Ecological Research Monographs

Yukari Suzuki-Ohno *Editor*

# Community Science in Ecology

## Case Studies of Public Participation in Ecological Research in Japan

Springer

# Ecological Research Monographs

**Series Editor**
Yoh Iwasa, Department of Biology, Kyushu University, Fukuoka, Japan

The book series Ecological Research Monographs publishes refereed volumes on all aspects of ecology, including Animal ecology Population ecology Theoretical ecology Plant ecology Community ecology Statistical ecology Marine ecology Ecosystems Biodiversity Microbial ecology Landscape ecology Conservation Molecular ecology Behavioral ecology Urban ecology Physiological ecology Evolutionary ecology  The series comprise books and edited collections by international experts in their fields.

Yukari Suzuki-Ohno
Editor

# Community Science in Ecology

## Case Studies of Public Participation in Ecological Research in Japan

Springer

*Editor*
Yukari Suzuki-Ohno
Graduate School of Life Sciences
Tohoku University
Sendai, Miyagi, Japan

ISSN 2191-0707 ISSN 2191-0715 (electronic)
Ecological Research Monographs
ISBN 978-981-97-0303-6 ISBN 978-981-97-0304-3 (eBook)
https://doi.org/10.1007/978-981-97-0304-3



Cover illustration: Sampling environmental DNA from seawater by volunteers in Japan. (Photo taken on September 13, 2022, by Masahiro Mitsuhata)

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

# Preface

"Citizen science," also called "community science," has attracted the attention of scientists, which is increasing the demand for books on the subject. In light of this, the book *Community Science in Ecology: Case Studies of Public Participation in Ecological Research in Japan* was written. The aim of writing it was twofold. The first was to spread and encourage the practice of community science programs by ecologists. Ecology in the twenty-first century requires ecological community science programs to understand and mitigate the rapid decline in biodiversity or species extinction. Ecologists need to gain more experience and analytical results from community science programs. The authors of this book are all ecologists and practitioners of community science programs and cover the following topics: the introduction of this book (Chap. 1), the basic knowledge about community science (Chap. 2), ecological community science programs (Chaps. 3–9), science communication (Chap. 10), database and the rights of participants (Chap. 11), decision-making in community science (Chap. 12), alien species extermination (Chap. 13), and wetland restoration with participants (Chap. 14). Lastly, in the Editor's note, I have given my opinion as to the challenges of community science programs in Japan.

The second was to introduce Japanese community science programs in English. There is extensive literature on community science, but most of it is from Europe and the United States. This book focuses on Japanese community science programs in the field of ecology because the literature on these programs in Asia is rarely accessible in the English language. Some chapters in this book are not in the general form of an original article in academic journals because this was unsuitable for describing the programs' details. The procedures and outcomes of ecological community science programs often depend on the target species and site locations, and the details of past programs are not always documented to find generality. I believe that it is important to accumulate detailed records of case studies as this book has done. This book will be valuable for scientists studying and practicing community science around the world. I hope that this book will help ecologists who plan or work on ecological community science programs and benefit their participants.

Sendai, Miyagi, Japan — Yukari Suzuki-Ohno

# Contents


**1 Introduction** . . . . . . . . . . 1
Yukari Suzuki-Ohno

**Part I What Is Community Science?**

**2 Fundamental Ideas and Concepts in Citizen Science** . . . . . . . . . . 21
Yuko Ikkatai

**Part II Ecological Community Science Programs**

**3 Practicing Collaborative Biodiversity Research with High Schools to Benefit Both Education and Invasive Species Monitoring** . . . . . . . 33
Masashi Yoshimura

**4 Hanamaru-Maruhana(Bumble Bee) National Census Using Photographs** . . . . . . . . . . 49
Yukari Suzuki-Ohno and Jun Yokoyama

**5 Cyberforest Using Video and Sounds** . . . . . . . . . . 73
Kazuhiko W. Nakamura

**6 Community Science Initiatives Utilizing Environmental DNA** . . . . . . 83
Michio Kondoh, Minoru Kasada, Takuzo Abe, Akihide Kasai, Akihiro Dazai, Reiji Masuda, Satoquo Seino, Shota Suzuki, Yukari Suzuki-Ohno, and Akifumi S. Tanabe

**7 Diverse Motivations in Citizen Science** . . . . . . . . . . 101
Shinichi Takagawa and Yoko Imai

**8 Dandelion Survey: Western Japan 2020, Kochi Prefecture. Distribution Survey of Native, Alien and Hybridized Dandelions (*Taraxacum* spp.) through Citizen Participation in Kochi Prefecture** . . . . . . . . . . 105
Kazumi Fujikawa

**9 Citizen Science and Natural History Museums in Japan** . . . . . . . . . . 131
So Ishida

**Part III Considering Data and Environments with Participants**

**10 Science Communication: Bridging Between Science and Society** . . . 151
Yuko Ikkatai

**11 The Essential Principle for Appropriate Data Policy of Citizen Science Projects: Correspondence for the Diverse and Transmutable Attributes of Participants** . . . . . . . . . . . . . . . . . . . . . . . 159
Takeshi Osawa

**12 Citizen Science for Social Decision-Making: Avoiding Missteps and Unlocking Potentials** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 173
Takeshi Osawa

**Part IV Changing Environments with Participants**

**13 The Importance of Dialogue Between Science and the Public Shown in the Invasive Bumblebee Problem** . . . . . . . . . . . . . . . . . . . . . 183
Koichi Goka

**14 Management of Wetland Ecosystems with the Participation of Citizens** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 199
Jun Nishihiro

**15 Editor's Note** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 211
Yukari Suzuki-Ohno

# Contributors

**Takuzo Abe** Minamisanriku Nature Center, Minamisanriku, Miyagi, Japan

**Akihiro Dazai** Center for Sustainable Society, Minamisanriku, Miyagi, Japan

**Kazumi Fujikawa** The Kochi Prefectural Makino Botanical Garden, Kochi-shi, Kochi, Japan

**Koichi Goka** National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan

**Yuko Ikkatai** Institute of Human and Social Sciences, Kanazawa University, Kanazawa-shi, Ishikawa, Japan

**Yoko Imai** Department of Urban Engineering, School of Engineering, The University of Tokyo, Bunkyo, Tokyo, Japan

**So Ishida** Osaka Museum of Natural History, Higashisumiyoshi-ku, Osaka, Japan

**Minoru Kasada** Graduate School of Life Sciences, Tohoku University, Sendai, Miyagi, Japan

Field Science Center for Northern Biosphere, Hokkaido University, Horokanai, Japan

**Akihide Kasai** Faculty of Fisheries Sciences, Hokkaido University, Hakodate, Hokkaido, Japan

**Michio Kondoh** Graduate School of Life Sciences, Tohoku University, Sendai, Miyagi, Japan

Advanced Institute for Marine Ecosystem Change (WPI-AIMEC), Tohoku University, Sendai, Miyagi, Japan

**Reiji Masuda** Maizuru Fisheries Research Station, Field Science Education and Research Center, Kyoto University, Kyoto, Japan

**Kazuhiro W. Nakamura** Graduate School of Frontier Sciences, The University of Tokyo, Tokyo, Japan

**Jun Nishihiro** Center for Climate Change Adaptation, National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan

**Takeshi Osawa** Graduate School of Urban Environmental Sciences, Tokyo Metropolitan University, Hachiouji, Tokyo, Japan

**Satoquo Seino** Graduate School of Engineering, Kyushu University, Fukuoka, Japan

**Yukari Suzuki-Ohno** Graduate School of Life Sciences, Tohoku University, Sendai, Miyagi, Japan

**Shota Suzuki** Minamisanriku Nature Center, Minamisanriku, Miyagi, Japan

**Shinichi Takagawa** The Nature Conservation Society of Japan, Chuo-Ku, Tokyo, Japan

**Akifumi S. Tanabe** Graduate School of Life Sciences, Tohoku University, Sendai, Miyagi, Japan

**Jun Yokoyama** Yamagata University, Yamagata-shi, Yamagata, Japan

**Masashi Yoshimura** Okinawa Institute of Science and Technology Graduate University, Okinawa, Japan

# Chapter 1
# Introduction

**Yukari Suzuki-Ohno**

**Abstract** For centuries, volunteers have accumulated data on animals and plants, developing what is now known as "citizen science" or "community science." It is meaningful for ecologists to be involved in community science for the future of ecology. This book "Community Science in Ecology: Case Studies of Public Participation in Ecological Research in Japan" covers case studies of community science programs conducted by ecologists (Chaps. 3, 4, 5, and 6), NPO staff (Chap. 7), and museum curators (Chaps. 8 and 9) in Japan. It also covers a wide range of topics needed to study and practice community science: basic knowledge about community science (Chap. 2), science communication (Chap. 10), database and the rights of participants (Chap. 11), decision-making in community science (Chap. 12), alien species extermination (Chap. 13), and wetland restoration with participants (Chap. 14). To understand why this book includes these chapters, I provide an overview of community science in the field of ecology by referring to these chapters in the Introduction. Introduction consists of "Ecological Community Science," "Ecological Community Science for Ecologists," "Ecological Community Science in Japan," "Science Communication and Data Openness of Ecological Community Science," "Decision-making and Conservation Activities in Ecological Community Science," and "Organization of This Book."

**Keywords** Community science · Citizen science · Science communication · Open data · Decision-making · Conservation · Elimination of alien species

## 1.1 Ecological Community Science

The word "citizen science," which scientists have begun to call "community science," has different definitions depending on its context (Chap. 2 of this book); however, here, I would like to define it simply as scientific activities carried out by

Y. Suzuki-Ohno (✉)
Graduate School of Life Sciences, Tohoku University, Sendai, Japan



Y. Suzuki-Ohno (ed.), *Community Science in Ecology*, Ecological Research Monographs, https://doi.org/10.1007/978-981-97-0304-3_1

volunteers. Community science has been developed by volunteers for centuries (Dickinson et al. 2010). There are various types of community science, such as data classification, annotation, transcription, and collection. Data classification and annotation are popular in a wide range of fields (e.g., astronomy), but data collection is more common in ecology (hereafter, community science in ecology is called "ecological community science"). Volunteers who are not ecologists belonging to universities or research institutes have participated in community science and have collected data by observing birds and catching insects. Traditional recording methods for data collection in ecological community science programs include observations (e.g., Sullivan et al. 2009) (Fig. 1.1) and specimens (e.g., Fontaine et al. 2012) (Fig. 1.2). eBird (https://ebird.org/home) is one of the most famous community science programs, collecting observational data (note: eBird also collects photograph and audio data). eBird has published its dataset, the "eBird Observation Dataset," in the open database Global Biodiversity Information Facility (GBIF, https://www.gbif.org/). The dataset contains 1,060,970,490 bird occurrence records with 100% taxon, 100% year, and 99.9% coordinate matches (as of June 2022) (https://www.gbif.org/dataset/4fa7b334-ce0d-4e88-aaae-2e0c138d049e). The collection of observational data is simple and widely used, but it requires participants to visually identify the species. The collection of specimens allows participants to identify species by anatomy or experts' opinions. Numerous new species have been reported based on specimens collected from volunteers (Fontaine et al. 2012). Specimens are suitable for investigating new or alien species because of the critical importance of species identification (Fig. 1.2, Chap. 3).

**Fig. 1.1** Observation of birds in a woodland area


**Fig. 1.2** Alien ant specimens collected in OKEON project (Chap. 3). Left: *Solenopsis invicta*. Right: *Linepithema humile* (Photographer: OKEON)

In the twenty-first century, ecological community science has had the largest impact on the methodology for collecting and classifying data in research on ecology and conservation (Kullenberg and Kasperowski 2016). The prevalence of the Internet and digital tools, such as digital cameras and smartphones, has promoted online ecological community science programs. This allows us to efficiently collect large numbers of high-quality data over a wide area at low costs. The choices of recording methods have increased with the addition of photographs, videos, and audio data (Figs. 1.3 and 1.4). These tools allow the recording of the occurrence data of the target species without capture and the identification of species by experts' or other participants' opinions (e.g., Losey et al. 2012; Silvertown et al. 2015; Saito et al. 2015; Suzuki-Ohno et al. 2017, Chaps. 4 and 5). iNaturalist (https://www.inaturalist.org) and iSpot (https://www.ispotnature.org) are typical online networks that share biodiversity information of photographs. Participants and experts can help identify species in photographs uploaded by other participants on the websites. Photographs are simple and widely used for observation. iNaturalist has published its dataset as "iNaturalist Research-grade Observations" in the open GBIF database. The dataset contains 44,166,226 occurrence records with 99.9% taxon, 100% year, and 99.7% coordinate matches (as of June 2022) (https://www.gbif.org/ja/dataset/50c9509d-22c7-4a22-a47d-8c48425ef4a7). In addition to data collection, data classification and annotation are actively performed using photograph and audio data. For example, animal photographs captured by motion-sensor cameras in the Serengeti National Park of Tanzania were classified by volunteers (Swanson et al. 2015, 2016), and the accuracy of identification of volunteers versus experts was high (98% in Swanson et al. 2016 and 96.6% in Norouzzadeh et al. 2018). Experts and volunteers also identified the bird species through live sounds streamed by automatic fixed cameras in the forest monitoring sites (Saito et al. 2015, Chap. 5).

The latest tool used for community science monitoring is environmental DNA (eDNA) (Biggs et al. 2015; Larson et al. 2017; Tøttrup et al. 2021; Meyer et al. 2021; Miya et al. 2022; Suzuki-Ohno et al. 2023) (Fig. 1.5). The technologies of polymerase chain reaction (PCR), the eDNA databases, and computational theories

**Fig. 1.3** Digital cameras and smartphones. Photograph, video, and audio data recorded by digital cameras and smartphones can be used as biodiversity data

have made it possible to identify species from eDNA and record occurrence data without relying on visible morphological features. In addition, eDNA metabarcoding allows for a comprehensive investigation of biodiversity at a sampling site. For example, 572 taxonomic groups of fish eDNA were collected from 81 coastal sites by volunteers using this method in 2020 and 2021 (Suzuki-Ohno et al. 2023, Chap. 6). This dataset was published in the ANEMONE DB (https://db.anemone.bio/). The details of these recording methods and tools in ecological community science programs are explained in Chaps. 3, 4, 5, and 6 of this book.

## 1.2 Ecological Community Science for Ecologists

As ecological community science has evolved, the types of ecological community science programs have diversified (Pocock et al. 2017; Chap. 2). Some programs are managed solely by only nonexpert volunteers to investigate a specific local site, whereas others are planned by ecologists and investigate a worldwide range. Some programs are conducted solely for fun, whereas others are aimed at collecting accurate data for scientific research. Discussing them at the same level causes

**Fig. 1.4** Fixed camera in Cyberforest (Chap. 5). Video and audio data recorded by fixed cameras can be used as biodiversity data

**Fig. 1.5** Environmental DNA (eDNA) collected by a sampling kit in Earthwatch project (Chap. 6). Left: Filtering seawater to collect eDNA of marine fishes. Right: A kit (syringe and cartridge) to collect eDNA (Photographer: M. Mitsuhata)

misunderstandings and conflicts that prevent the development of ecological community science. When discussing ecological community science, it is important to clarify the following: (1) main members who plan the program (e.g., volunteers, nonprofit organization (NPO)/nongovernmental organization (NGO)/Public Interest Incorporated Association (PIIA) staff, museum curators, or ecologists), (2) the relationship between the main members who plan the program and those who participate or cooperate in the program (e.g., partners, supporters, or participants in other programs), (3) the geographic range covered in the program (e.g., a specific site, region, or nationwide), (4) the method of collecting/classifying/annotating data (e.g., onsite, or online), (5) the method of recording data (e.g., observations, specimens, photographs, videos, audio, or eDNA), and (6) the aim of the program (e.g., an increase of local attachment, environmental education, conservation, or contribution to science).

The type of ecological community science programs that many ecologists are interested in will correspond to data collection by an unspecified number of participants for nationwide scientific research planned by ecologists. This type benefits the ecologists who plan or contribute to them in the following ways. (1) As many volunteers participate in the program, ecologists can obtain more numbers of data. (2) If the program is of the type in which many monitoring sites are set over wide areas or monitoring sites are freely selectable by volunteers, they can obtain data over wide areas. (3) If the program is of the type that monitoring sites are freely selectable by volunteers, the data may include those of places that they would not normally be able to investigate (e.g., private gardens of volunteers and remote islands). (4) The programs can be used for science outreach activities and environmental education through training in data collection, reporting the collected data, and the analytical results of the data to participants. (5) The program could be collaborative if the program is of the type that frequent communication with participants is possible. In this way, participants may improve their monitoring/classifying/analyzing methods. They may provide new data or ideas for research. The last two benefits, (4) and (5), are also common in data classification and annotation by volunteers. The details of these benefits are found in Chaps. 4 and 6 of this book.

Occurrence data collected by participants can be used to study species distribution (e.g., Losey et al. 2012; Miyazaki et al. 2014; Suzuki-Ohno et al. 2017), alien species invasion (e.g., Delaney et al. 2008; Kadoya et al. 2009; Miyazaki et al. 2016; Morii and Nakano 2017), species composition (e.g., Washitani et al. 2020), and phenology (e.g., Henderson et al. 2012). Some scientists have pointed out that the accuracy of data collected by volunteers may sometimes be too low for the use of scientific research. However, several methods to mitigate the effects of spatially biased data (e.g., Phillips et al. 2009; Kramer-Schadt et al. 2013) or to ensure high accuracy of data (e.g., Van Eupen et al. 2022) have been proposed in previous studies. If the data contain images such as photographs or videos, these can be used to study phenotypic variation (e.g., Silvertown et al. 2011), feeding behavior (e.g., Morii and Nakano 2017), and image analysis by deep learning (e.g., Horn et al. 2018; Suzuki-Ohno et al. 2022). Data collected by participants can also be used to study species' functions. In 2022, Cool Earth via dSOIL (https://dsoil.jp/en/) initiated a community science program called "COOL EARTH LAB." In this program, participants receive an experimental culture jar and vials provided by scientists, put the soil into the jar, sample the gas from the jar into the vials multiple times, and send the jar and the vials back to the scientists. The scientists analyze the gas and soil to investigate $NO_2$ concentration, soil bacteria, and their *nosZ* gene. These results will reveal the relationship between soil bacteria and their function of reducing $NO_2$. By devising equipment and manuals in community science programs, data collected by participants can be applied to various studies in ecology.

## 1.3 Ecological Community Science in Japan

Community science programs in Europe and the United States are actively discussed, but it does not mean that there are few community science programs in Asia. There are many ecological community science programs in Asia. In Japan, there has been more than a century of history of ecological community science (Kobori et al. 2016). This is most likely because Japan is a global hotspot for biodiversity and Japanese people have enjoyed feeling seasonal changes from the change of observed organisms (i.e., phenology). There are four distinct seasons, and the species observed vary during each season. Japanese people have enjoyed cherry blossoms and the arrival of swallows in spring, observing and catching insects (e.g., fireflies, beetles, stag beetles, cicadas, and dragonflies) in summer, seeing colored leaves and listening to the singing of insects (e.g., bell crickets, and pine crickets) in autumn, and watching winter birds in winter. In a 1000-year-old book, "*the Makura no Soshi*" (translated as "The Pillow Book" in English) by Sei Shonagon, the author explains how she loved the light of fireflies, the singing of insects, and the sight of wild geese flying (Sei Shonagon n.d.).

Many ecological community science programs in Japan have been managed by NPOs, NGOs, PIIAs, museum curators, scientists, and volunteers. Famous examples of ecological community science programs managed by NPOs and NGOs are "Sea Turtle Survey" of the Sea Turtle Association of Japan (http://www.umigame.org/) and "Monitoring Sites 1000" project of the Nature Conservation Society of Japan (NACS-J) (Chap. 7, https://www.nacsj.or.jp/english/). Sea Turtle Survey investigated the distribution of sea turtle nesting habitats in the Japanese archipelago for the conservation of sea turtles. This survey was initiated by students in an elementary school and a junior high school in the 1950s and continued to increase in participants at various sites, which led to the establishment of the Sea Turtle Association of Japan in 1990. It is still ongoing, which makes it a remarkably long-term survey even by international standards. Monitoring Sites 1000 Project began after establishing NACS-J. The predecessor of NACS-J was formed by local biologists and mountain climbers in 1949, and NACS-J was established to protect nature in 1951 (Fig. 1.6). NACS-J has collaborated with various NPOs, NGOs, volunteer groups, scientists, and administrations. Monitoring Sites 1000 project was initiated by these groups and the Biodiversity Center of Japan in the Ministry of the Environment in 2003. The details of Monitoring Sites 1000 project are described in Chap. 7 of this book. The NPOs and NGOs cooperating with Monitoring Sites 1000 also manage long-term ecological community science programs. One of the NPOs cooperating with Monitoring Sites 1000 is Bird Research (http://www.bird-research.jp/index-e.html). Bird Research conducts several programs that collect long-term monitoring data of birds, such as verandah birdwatching initiated in 2005. They also conduct a program to identify bird species using audio data from forest monitoring sites in Cyberforest (Chap. 5).

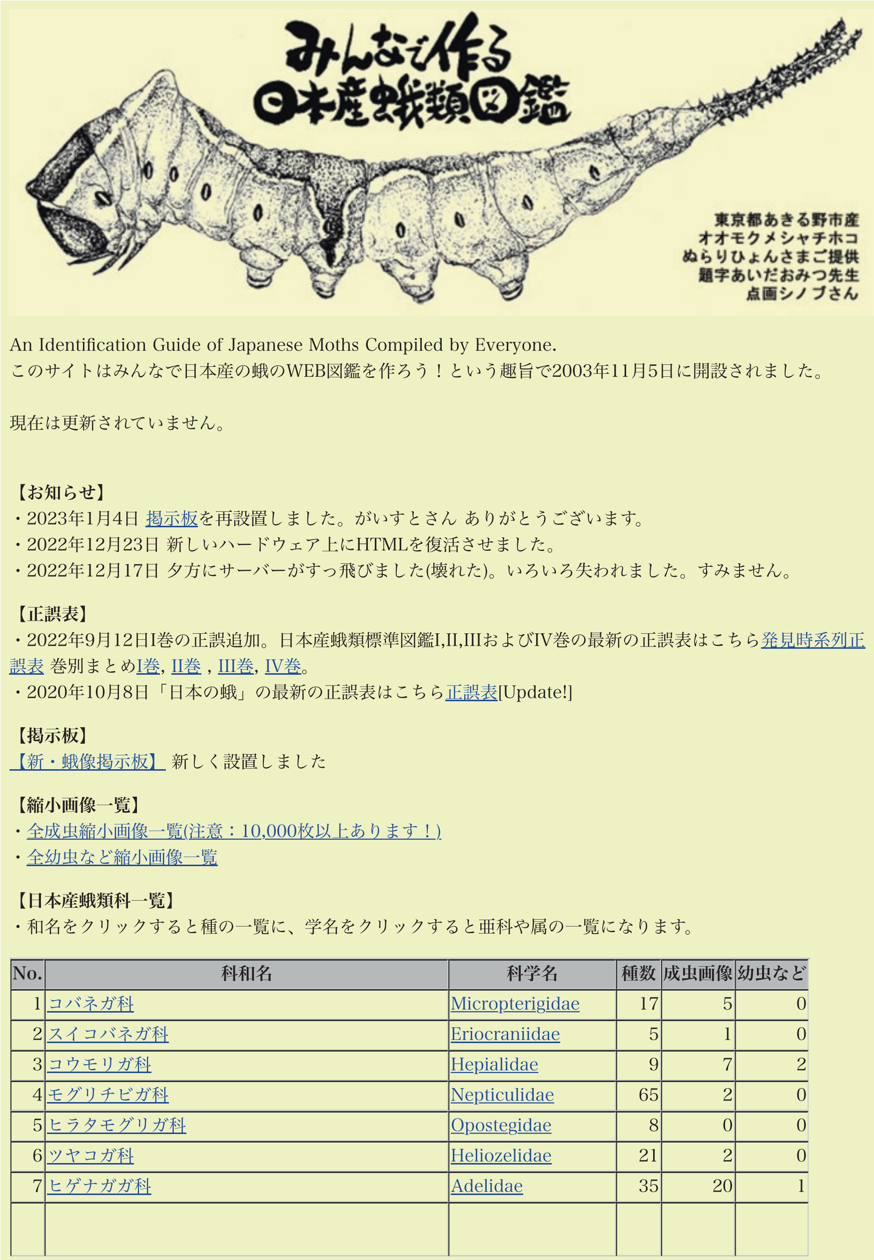
Famous examples of ecological community science programs managed by museum curators and scientists include "Field Research of Dandelions in West


**Fig. 1.6** The pamphlet of Nature Conservation Society of Japan (NACS-J)

Japan" (Chap. 8) and "FishPix" (https://fishpix.kahaku.go.jp/fishimage-e/index.html in English, or https://nh.kanagawa-museum.jp/kpmnh-collections/ in Japanese). Field Research of Dandelions in West Japan began in 1975 and has been managed by PIIA Nature Conservation Society of Osaka, museums, and some laboratories of universities. Dandelion specimens in the western regions of Japan were collected every 5 years, and species of dandelions have been identified by museum curators and university faculty in the western regions of Japan (Chap. 8). FishPix is a database of fish photographs built and managed by the Fish Divisions of the Kanagawa Prefectural Museum of Natural History, Odawara, and the National Museum of Nature and Science. FishPix began in 1998 and has collected over 150,000 photographs of fish species (as of June 2022). These photographs were mainly sent by amateur SCUBA divers. The museums also provide a venue for volunteer groups to make presentations on their community science activities (e.g., Osaka Natural History Festival in the Osaka Natural History Center, Kyousei-no-hiroba in the Museum of Nature and Human Activities, Hyogo, and Field Reporter in the Lake Biwa Museum). The details of the ecological community science programs managed by museum curators are explained in Chaps. 8 and 9 of this book.

Famous examples of ecological community science programs managed by scientists and volunteers not covered in PART II were "An identification guide of Japanese moths compiled by everyone" (hereafter it is called "JPMOTH," http://www.jpmoth.org/) and "WEB *sakana-zukan*" (https://zukan.com/fish/). JPMOTH has interesting origins (Jinbo and Suzuki 2006). The predecessor of JPMOTH was an open anonymous Internet forum, and it generated the website of JPMOTH managed by two volunteers and a scientist (Fig. 1.7). Over 10,000 photographs of moth adults and larvae were taken by the participants, and the number of species/subspecies in the photographs was more than 4000 species/subspecies. The website of the identification guide in JPMOTH was started in 2003 and paused in 2010, but the place of communication for moth enthusiasts has moved to the open anonymous Internet forum in JPMOTH and the semi-closed Facebook group "Moth Club." Moth enthusiasts participate in communication by uploading photographs of collected moths and larvae. JPMOTH influenced overseas ecological community science and triggered an ecological community science program called "twmoth" in Taiwan (https://twmoth.tesri.gov.tw/peo/aboutme). The occurrence data of Taiwanase moths collected by twmoth is available (https://www.gbif.org/dataset/e0b8cb67-6667-423d-ab71-08021b6485f3) in GBIF. WEB *sakana-zukan* is a database of fish photographs built and managed by some scientists and volunteers. The WEB *sakana-zukan* began in 2002 and collected over 50,000 photographs of 3648 fish species (as of June 2022). These photographs were often sent by amateur anglers and have been used in scientific studies (Miyazaki et al. 2014, 2016, 2020).

In contrast to the high level of contribution of Japanese volunteers to community science programs in Japan, the contribution of Japanese volunteers to global community science programs may not be significant. According to data from eBird and iNaturalist, the percentage of observers in Japan is relatively low. On the eBird website (https://ebird.org/region/world?yr=all), Japan's records, species, and observers are 1.3%, 5.7%, and 0.5% of the world's total, respectively (as of May 2022). On the iNaturalist website (https://www.inaturalist.org/observations), Japan's records, species, and observers are 0.24%, 4.6%, and 0.38% of the world's total, respectively (as of May 2022). This may be because Japanese volunteers do not know about these global community science programs or have originally


みんなで作る日本産蛾類図鑑

東京都あきる野市産
オオモクメシャチホコ
ぬらりひょんさまご提供
題字あいだおみつ先生
点画シノブさん

An Identification Guide of Japanese Moths Compiled by Everyone.
このサイトはみんなで日本産の蛾のWEB図鑑を作ろう！という趣旨で2003年11月5日に開設されました。

現在は更新されていません。

【お知らせ】
・2023年1月4日 掲示板を再設置しました。がいすとさん ありがとうございます。
・2022年12月23日 新しいハードウェア上にHTMLを復活させました。
・2022年12月17日 夕方にサーバーがすっ飛びました(壊れた)。いろいろ失われました。すみません。

【正誤表】
・2022年9月12日I巻の正誤追加。日本産蛾類標準図鑑I,II,IIIおよびIV巻の最新の正誤表はこちら発見時系列正誤表 巻別まとめI巻, II巻 , III巻, IV巻。
・2020年10月8日「日本の蛾」の最新の正誤表はこちら正誤表[Update!]

【掲示板】
【新・蛾像掲示板】 新しく設置しました

【縮小画像一覧】
・全成虫縮小画像一覧(注意：10,000枚以上あります！)
・全幼虫など縮小画像一覧

【日本産蛾類科一覧】
・和名をクリックすると種の一覧に、学名をクリックすると亜科や属の一覧になります。

| No. | 科和名 | 科学名 | 種数 | 成虫画像 | 幼虫など |
|---|---|---|---|---|---|
| 1 | コバネガ科 | Micropterigidae | 17 | 5 | 0 |
| 2 | スイコバネガ科 | Eriocraniidae | 5 | 1 | 0 |
| 3 | コウモリガ科 | Hepialidae | 9 | 7 | 2 |
| 4 | モグリチビガ科 | Nepticulidae | 65 | 2 | 0 |
| 5 | ヒラタモグリガ科 | Opostegidae | 8 | 0 | 0 |
| 6 | ツヤコガ科 | Heliozelidae | 21 | 2 | 0 |
| 7 | ヒゲナガガ科 | Adelidae | 35 | 20 | 1 |
| | | | | | |

**Fig. 1.7** The screenshot of web site of the identification guide of Japanese moths compiled by everyone (JPMOTH)

participated in Japanese local groups and do not want to display their photographs or observation locations in global community science programs. The number of species is relatively high compared to the number of observers and records in Japan, which indicates that data on Japanese endemic species are valuable for global community science. Since the Wild Bird Society of Japan (https://www.wbsj.org/en/), which is the Public Interest Incorporated Foundation of bird research and conservation in Japan, started operating eBird Japan in 2021 and planning events for eBird, the bird occurrence data in Japan will increase in eBird in the future.

Japanese ecologists are starting to contribute to global community science by protecting traditional community science programs (e.g., Osawa 2013) and promoting new ones in prefecture units or nationwide (e.g., Kadoya et al. 2009; Saito et al. 2015; Morii and Nakano 2017; Washitani et al. 2020; Suzuki-Ohno et al. 2017, 2023). Chapters 3, 4, 5, and 6 of this book introduce examples of ecological community science programs planned by ecologists in Japan. Chapters 7, 8, and 9 of this book introduce examples of ecological community science programs planned by NPO/NGO/PIIA and museums in Japan. In the following sections, I focus on the importance of science communication, data openness and closedness, and also decision-making and conservation activities for ecological community science programs.

## 1.4 Science Communication and Data Openness of Ecological Community Science

Science communication is the communication of scientific topics to nonexperts and is sometimes called outreach. Ecological community science programs can be considered a part of science communication (Chap. 10) and often require high science communication skills. If the aim of the program is environmental education and outreach, ecologists will be especially aware of science communication. However, if the aim is to collect data for scientific research, they may not be so. Even when the primary aim of the program is neither environmental education nor outreach, improving science communication skills will lead to collecting more accurate data and will facilitate collaboration with volunteers.

The content and methods of communication should be adaptable to participants from different educational levels and life circumstances. The content should be simple enough for nonexperts but accurate enough to avoid misunderstandings. The content of science communication is not limited to ecological information about target species but also includes other information, such as the procedure of scientific research, data utilization, data copyrights, and data management related to rare species. One-way communication is necessary to provide scientific information from experts, and two-way communication is necessary to increase the depth of understanding and the educational effects on participants (Chap. 10).