022	1245	1241	0.0175	0.0313	22.1	1	< 0.001	946
IG						1267	1261	0.0023	0.0041	2.88	2	0.237	946
GA	0.0221	0.00487	4.531	< 0.001	1.022	1247	1241	0.0176	0.0316	22.3	2	< 0.001	946
IA	**0.0219**	**0.0046**	**4.76**	**< 0.001**	**1.022**	**1245**	**1239**	**0.0197**	**0.0353**	**24.9**	**2**	**< 0.001**	**946**
IGA	0.0229	0.0049	4.682	< 0.001	1.023	1246	1238	0.02	0.0358	25.3	3	< 0.001	946

R^2McF: McFadden's R^2, R^2N: Nagelkerke's R^2. The categories of the dependent variable are; the respondents don't know (1) / know (2) that rare species are living in natural lands near the residential places. The model shown by bold numbers and characters is the selected model based on AIC and *p* value. The most left column shows the model names based on the independent variables used in the analysis; *I* Income, *G* Gender, *A* Age. As for the independent variable for gender, it is a categorical variable, and its categories are; male (1) and female (2). A positive estimated value of its coefficient indicates that females tend to have higher dependent values than males

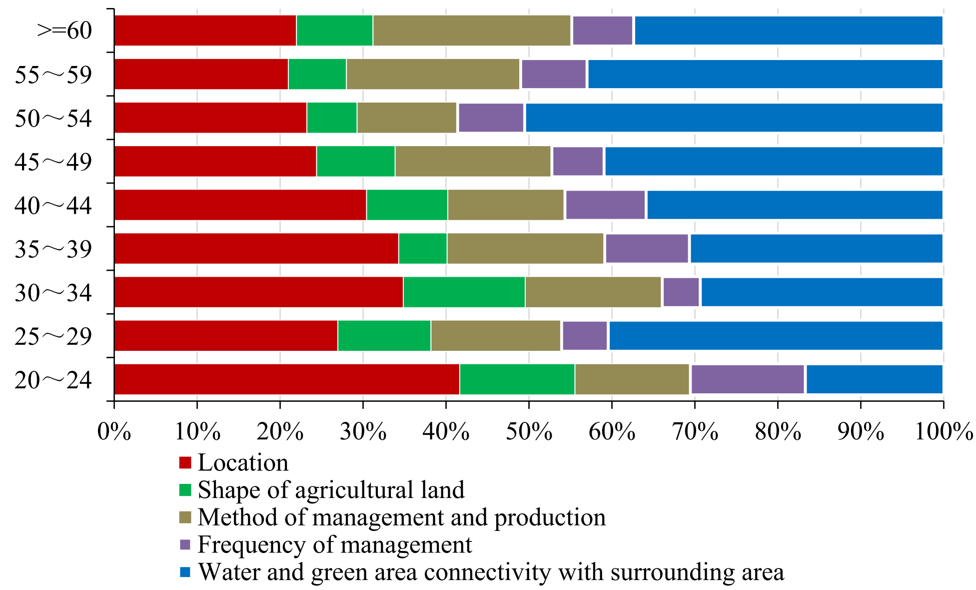


Fig. 3 Answer to the question by age groups; which factor is essential for agricultural land management, if biodiversity conservation, including rare species conservation and productivity of agricultural lands, are considered from a holistic perspective?

Table 6 Results of logistic regression analysis on the essential factors for agricultural land managements

	Essential factors for agricultural land managements							Number of analyzed samples
	AIC	Deviance	R^2McF	R^2N	Overall model Test			
					χ^2	*df*	*p*	
I	2783	2767	0.0032	0.0042	8.78	4	0.067	946
G	2791	2775	0.0004	0.0006	1.24	4	0.871	946
A	2775	2759	0.0061	0.0081	17	4	0.002	946
IG	2766	2790	0.0035	0.0047	9.83	8	0.277	946
GA	2778	2754	0.0080	0.0105	22.2	8	0.005	946
IA	**2774**	**2750**	**0.0093**	**0.0123**	**25.9**	**8**	**0.001**	**946**
IGA	2777	2745	0.0112	0.0147	31.1	12	0.002	946

Numbers of coefficients calculated for individual independent variables are large as shown in Table 7, because the dependent variable is multinomial. Considering the readability of the results, AIC and other related indicator values are included in this table. The most left column shows the model names based on the independent variables used in the analysis; *I* Income, *G* Gender, *A* Age

Table 7 Results of logistic regression analysis on the essential factors for agricultural land managements: Model IA

	Variable	Estimate	SE	*Z*	*p*	Odds ratio
1	Intercept	0.3385	0.3440	0.984	0.325	1.403
	Age	**− 0.0175**	**0.0057**	**− 3.077**	**0.002**	**0.983**
	Income	0.0003	0.0003	1.184	0.236	1.000
2	Intercept	− 1.4102	0.4830	− 2.919	0.004	0.244
	Age	− 0.0057	0.0079	− 0.727	0.468	0.994
	Income	**0.0007**	**0.0003**	**2.014**	**0.044**	**1.001**
3	Intercept	− 1.4833	0.3988	− 3.719	< 0.001	0.227
	Age	0.0077	0.0063	1.22	0.223	1.008
	Income	**0.0007**	**0.0003**	**2.717**	**0.007**	**1.001**
4	Intercept	− 1.0774	0.5204	− 2.07	0.038	0.340
	Age	− 0.0121	0.0086	− 1.404	0.16	0.988
	Income	0.0003	0.0004	0.699	0.484	1.000

1: Location, 2: Shape of agricultural land, 3: Method of management and production, 4: Frequency of management*5: "water and green area connectivity with surrounding area" is the reference category in the model

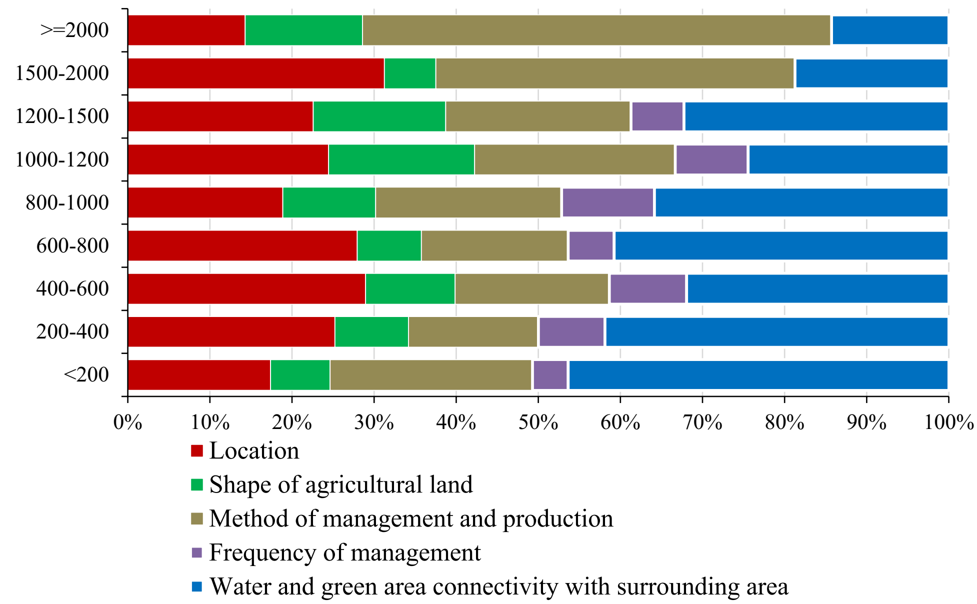


Fig. 4 Answer to the question by household income levels (Unit: 10 thousand JPY); which factor is essential for agricultural land management, if biodiversity conservation, including rare species conservation and productivity of agricultural lands, are considered from a holistic perspective?

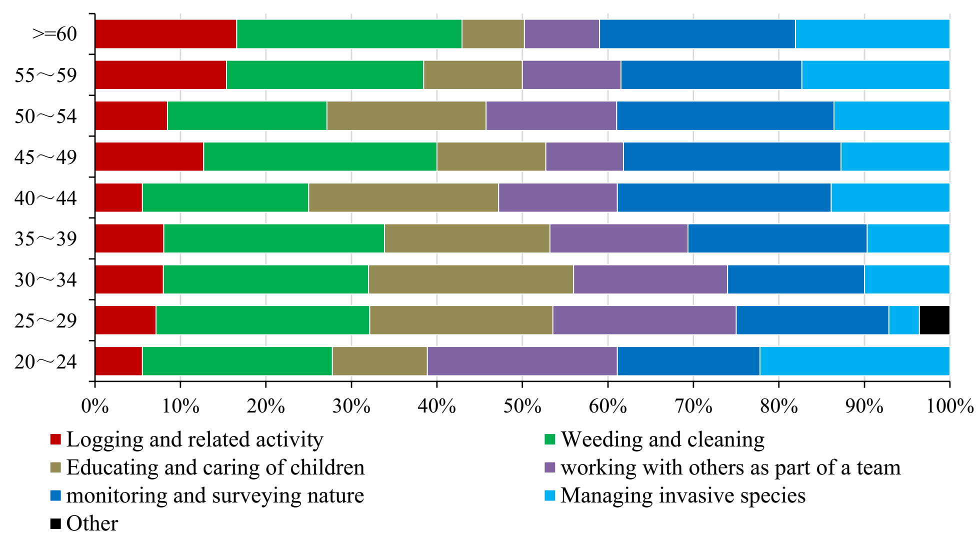


Fig. 5 Answers to the question by age groups; what type of activities would you participate in for green area management and biodiversity conservation?

However, respondents over 55 years of age had preferences similar to the younger respondents (under 30 years old) who did not prefer a longer duration for participation in the activities. These results implied that gaps existed in the old age groups regarding the preferred duration.

Furthermore, the patterns of duration preferred by respondents according to different household income levels are shown in Fig. 8. Respondents with household incomes of 6–8 million JPY/year preferred a relatively longer time for the activities (Fig. 8); however, respondents with comparatively higher or lower household income preferred shorter durations.

Regarding the distance from residential areas to the place of green area management activities, the trend of answers was not as distinct as that for the responses on the preferred duration. Nevertheless, older generations preferred to participate in the activities held at places relatively far from their residential areas (Fig. 9). This result was consistent with the trend shown in Fig. 7, which shows a correlation between age and distance. Although this result might be influenced by the status of owning cars and other transportation modes, the maximum distance from residential areas to the place of the management activities could be correlated with the preferred duration of the activities.

Table 8 Results of logistic regression analysis on preferred activities for the green area management and biodiversity conservation: Educating and caring of children

Educating and caring of children	Income					Gender				
	Estimate	SE	*Z*	*p*	Odds ratio	Estimate	SE	*Z*	*p*	Odds ratio
I	0.00059	0.00044	1.35	0.177	1.001					
G						0.845	0.3150	2.68	0.007	2.327
A										
IG	0.00070	0.00045	1.54	0.123	1.001	0.884	0.3190	2.77	0.006	2.421
GA						0.4687	0.3407	1.38	0.169	1.598
IA	0.00060	0.00047	1.29	0.197	1.001					
IGA	0.00066	0.00047	1.406	0.16	1.001	0.5097	0.3441	1.481	0.138	1.665

Educating and caring of children	Age					AIC	Deviance	R^2McF	R^2N	Overall model test			Number of analyzed samples
	Estimate	SE	*Z*	*p*	Odds ratio					χ^2	*df*	*p*	
I						251	247	0.0072	0.0125	1.8	1	0.18	204
G						246	242	0.0289	0.0491	7.19	1	0.007	204
A	**−0.0417**	**0.0111**	**−3.78**	**< 0.001**	**0.959**	**237**	**233**	**0.0623**	**0.104**	**15.5**	**1**	**< 0.001**	**204**
IG						245	239	0.0383	0.0648	9.54	2	0.008	204
GA	−0.0364	0.0117	−3.12	0.002	0.964	238	232	0.0698	0.116	17.4	2	< 0.001	204
IA	−0.042	0.0112	−3.75	< 0.001	0.959	238	232	0.0689	0.114	17.1	2	< 0.001	204
IGA	−0.0362	0.0119	−3.052	0.002	0.964	238	230	0.0777	0.128	19.3	3	< 0.001	204

R^2McF: McFadden's R^2, R^2N: Nagelkerke's R^2. The categories of the dependent variable are; the respondents did not select (0) / selected (1) the activity. The model shown by bold numbers and characters is the selected model based on AIC and *p* value. The most left column shows the model names based on the independent variables used in the analysis; *I* Income, *G* Gender, *A* Age. As for the independent variable for gender, it is a categorical variable, and its categories are; male (1) and female (2). A positive estimated value of its coefficient indicates that females tend to have higher dependent values than males.

Table 9 Results of logistic regression analysis on preferred activities for the green area management and biodiversity conservation: Working with others as part of a team

Working with others as part of a team	Income					Gender				
	Estimate	SE	*Z*	*p*	Odds ratio	Estimate	SE	*Z*	*p*	Odds ratio
I	0.00112	0.00045	2.47	0.014	1.001					
G						0.342	0.3230	1.06	0.289	1.408
A										
IG	0.00116	0.00045	2.55	0.011	1.001	0.40537	0.3290	1.23	0.218	1.5
GA						−0.0498	0.3529	−0.141	0.888	0.951
IA	**0.00116**	**0.00047**	**2.461**	**0.014**	**1.001**					
IGA	0.00117	0.00047	2.4594	0.014	1.001	0.01393	0.3591	0.0388	0.969	1.014

Working with others as part of a team	Age					AIC	Deviance	R^2McF	R^2N	Overall Model Test			Number of analyzed samples
	Estimate	SE	*Z*	*p*	Odds ratio					χ^2	*df*	*p*	
I						238	234	0.0257	0.043	6.16	1	0.013	204
G						243	239	0.0046	0.0079	1.11	1	0.291	204
A	−0.035	0.011	−3.17	0.002	0.966	233	229	0.0445	0.0737	10.7	1	0.001	204
IG						238	232	0.032	0.0533	7.66	2	0.022	204
GA	−0.0356	0.0118	−3.019	0.003	0.965	235	229	0.0446	0.0738	10.7	2	0.005	204
IA	**−0.03618**	**0.0115**	**−3.154**	**0.002**	**0.964**	**229**	**223**	**0.07**	**0.114**	**16.8**	**2**	**< 0.001**	**204**
IGA	−0.03601	0.0123	−2.94	0.003	0.965	231	223	0.07	0.114	16.8	3	< 0.001	204

R^2McF: McFadden's R^2, R^2N: Nagelkerke's R^2. The categories of the dependent variable are; the respondents did not select (0) / selected (1) the activity. The model shown by bold numbers and characters is the selected model based on AIC and *p* value. The most left column shows the model names based on the independent variables used in the analysis; *I* Income, *G* Gender, *A* Age. As for the independent variable for gender, it is a categorical variable, and its categories are; male (1) and female (2). A positive estimated value of its coefficient indicates that females tend to have higher dependent values than males.

Table 10 Results of logistic regression analysis on preferred activities for the green area management and biodiversity conservation: Logging and related activity

Logging and related activity	Income					Gender				
	Estimate	SE	*Z*	*p*	Odds ratio	Estimate	SE	*Z*	*p*	Odds ratio
I	0.00067	0.00044	1.53	0.126	1.001					
G						**−1.1150**	**0.3640**	**−3.07**	**0.002**	**0.328**
A										
IG	0.00062	0.00045	1.37	0.17	1.001	−1.0970	0.3650	−3.01	0.003	0.334
GA						−1.0297	0.3847	−2.677	0.007	0.357
IA	0.00073	0.00044	1.64	0.102	1.001					
IGA	0.00065	0.00045	1.437	0.151	1.001	−0.9956	0.3862	−2.578	0.01	0.37

Logging and related activity	Age					AIC	Deviance	R^2McF	R^2N	Overall Model Test			Number of analyzed samples
	Estimate	SE	*Z*	*p*	Odds ratio					χ^2	*df*	*p*	
I						252	248	0.0093	0.016	2.33	1	0.127	204
G						**244**	**240**	**0.0421**	**0.0712**	**10.5**	**1**	**0.001**	**204**
A	0.0184	0.0104	1.77	0.077	1.019	251	247	0.0128	0.022	3.2	1	0.073	204
IG						244	238	0.0496	0.0835	12.4	2	0.002	204
GA	0.00745	0.0112	0.668	0.504	1.007	246	240	0.0438	0.0741	11	2	0.004	204
IA	0.0197	0.0106	1.86	0.063	1.0199	251	245	0.0235	0.0402	5.88	2	0.053	204
IGA	0.00898	0.0113	0.793	0.428	1.009	246	238	0.0521	0.0876	13.1	3	0.005	204

R^2McF: McFadden's R^2, R^2N: Nagelkerke's R^2. The categories of the dependent variable are; the respondents did not select (0) / selected (1) the activity. The model shown by bold numbers and characters is the selected model based on AIC and *p* value. The most left column shows the model names based on the independent variables used in the analysis; *I* Income, *G* Gender, *A* Age. As for the independent variable for gender, it is a categorical variable, and its categories are; male (1) and female (2). A positive estimated value of its coefficient indicates that females tend to have higher dependent values than males.

Table 11 Results of logistic regression analysis on preferred activities for the green area management and biodiversity conservation: Managing invasive species

Managing invasive species	Income					Gender				
	Estimate	SE	*Z*	*p*	Odds ratio	Estimate	SE	*Z*	*p*	Odds ratio
I	0.00045	0.00043	1.06	0.29	1.000					
G						**−1.7639**	**0.3830**	**−4.609**	**< 0.001**	**0.171**
A										
IG	0.00037	0.00045	0.82	0.412	1.000	−1.7540	0.3830	−4.577	< 0.001	0.173
GA						−1.8190	0.4057	−4.484	< 0.001	0.162
IA	0.00049	0.00043	1.14	0.254	1.000					
IGA	0.00036	0.00045	0.7867	0.431	1.000	−1.7999	0.4061	−4.432	< 0.001	0.165

Managing invasive species	Age					AIC	Deviance	R^2McF	R^2N	Overall model test			Number of analyzed samples
	Estimate	SE	*Z*	*p*	Odds ratio					χ^2	*df*	*p*	
I						270	266	0.0042	0.0075	1.12	1	0.291	204
G						**245**	**241**	**0.0986**	**0.166**	**26.3**	**1**	**< 0.001**	**204**
A	0.0143	0.0099	1.45	0.148	1.014	269	265	0.0079	0.0142	2.12	1	0.145	204
IG						246	240	0.101	0.17	27	2	< 0.001	204
GA	−0.0046	0.0110	−0.42	0.675	0.995	247	241	0.0992	0.167	26.5	2	< 0.001	204
IA	0.0150	0.0100	1.51	0.132	1.015	270	264	0.0128	0.0228	3.42	2	0.181	204
IGA	−0.0039	0.0111	−0.349	0.727	0.996	248	240	0.102	0.171	27.1	3	< 0.001	204

R^2McF: McFadden's R^2, R^2N: Nagelkerke's R^2. The categories of the dependent variable are; the respondents did not select (0) / selected (1) the activity. The model shown by bold numbers and characters is the selected model based on AIC and *p* value. The most left column shows the model names based on the independent variables used in the analysis; *I* Income, *G* Gender, *A* Age. As for the independent variable for gender, it is a categorical variable, and its categories are; male (1) and female (2). A positive estimated value of its coefficient indicates that females tend to have higher dependent values than males.

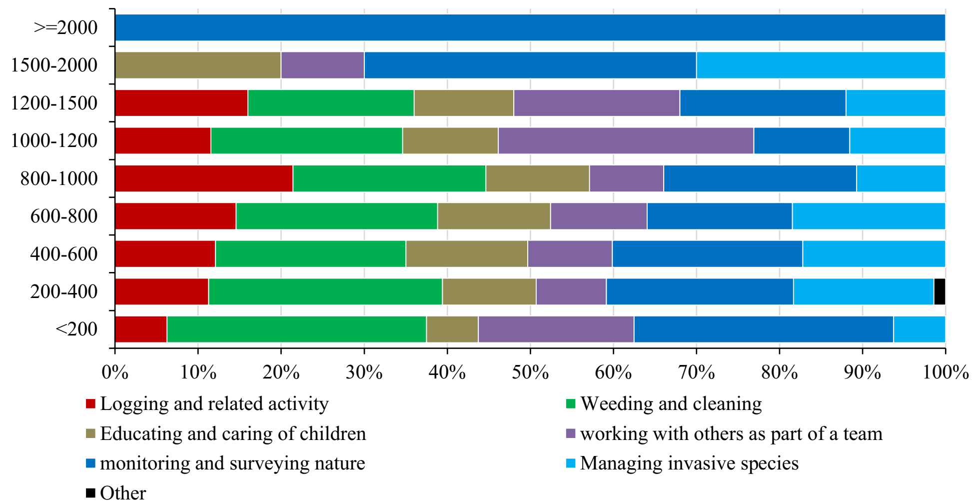


Fig. 6 Answers to the question by household income levels (Unit: 10 thousand JPY); what type of activities would you participate in for green area management and biodiversity conservation?

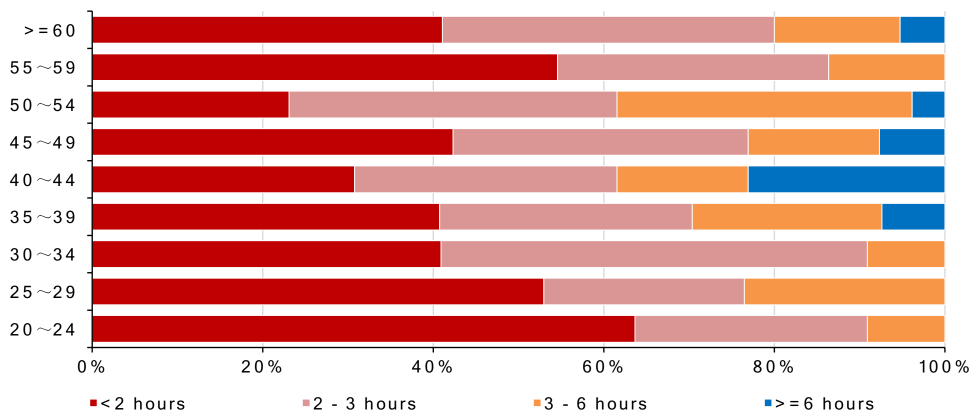


Fig. 7 Answers to the question by age groups; for how long would you like to participate in green area management activities in a day?

Discussion

This study identified the gaps between the perceptions, experience, and knowledge of different age groups regarding the Satoyama species, and investigated their preferences for participating in management and conservation activities. The trends observed in this study were consistent with similar existing studies. For example, Soga et al. (2019) showed that the level of experience regarding plant species was positively correlated with age. Further, Sharp et al. (2011) reported that public preferences for invasive alien species management were affected by demographic attributes. In their study, 40 or older respondents chose an adaptive eco-centric orientation, implying that a certain degree of human intervention is required for ecosystem restoration. In this study, we reported that the age of the citizens was correlated with the level of experience of the species. For example, the giant water bug was widely familiar among the respondents; however, the younger generations had less experience of seeing the species, which may, in turn, influence their awareness of nature. This intergenerational difference might influence the loss of species habitats, such as paddy fields lacking concrete structures. Moreover, respondents from various generations were familiar with the Tokyo salamander, possibly because the name was easy to remember as Tokyo and salamander (Sanshouo in Japanese) are relatively common in Japan. Additionally, even the youngest age group was familiar with the salamander name (Fig. 1), thus, reflecting the influence of school education. Satoyama species conservation has been gaining more attention since a decade when the Satoyama Initiative was inaugurated at the 10th

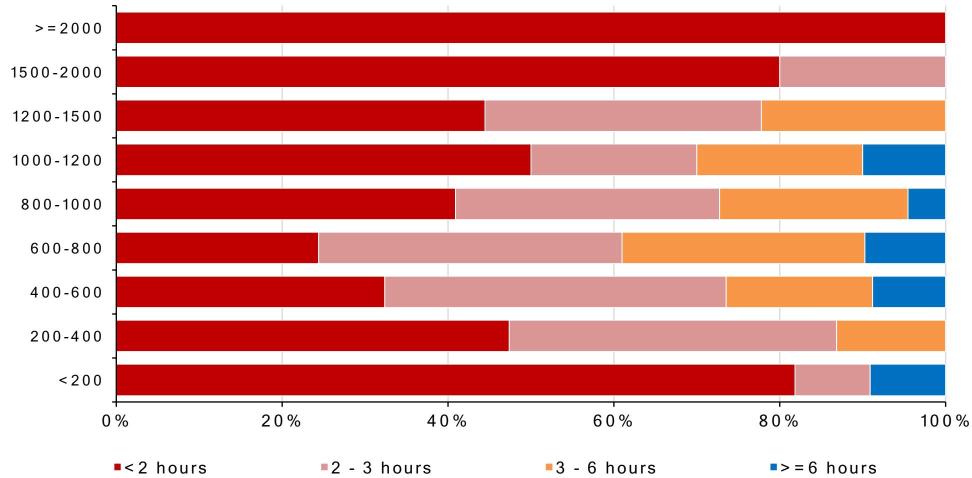


Fig. 8 Answers to the question by household income groups (Unit: 10 thousand JPY); for how long would you like to participate in green area management activities in a day?

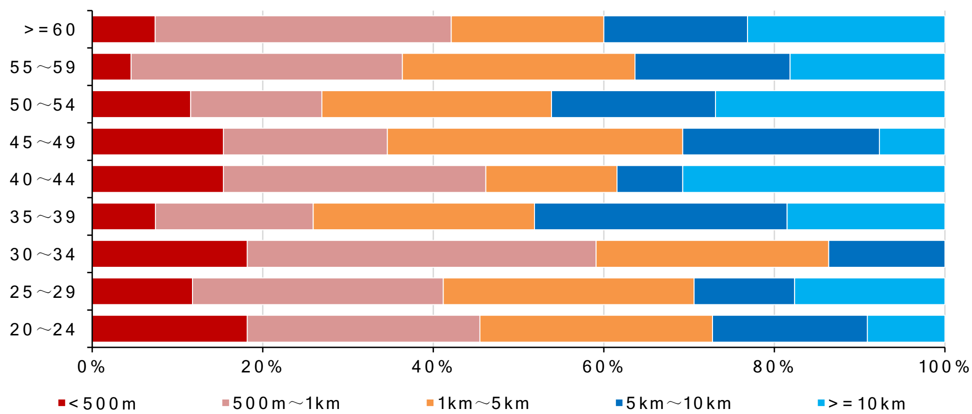


Fig. 9 Maximum distance from residential areas to the place of green area management activities for respondents to join the activities (Answers by age groups)

Conference of Parties to the Convention on Biological Diversity. Furthermore, previously, the Yamato salamander (*Hynobius vandenburghi*) (Matsui et al. 2019) in Aichi Prefecture was regarded as the Tokyo salamander, and the Red Data Book of Aichi Prefecture published in 2002 had a record of Tokyo salamander; however, presently, Yamato salamander and Tokyo salamander are considered as different species. Accordingly, the respondents who had seen old records might have answered that they are familiar with the name or have seen the Tokyo salamander. Thus, future surveys are needed to verify the influence of these backgrounds on the knowledge and awareness of different generations.

Regarding intergenerational communication between different age groups, younger respondents believed that the "location" of agricultural lands as green areas was an essential factor for the management and productivity of the lands, whereas older respondents believed that "water and green area connectivity with surrounding area" was an essential factor. Although a single common critical factor for the management and productivity of agricultural lands was absent, understanding the comprehensive differences between the age groups and investigating the causes of the differences can be a preliminary step. It can facilitate efficient consensus building in green area management and biodiversity conservation in a shrinking society with limited human and economic resources.

The results of the essential factors for management implied that the respondents in relatively old age groups knew the importance of networks of water and green areas based on their experience. Conversely, as younger respondents did not have such experience, they stated location as an essential factor for agricultural land productivity and biodiversity conservation. Moreover, the respondents with a higher-income level preferred or believed in specific management methods at the micro-level rather than at the landscape level and macro-scale approaches. Thus, this gap in the responses between the respondents with different income level groups should be considered during consensus building among different stakeholders for green area management to ensure effective communication between them on the essential factors for management.

Regarding the connection with nature, which can be a basis for the motivation of conservation activities, Cleary et al. (2020) suggested that both current and past experiences of nature could enhance the connection of citizens with nature. Their results implied that younger generations (20–30 years of age) with less experience of nature could improve their connection with nature based on their current experiences of visiting natural habitats and observing Satoyama species. However, Torkar and Krašovec (2019) stated that experiences, such as visiting forests, do not directly improve the knowledge of the ecosystems. By implementing proper education for citizens, knowledge of the ecosystems and biodiversity can be enhanced and shared among citizens even if they have not experienced nature extensively. Moreover, cultural and generational variations should be considered while studying different perceptions (Kohsaka and Handoh 2006; Kovács et al. 2020). Previous studies have discussed other attributes, such as gender and residential place, to analyze the relationships between these attributes and the experience regarding wild plant species (Kaasinen 2019; Soga et al. 2019). Although a limited number of species were analyzed in this study, the results suggested that male and female respondents showed different awareness regarding the selected Satoyama species. Future studies should analyze the influence of such attributes on the experience, knowledge, and preferences of citizens regarding Satoyama species and their conservation.

Several studies have reported the "extinction of experience" (Imai et al. 2018; Gaston and Soga 2020). Although our research focused on the differences in the knowledge, experiences, and preferences between groups of different age, gender, and income levels, it has implications for research on childhood experience. The experiences in natural habitats might not be complemented by the knowledge obtained through communication established in management and conservation activities. In particular, the childhood experiences might differ between male and female respondents, which could be reflected through the questionnaire survey responses. In this regard, future research should investigate childhood experiences of nature and knowledge about wildlife, and examine the effects of this knowledge and experience on the behaviors of citizens to identify the essential factors that can promote conservation activities across diverse generations. Existing studies in environmental education and related environmental studies provide elements for developing future research frameworks (Liefländer et al. 2013; Li and Chen 2015; Tuncer and Sahin 2016; Clayton et al. 2017; Giusti 2019). Based on these studies, frameworks, and empirical survey data on the experience, knowledge, and preferred conservation activities of citizens, future studies could conduct an in-depth research to address the intergenerational differences.

Conclusion

The survey analysis results comprehensively demonstrated the gaps between different age groups regarding the experience, knowledge, and preferences of the management and conservation activities. Besides the intergenerational gaps, this study revealed that the gaps between different household income levels and gender groups regarding the experience, knowledge, preferences are important factors for green area management, and conservation activities. The hypothesis stated in the Introduction Section was verified by the analysis. In particular, the roots of the different preferences and levels of awareness between different age and income level groups should be explored further to provide effective communication methods and strategies to facilitate mutual understanding among different stakeholders. Furthermore, the roles of common preferences as a basis of empathy between them could be investigated in future research to facilitate effective communication.

Appendix

See Table 12.

Table 12 Descriptive statistics

	Variable		Variable type	Category of variable	Mean	Std. dev	Min	Max
1	Gender		Binary	1: male, 2: female	1.42	0.49	1	2
	Age		Continuous	-	51.69	14.81	20	87
	Income		Ordinal (median of each category of Income was used for the analysis as continuous variable)	1: < 200 2: 200–400 3: 400–600 4: 600–800 5: 800–1000 6: 1000–1200 7: 1200–1500 8: 1500–2000 9: ≥ 2000 (Unit: 10 thousand JPY)	3.42	1.62	1	9
2	Knowledge and experience on specific species	Giant water bug	Ordinal	1: Don't know 2: Know the names 3: Have seen	2.22	0.68	1	3
		Golden venus chub	Ordinal		1.32	0.61	1	3
		Tokyo salamander	Ordinal		1.50	0.59	1	3
3	Knowledge on general rare species		Binary	1: Don't know/ 2: Know that rare species are living in natural lands near the residential places	1.61	0.49	1	2
4	Essential factors for agricultural land managements		Nominal	1: Location, 2: Shape of agricultural land, 3: Method of management and production, 4: Frequency of management, 5: water and green area connectivity with surrounding area	-			
5	Preferred activities for the green area management and biodiversity conservation		Nominal	1: Logging and related activity, 2: Weeding and cleaning, 3: Educating and caring of children, 4: working with others as part of a team, 5: monitoring and surveying nature, 6: Managing invasive species, 7: Other	-			
6	Preferred time length of green area management activities		Ordinal	1(< 2 h), 2(2–3 h), 3(3–6 h), 4(≥ 6 h)	1.91	0.91	1	4
7	Preferred distance from residential areas to the place of green area management activities		Ordinal	1(< 500 m), 2(500 m ~ 1 km), 3(1 km ~ 5 km), 4(5 km ~ 10 km), 5(≥ 10 km)	3.11	1.31	1	5

The category of income (9: ≥ 2000) was not used for the analysis because median of each category of income was used for the analysis and the number of respondents in the category is less than 10.

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