Research article

Social Characteristics and Sustainability of Residents-Led Biological Monitoring in Japanese Agricultural Landscapes

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Abstract Biological monitoring in agricultural landscapes is conducted as part of local residential activities in some rural regions. Such survey activities are expected to have social effects such as environmental education and community empowerment, in addition to biodiversity monitoring. However, it remains unclear how residents conduct the biological surveys, assess the sustainability of the activities, and identify potential effects on their communities. This study aims to clarify the social characteristics of biological surveys by residents and examine the sustainability of the activities. The survey reports of 37 local activities in aquatic habitats of rice-farming landscapes in the city of Utsunomiya in the Tochigi Prefecture, Japan, were collected. By using the reports, the basic activity features of the surveys, such as the number and the attributes of participants, the time, dates and sites of the surveys, were examined, and the local organizations were clustered based on the similarities of the features. Finally, the number of detected species by the biological surveys and the contents of group discussions, which were held after the surveys, in each cluster were compared. The results showed that the number of participants of the biological surveys ranged from 11 to 235, and the participation rate of children was high at 94.1%, while the participation rate of experts was low at 20.6%. Our main findings are as follows: (1) the residential organizations with invited biological experts detected the highest number of species. (2) the cluster with no children tended to have no discussion. In conclusion, our findings imply that expert participation is vital for finding species and that child participation is essential for sustainability of this biological monitoring.

Keywords biological survey by residents, citizen science, agricultural environments, paddy fields

INTRODUCTION

In Japan, the "Survey on Lives in Paddy Fields" has been conducted nationwide by the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Ministry of the Environment (MOE) since 2001 to assess the current status and changes in ecosystems around rice paddies. The survey conducted by the government has a problem with the number of sites and is qualitative and quantitative limited in survey items due to cost and work resources (Watabe et al., 2011). Meanwhile, in the prefectural government alone, local residents have a movement to conduct surveys of living things. In Tochigi Prefecture, as a measure of Improvement in Land, Water and Environment Conservation, "Survey on Lives in Paddy Fields and Surrounding Environment" has been mandatory for organizations implementing the payment grant of multifunctionality since 2007.

By having residents take the initiative in conducting the survey, various effects can be expected, from educational effects to regional revitalization (Mineta et al., 2008; Tanaka et al., 2008; Mizutani et al., 2014): solving economic problems, arousing interest in nature, raising environmental awareness, restoring local communities, and increasing willingness to participate in environmental conservation activities.

Quantitative elucidation of the relationship between paddy fields biodiversity and the efforts of the survey with local residents by using survey data will contribute to the formation/reformation of local communities and the conservation of biodiversity.

OBJECTIVE

This study aims to clarify the social characteristics of residents-led biological monitoring in Japanese agricultural landscapes from the viewpoints of activity features and examine the sustainability of the survey activities.

METHODOLOGY

Target Area

Target area is the city of Utsunomiya, Tochigi Prefecture in Japan. In this study, we used the secondary data from the community-based biological survey conducted in 2018. 37 residential organizations in Utsunomiya City conducted this survey in rice paddies, surrounding farm ditches, and reservoirs.

Data Collection

In this study we collected secondary data; the data were the survey reports collected by Utsunomiya City in 2018 with a specific format used in the "Survey on Lives in Paddy Fields and Surrounding Environment". Table 1 shows an example of a part of the sheets.

Table 1 An example of the survey sheets used in the biological survey by the local residents in Utsunomiya City in 2018

Subjects		Specific explanations about the survey
Basic information		Name of the activity organization, date of survey, an outline of participants, survey location, number of years since infrastructure development, the design of the farm ditch, flow velocity, presence of vegetation in the ditch.
Captured species	Paddies	Species name and the captured number of each species regarding birds, butterflies, dragonflies, amphibians, reptiles, fishes, shellfishes, insects, water plants
	Farm ditches	Species name and the captured number of each species regarding amphibians, fishes, shellfishes, insects, water plants
	Reservoirs	Species name and the captured number of each species regarding amphibians, fishes, shellfishes, insects, water plants
Discussions		Participants' ideas on the results of the survey, participants' ideas on the conservation environments in their rural area.

Source: Guideline of "Survey on Lives in Paddy Fields and Surrounding Environment" by Tochigi Prefecture

The report has a discussion part that describes the participants' ideas and/or exchange of opinions on the biological survey or plan of the communities through the applicable events after finishing the capture of species surrounding the environment.

Under the multifunctional payment grant system implemented by Tochigi Prefecture, grant management organizations are established in each region, mainly by farmers, and the biological

surveys are conducted under the direction of these residential organizations. The organizations are only required to conduct this survey and submit the report. Therefore, the specific survey methods (participants, location, time, methodology, timing and awareness of ecosystem conservation, etc.) are vary depending on the organization.

Data Analysis

First, in order to clarify the basic features of the residents' survey activities, five items were selected, tabulated, and organized as follows: 1) the number of participants in the survey activities; 2) attributes of the participants (the breakdown of the attributes is non-organization member farmers, non-farmer local residents, children under high school age, other local organizations, and biological experts); 3) survey sites (paddy field, farm ditch, and reservoir) and survey timing; 4) contents of the after-survey discussion; 5) presence of photographic records.

Second, cluster analysis with ward's method was conducted to categorize and analyze the organization characteristics according to the similarity of the activities features in the above five items. Relationships between survey features and detected species and group discussion were compared between each category obtained by the cluster analysis. Based on this result, the issues for sustainable biological monitoring were discussed by focusing on the participant attributes.

RESULTS AND DISCUSSION

Basic Activity Features of Biological Surveys by Residents

According to city officials and the participatory observation by the authors, the survey was conducted according to the following procedure: firstly, participants received an explanation and some cautions from an organizer of the residential organizations at the beginning of the survey. Then, the participants spread out in paddies or ditches, capturing creatures with nets or hands for about an hour or above, and collected the captured species in buckets and other containers.

The number of participants in the survey activities was relatively large over many organizations (57 participants in average, 11 participants at minimum and 235 participants at maximum). Eight organization didn’t mention the number of participants in the reports and the largest group of participants was between 21 and 60 participants, accounting for about 46% (Fig.1). Regarding the attributes of the participants, 34 organizations provided a breakdown of the attributes of the participants and three organizations did not. Fig. 2 shows the ratio of participation in the survey by each of the participant attributes (n = 34). Of the 34 organizations that described the attributes of the participants, ten organizations (29.4%) had non-member farmers participating, and 24 organizations did not. The number of organizations in which non-farmer local residents participated was 29 (85.3%), and they did not participate in was five. Seven organizations (20.6%) invited biological experts and 27 organizations did not.

In order to examine the relationship between the number of participants and the number of attributes of participants, single regression analysis was conducted on this data; as the result, no relationship was found between the number of attributes and the number of participants ($R^2 = 0.04$). This result supports that the number of participants does not necessarily correlate with the diversity of their attributes. The ratio of organizations that involved children and non-farmer local residents in their surveys to the total number of organizations was more than 80% (94.1% for children and 85.3% for non-farmer residents, Fig.2), suggesting that local residents thought this event would have some positive impacts to equip children with environmental education. However, the participation of biological experts was only less than 20%, and we can conclude that the attendance of experts to the residential biological survey is not shared.

As for the date, time and survey sites, 36 organizations stated the survey date and time in the reports, and one organization did not. Two of 36 organizations conducted the survey twice, at different times of the year. All 36 organizations conducted the survey at farm ditch. In the case of paddy fields, 18 organizations (50.0%) investigated, and about three organizations (8.3%) surveyed

reservoirs. Fig. 3 shows the frequency of the first survey timing of the 36 organizations by survey sites (farm ditch, paddy and reservoir). Survey timing shows similar trend between farm ditch and paddy: almost surveys were conducted during the irrigation season (from April to early October) and the most surveys were conducted during a month from mid-July to mid-August. During this period, the water flow of farm ditch is high, the paddy fields are irrigated, and it is favorable timing for farmers because the busy rice-planting season had passed. For these reasons, it is likely that most surveys at farm ditch and paddy were conducted from mid-July to mid-August. The frequency of survey at paddies was relatively lower than that at farm ditches. It is assumed that the reason for this is that many organizations found it difficult to conduct surveys in the rice paddies and allow children to enter because the paddies are privately owned and the rice plants are growing around July and August. Considering several surveys were conducted in end of October to beginning of November, the biological surveys were conducted during the irrigation period when the water flow of farm ditch is plentiful, and either after rice planting (mid-July to mid-August) or during the rice harvesting period (October to November). The survey at reservoir was conducted at mid-July and end of November. Because reservoirs are water storage facilities, they are often waterlogged throughout the year, so the timing of the surveys was likely not affected by the agricultural cycle.

Regarding the contents of the after-survey discussion, following is the list of examples of three ways to describe the discussion held by participants with each other after the survey:

1. general contents such as impressions,
2. motivation such as re-evaluation and re-recognition for their communities or the surrounding environment (e.g., "I want to make efforts in conservation activities to coexist with other lives while cherishing the nature of the region"),
3. future prospects such as specific countermeasure plans for environmental education.

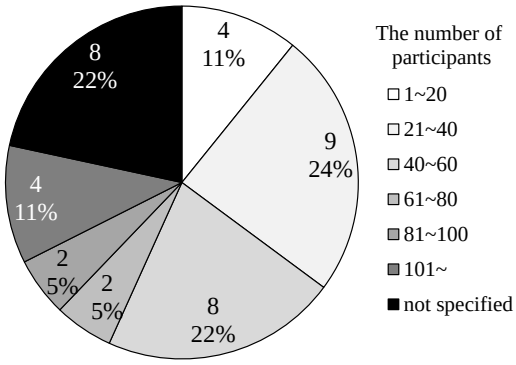

Fig. 1 Frequency of the number of participants (n = 37 organizations)

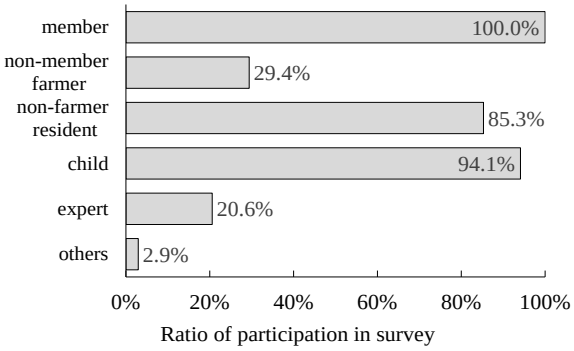

Fig. 2 The attributes of the participants (n = 34 organizations)

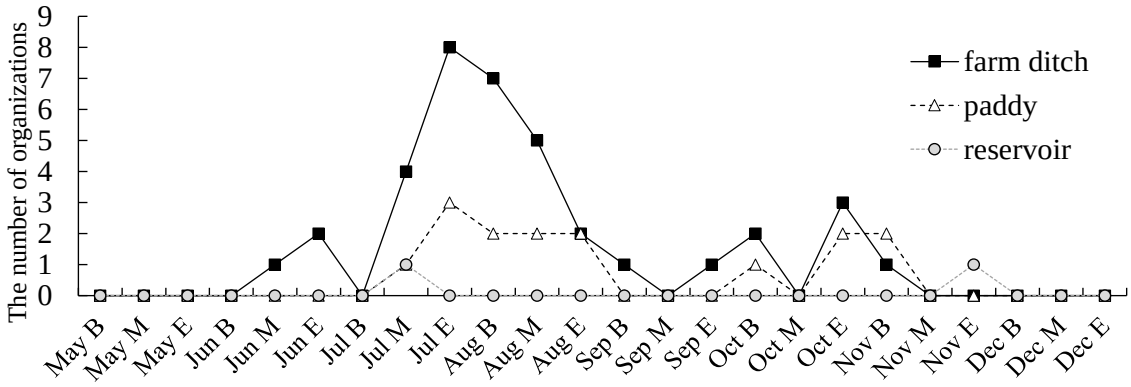

Fig. 3 Frequency of the first survey timing of 36 organizations by survey sites

The group discussions, including parents and children, were held after the survey. A typical example is that the survey organizers served lunch to participants and sat around inside or outside near the paddy fields. They had a conversation on the above three topics. 35 organizations wrote down the memo, contents, or the results of their discussions, and two organizations did not.

Relationships between Activity Features of Surveys and Detected Species and Group Discussion

In the cluster analysis, based on the analysis results in the previous section, we selected 15 items that impacted the residential biological survey from the social aspect, including the attributes of participants, survey times, and photographic records. The number of participants was excluded from the analysis for reliability reasons because of the high variability in values compared to the other variables. Accordingly, the 34 organizations' data which completed all items were used in the analysis and three organizations' data were excluded. The result of cluster analysis allowed us to distinguish the following characteristics among each organization (Fig. 4, Table 2).

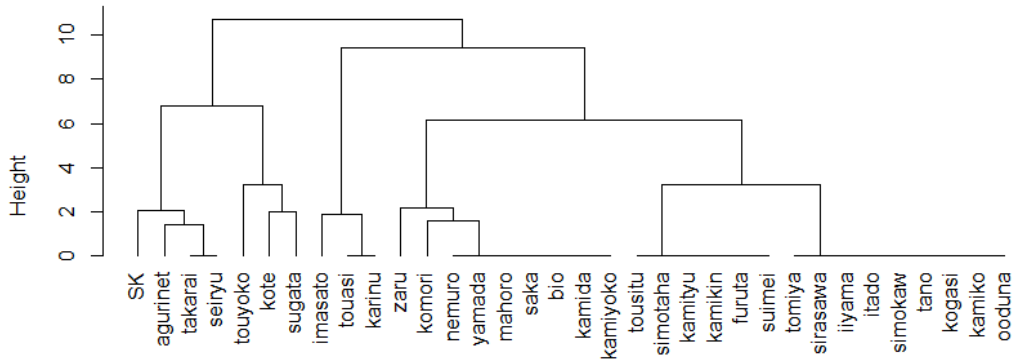

Fig. 4 The classification of the organizations

The texts on the horizontal axis represent the name of the organizations. The classification was pruned at the height of five.

Table 2 The details of the cluster classification and described characteristics

No.	Characteristics	Type	Score of discussion	Detected species
Class 1	Children attended, non experts attended, all documents submitted, survey one time, one or two attributes.	Complete document type	3.0	8.3
Class 2	Children attended, non experts attended, survey one time, almost one attribute.	Children participate type	2.4	10.0
Class 3	Children attended, experts attended in some case, survey two times, two or three attributes.	Multiple surveys type	3.3	12.0
Class 4	Children attended, experts attended, survey one times, two or three attributes.	Multi-attributes type	2.3	12.8
Class 5	Non children attended, non experts attended, survey one times, no attribute.	Non-child participate type	1.7	8.3

(1) Complete document type: no inadequacies in the documentation, photographs of the captured species, and a location map that explicitly describes the survey points were submitted. (2) Children's participate type: characterized by children's participation but not experts. (3) Multiple surveys type: The difference from the previous group, class 2, is that the survey was conducted multiple times throughout the year. This type was also characterized by children's participation, while experts might or might not attend the events. (4) Multi-attributes type: children and experts participated, and the attributes of the participants were diverse. (5) Non-child participate type: children and experts do not participate.

Table 2 shows that the average discussion scores of the organizations with children participating (3.0 of class 1, 2.4 of class 2, 3.3 of class 3 and 2.3 of class 4; 2.8 in average) were higher than that of the organizations without children (which was 1.7 of class 5). In addition, the organizations surveyed multiple times were more likely to include both child and expert, and had the highest discussion scores (3.3). Children's participation (resulting in increasing the number of surveys) indicated a high level of interest in the survey of natural lives in the community environment, leading to more active discussions.

The group with the highest number of species captured also had experts participating (Table 2). The number of species got the highest is not because the actual number of species captured was high, but instead because the captured lives could be identified at the species level when experts were present in the survey.

Issues for Sustainable Biological Monitoring

In this section, the issues for sustainable biological monitoring are discussed based on the results described so far.

The first is the lack of collaboration with experts. Only seven organizations out of 37 (around 19%) confirmed cooperating with biological experts. Considering that the clustered group with the highest number of species captured had experts participating, having experts participate at least once in every organization will be necessary to improve the quality of biological surveys. In general, it remains concerns about the accuracy of data collected by non-experts (Crall et al. 2011; Gardiner et al. 2012). With a guidance from experts, surveys can be conducted efficiently (Bonter and Cooper, 2012), and experts can be expected to give comprehensive advice and learning opportunities for children about the local environment based on the species habitat conditions. Survey method is also relevant for data quality (Lewandowski and Specht, 2015); for example, species photos and other information such as species features of color, voice and so on, are important to identify the species later. Taking species photos and stock correct information by matching the captured species with its name will also help the communities to figure out their environment ecosystem in the future (Kosmala et al., 2016).

Our cluster analysis results indicate that the residential biological survey, especially those with children, positively impacted communities' attitudes toward their environment (Table 2). According to Asah and Blahna (2012), the participation of non-experts is most motivated by personal and social benefits such as education and social interaction with other members rather than environment-related reasons. In the case of our study, the survey was discussed among the adult participants from the child's perspective, such as they want to continue to participate next year because the survey was a good experience for their children, and they wanted to protect their surrounding environments for their kids. Furthermore, the survey group without children did not discuss the prospect of their survey (Table 2). This implies that the participation of children has a role not only to deepen the contents of discussion which are held after the surveys, but also for the motivation of adult participants. The residential biological survey is considered to rouse interest in nature and increase motivation to participate in environmental conservation activities (Mizutani et al., 2014; Eberhardt et al., 2022), and our findings also followed their results. We showed that residential participation, especially when they include children, would shape community-wide conservation activities (Knafo and Galansky, 2008; Hartley et al., 2015) by promoting an understanding of their local environment and the resulting sustainable surveys.

CONCLUSION

We clarified the features of the residents' survey activities and examined the relationship between the features and the detected species and the contents of discussion which were held after the surveys. The group with invited biological experts detected the highest number of species. When children attended the discussion, participants tended to discuss their future prospects of activities,

leading to the sustainability of the biological survey by local residents. These results support that the participation of experts and children are recommended for sustainable biological monitoring.

The remaining problem is that only a few organizations mentioned a specific vision for environmental education in their discussions. Of the 35 organizations that recorded their discussions, only six organizations (17%) described their future prospects. Few concrete descriptions of future prospects based on the results of the discussions meant the influence of this survey on their communities was still unclear. For a countermeasure, when discussing the results of biological surveys, it would be helpful to prepare quantitative data on the survey results and maps of the species habitat status to serve as indicators for local communities. The discussion content should be broadened to include comments from experts and specific future perspectives on the nature of the survey and the community.

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