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Title

**Analyzing the change in long-term information provision on cat management around a World
Natural Heritage Site**

Authors

Mitsui, Satomi (Corresponding Author)

Graduate school of Agriculture, Hokkaido University

Address: Kita 9, Nishi 9, Kita-ku, Sapporo, Hokkaido 060-0808 Japan

Tel: +81-80-5694-4057

E-mail: smitsui@for.agr.hokudai.ac.jp

ORCID ID: 0000-0001-5843-4272

Kubo, Takahiro

Center for Environmental Biology and Ecosystem Studies,

National Institute for Environmental Studies

Address: 16-2 Onogawa, Tsukuba, Ibaraki 305-8506 Japan

Tel: +81-29-850-2897

E-mail: kubo.takahiro@nies.go.jp

Yoshida, Masahito

University of Tsukuba World Heritage Studies, Graduate School of Comprehensive Human Sciences

Address: 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8571 Japan

Tel : +81-29-853-7099

E-mail: yoshida_masahito@heritage.tsukuba.ac.jp

Abstract

Providing accurate long-term information is essential in enhancing invasive species management. The management of invasive species—for example, outdoor cats—depends on human behavior and requires cooperation among stakeholders. Previous studies have evaluated stakeholders' attitudes concerning invasive species, however, far too little attention has been paid to long-term information provisions. This study analyzes the information on cats in the Ogasawara Islands, a World Natural Heritage Site in Japan. We used monthly newsletters published by the local government for 21 years, which contain 150 articles about cats. We then applied content analysis to the data to assess both the frequency of keywords and co-occurrence network of words in order to understand the trends in keywords' appearances and changing contexts. We categorized the data into three periods of seven years each, and found distinct differences. Results showed that information on cat management has gradually changed, as policies have changed. In the first period, there were three co-occurrence networks, which focused on capturing outdoor cats, proper keeping of pet cats, and veterinary care. During the second period, there were two networks, which focused on cat and World Natural Heritage Site management. During the third period, all keywords were connected into one network that included the words "outdoor cat," "pet," and "World Natural Heritage Site." The changes imply that contents of information have shifted from pest management to ecosystem management. Visualizing how this information is provided over the long-term can remind stakeholders of previous communication efforts and enhance their cooperation on future conservation.

Keywords

Communication; Content analysis; Invasive species; Local newspaper; Ogasawara Islands; Stakeholders

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1. Introduction

Invasive species are key obstacles to conserving global biodiversity (Bremner and Park 2007; Early et al. 2016). Since unintentional introduction is one of the main ways invasive species spread (Pasko 2014), it is essential to enhance stakeholder awareness to better manage invasive species (Fischer and Young 2007; Vane and Runhaar 2016). A lack of public participation in invasive species management deteriorates biodiversity conservation.

Many recent studies have attempted to understand public attitudes concerning invasive species management; they have demonstrated that the information provision is essential to raising public support for invasive species management. Selge et al. (2011), for example, conducted interviews and group discussions with multiple stakeholders, including the public and professionals dealing with invasive species, in the northeast of Scotland. They found that it is important to convey information about the harm caused by invasive species and human responsibility to gain public support in effectively managing invasive species. Vane and Runhaar (2016) compared three specific cases of invasive species eradication in the Netherlands and found the public did not show support for the eradication of the indian house crow but did support the eradication of both pallas' squirrel and the american bullfrog. Vane and Runhaar described examples to demonstrate that regular information provision enhances public support for eradication programs; they provided insight into practical measures, including information provision, to better manage invasive species.

Few studies, however, have assessed the contents of information provided to residents concerning invasive species. Two exceptions are Jager et al. (2016) and Robinson et al. (2016); Jager et al. (2016) analyzed the contents of online news articles about Michigan mute swans over the course of 11 months. They suggest that online news influences public thinking and perform a content analysis to evaluate how that could be useful for managers. Robinson et al. (2016) investigated online information on invasive plants: japanese knotweed (*Fallopia japonica*). They found that management of invasive species is likely to vary depending on people's understanding of the problems the plants cause and their knowledge of best practices. They also reported that the number of documents regarding the plants provided by local government is higher and likely to be accessed more than that put out by other authorities. This implies that government authorities have an important role in enhancing information provision and should provide clear, detailed, and consistent information. However, the above studies have not addressed the change in provided information over time, or how the information is tailored to policies concerning invasive species.

In this study, we analyze the information provided in the Ogasawara Islands, Japan concerning one of the worst invasive species: outdoor cats (Lowe et al. 2000), a group that includes all feral/stray cats and

free-roaming pet cats. By using information provided over a long period of time, we are attempting to disclose the relationship between provided information and implemented policies by the local government. This is the first study to undertake a longitudinal analysis of invasive studies, although some studies address long-term information provisions in wildlife management (Bhatia et al. 2013; Muter et al. 2013). Outdoor cat is a significant example of an invasive species that requires public participation, because their behavior and ecology heavily depends on human behavior (Calver et al. 2007; Lord 2008; van Heezik 2010). Recent studies, such as Nogales et al. (2013), report that outdoor cats cause global wildlife extinction, especially on islands. Therefore, an effective information strategy is urgently needed. To reduce negative impacts on biodiversity in the Ogasawara Islands, the local government has implemented policies to better manage cats, including outdoor cats and pet cats which are major sources of outdoor cats (Lepczyk et al. 2004; Wald et al. 2013).

The purpose of this study is to evaluate the long-term information concerning cat management in the Ogasawara Islands, Japan; we apply content analysis to the newsletters provided by the local government for 21 years to understand both the trends in the appearance of specific keywords and the changing context of the newsletters. Our findings enhance public support for invasive species management. The remainder of the paper is structured as follows: Section 2 describes the content analysis we applied to local newsletters; Section 3 presents the results of our content analysis, illustrating changes in keywords in three periods over 21 years; and Section 4 discusses the information provision on invasive species based on the contents of newsletters in the Ogasawara Islands and suggests how to most effectively gain public support.

2. Methods

2.1 Study Area

The Ogasawara Islands are located 1,000 km south of the main Japanese archipelago and are composed of more than 30 small islands (Figure 1). The islands have roughly 2,500 residents; most live in the cities of Chichijima Island (hereafter Chichijima) and Hahajima Island (hereafter Hahajima). Because the islands have never been connected to the continent, there are many endemic animals and plants (Government of Japan, 2010), including the red-headed wood pigeon (*Columba janthina nitens*), the bonin honeyeater (*Apalopteron familiare*), and the bonin flying fox (*Pteropus pselaphon*). In addition, the islands provide breeding sites for seabirds and serve as relay stations for migratory birds (Horikoshi et al. 2009). In recognition of their unique ecosystems, the Ogasawara Islands were inscribed a World Natural Heritage Site in 2011.

< Figure 1. >

Invasive species, however, including outdoor cats, now seriously threaten the islands' ecosystem. The International Union for Conservation of Nature (IUCN) requested that continued efforts be made to manage invasive species and maintain the islands' value over time (Yoshida 2012). Therefore, the local government of Ogasawara Village has conducted initiatives to manage cats as invasive species management, as described in Table 1. They started a trap-neuter-return (TNR) project in 1996, in which outdoor cats are trapped in box traps, brought to a veterinarian to be spayed or neutered, embedded with microchips, and returned to the same place where they were captured. These cats are not killed, since the local government considers animal welfare and the presence of animal protection groups. In 1999, the government implemented an ordinance that obligated cat owners to properly keep and register their cats. This ordinance aims not only to contribute to better cat welfare and public health, but also to protect biodiversity. Since 2003, the government has expanded the area in which outdoor cats are captured into mountainous areas, to preserve the habitats and breeding grounds of sea birds and red-headed wood pigeons. The red-headed wood pigeon is now endangered, due to predation by outdoor cats, and, in January 2008, the government held a "Red-Headed Wood Pigeon Population and Habitat Viability Assessment Workshop," where various stakeholders—including the local government, residents, nonprofit organizations, and scientists—gathered to discuss how to best protect the birds. Their solution was to set a management target for outdoor cats and to make an eradication action plan (Nakayama 2009; Horikoshi et al. 2010). Since 2010, Chichijima has introduced a new transport project. In the project, captured outdoor cats are not returned to their original location, but are moved to Tokyo, on mainland Japan. In addition, a 2010 ordinance required all pet cats in the Ogasawara Islands to have microchips and

many cat owners now spay/neuter their pets, in part because the government offers free periodic animal health examinations. As of April 2016, the spay/neuter rate of pet cats was 100% and rate of microchipping was 88.4%.

< Table 1 >

2.2 Data Selection

Because the islands are so isolated, residents' information sources are considerably restricted. There is one ferry between the islands and mainland Japan, but this operates only once a week and takes 24 hours one way. There is thus no way for residents to obtain the latest newspaper every day, although they have access to the Internet and television. Therefore, this study focused on information from *Sonmin-dayori*, the local monthly newsletter published by the local government, which provides residents with essential information on living in the islands. For example, many headlines contain information on living and health, the natural environment, and how to preserve the islands' World Natural Heritage status. We found 150 articles containing the word "cat" in monthly newsletters from the fiscal year 1996 to 2016 as a data source for the content analysis.

2.3 Content analysis

We applied the content analysis using KH-corder (Higuchi 2004), which assesses both the frequency of keywords and their co-occurrence network, to the 150 articles. The former analysis (hereafter referred to as "the frequency analysis") aims to understand the trends in information quantity: we counted the mentions of the word "cat" in each fiscal year from 1996 to 2016. The latter analysis (hereafter referred to as "the network analysis") aims to visualize the context of the keywords' use and disclose the change in information provision over time. Before applying the network analysis, we separated 150 articles into three periods, each consisting of seven years: 1996–2002, 2003–2009, and 2010–2016. Then, we broke down the words in articles by morphemes, and limited our analysis to nouns. (Note that we excluded proper nouns, including people's names, organization names, and place names, although we kept wildlife names [e.g., red-headed wood pigeon].). We then selected the 30 keywords that occurred at the highest frequency in each period and applied the network analysis to these keywords. The co-occurrence network diagrams were created by analyzing the combinations of words with high co-occurrence frequency, which often simultaneously appeared in one sentence. The co-occurrence frequency is the number of sentences including two specific words divided by the number of sentences that include at least one of the two words. We drew 50 lines in descending order of co-occurrence frequency and showed the frequency of the words' use using different-sized circles (see Figures 3–5 in the Results section).

3. Results

3.1 Trends in the Usage of the Word “Cat”

The frequency analysis showed that local government has provided information concerning cats for over 21 years, although the number of times the word “cat” appears varies. As described in Figure 2, “cat” appears more frequently in 1997, 2007, and 2012.

In 1997, articles provided information on discussion meetings with residents to enforce the ordinance regarding the proper care of cats. The articles in 2007 mainly described the “Red-Headed Wood Pigeon Population and Habitat Viability Assessment Workshop”—for example, one article explained the conservation goals for this species.

In 2012, many articles reported on the management of the cat population as one of the countermeasures to protect the islands value as World Natural Heritage Site.

< Figures 2. >

3.2 The Network of Connected Words

The network analysis showed the co-occurrence network has gradually changed over the 20 years we studied. Here we describe the three networks in chronological order (i.e., 1996–2002, 2003–2009, and 2010–2016).

During the first period (1996–2002), the cat-related words could be divided into three groups—1A, 1B, and 1C—based on the type of information provided, as described in Figure 3. The articles in Group 1A focused on capturing outdoor cats, as follows:

- Residents are annoyed at the deterioration of public health due to scattered garbage and manure by outdoor cats (June 1997).
- Please understand the importance of managing the outdoor cat population and cooperate in order to preserve the precious Ogasawara natural environment and maintain residents’ living environment (July 2001).
- Captured cats are spayed/neutered to constrain population growth (July 2002).

Group 1B is composed of information on properly caring for pet cat. These articles encouraged cat owners to stop abandoning their cats, prevent unnecessary breeding, and properly care for their pets inside to decrease the number of outdoor cats. These articles also included information about the ordinance to properly care for pet cats. Examples are as follows:

- It is the owners’ responsibility to properly keep pet cats and dogs, suppress unnecessary

breeding, and ensure they are not annoying (July 1996).

- The Ogasawara Village enforces the ordinance that obligated cat owners to properly keep and register their cats (March 1999).

Since the local government conducted a veterinary care project during this period, articles in Group 1C provided information to enhance pet owners' cooperation in spay/neuter surgeries:

- If you have trouble keeping cats, please consult the health center (May 2003).
- A reservation is required to receive medical care (February 2003).

< Figures 3. >

During the second period (2003–2009), words could be divided into two groups, 2A and 2B, as described in Figure 4. Articles in Group 2A focused on cat management; the government implied that pet cats, when not properly kept, could become outdoor cats. The main purpose of managing the cat population was to protect rare species, such as the red-headed wood pigeon, from predation:

- The reason for the outdoor cats population both inside and outside of the village is humans, who irresponsibly abandon pet cats or do not restrict breeding (April 2005).
- We have caught outdoor cats in the East and Central mountain area of Chichijima to preserve the breeding area of the red-headed wood pigeon (nationally designated an endangered species) (January 2006).

Group 2B is composed of information on how to inscribe as a World Heritage Site and countermeasure against invasive species. The examples are as follows:

- Currently, the ecology of the Ogasawara Islands is being rapidly destroyed by invasive species brought in by human activities (April 2007).
- A major requirement becoming a World Natural Heritage Site is to properly protect nature (December 2008).
- Cat management can be a countermeasure against invasive species in order to designate the area as a World Natural Heritage Site (June 2009).

< Figures 4. >

In the third period (2010–2016), words concerning “cats” could be grouped together into one group. the

whole key words were connected as a lump including “capture,” “outdoor cat,” “mountain,” “settlement,” and “World Natural Heritage Site.” There are also links between the words “pet,” “invasive species,” and “community.” Examples are as follows:

- It is important to properly keep pets in order to prevent the predation of rare birds and to prevent the populations of animals that will have a significant influence on whether the Ogasawara Islands are designated as a World Natural Heritage Site (November 2011).
- The ecosystem of Ogasawara is rapidly destroyed due to the influence of invasive species brought in by human activities (July 2014).
- As a result of promoting countermeasures against outdoor cats, the number of red-headed wood pigeons has increased to 200–300 (February 2016).

< Figures 5. >

4. Discussion

Obtaining residents' cooperation is essential to enhancing invasive species management (Reed 2008; Ford-Thompson et al. 2012), because countermeasures against the species must be continually conducted to prevent spreading and invasion (Vaske et al. 2011; Gozlan et al. 2013; Lohr and Lepczyk 2014). In this study, we analyzed the contents of local newsletters and showed how a local government provided information concerning invasive species, outdoor cats, to enhance their management in the Ogasawara Islands, Japan. This is a good example of invasive species because its success depends on residents' cooperation—most cat behavior and ecology are decided by human behavior (van Heezik 2010)—and because cats are one of the world's worst invasive species (Lowe et al. 2000). To our knowledge, this is the first study to empirically document long-term information provisions by a local government in terms of invasive species management and to show the changing context over time.

Our frequency analysis showed that the local government has continuously provided information on cats to residents for over 20 years (Figure 2). The continuity of information contributed to the enhancement of conservation policy (Vane and Runhaar 2016). Furthermore, the number of times the word “cat” appeared fluctuated over time in accordance with relevant policy events. This implies that the local government attempted to encourage residents to cooperate with cat management. Figure 2 identifies the three years the word “cat” appeared the most: 1997, 2007, and 2012. These can be connected to relevant policy events (see Table 1). In 1997, discussion meetings were held with residents to enforce the ordinance regarding the proper keeping of pet cats, and the local government asked residents to participate through the newsletters. In 2007, mentions of “cat” were mostly due to the “Red-Headed Wood Pigeon Population and Habitat Viability Assessment Workshop.” The newsletters provided residents with information about preservation goals for the red-headed wood pigeon, a summary of the action plan, and the local government's future vision. This event prompted residents to properly care for their cats and to better understand cat issues in the islands, since they were constantly provided with information about the threat cats posed to rare species. While there was no specific policy regarding cats implemented in 2012, the area was designated a World Natural Heritage Site in 2011. Thus, it seems that policy makers attempted to respond to IUCN's requests about integrating stakeholders' participation into invasive species management by providing residents with information via newsletters. Because of the information provided, a high rate of pet owners spayed/neutered and microchipped their cats. As described by Bremner and Park (2007), our findings indicate that continual communication regarding policies can contribute to resident cooperation and accelerate conservation.

We also found that not only has the frequency of the word “cat” changed over the time period of the study, but the context of the newsletters has also changed. The network analysis implied that over time the

model of cat management has shifted from “pest management” to “ecosystem management” (Figures 3–5).

Figure 3 shows the three groups of the networks. The networks focused on capturing outdoor cats, proper care of pet cats, and veterinary care, respectively. However, the context to these is concern over the environment around residents’ homes. For example, the local government asked residents to capture outdoor cats, properly care for pet cats, and have their cats spayed/neutered in order to prevent breeding, resolve public health issues, and improve the deteriorated environment. This may be because it is easier to attract residents’ attention when they are personally affected by an issue. Whether or not policy makers intended this to be the case, it was a good approach for the local government to take when communicating with residents about outdoor cats and is in line with recommendations by previous studies (Lohr and Lepczyk 2014).

Over the second period, the articles that mentioned cats not only focused on cat management but also designating the area as a World Natural Heritage Site and invasive species management (Figure 4). This implies that the local government started preparing to meet the necessary requirements to become a World Natural Heritage Site and attempted to interest residents in invasive species, including outdoor cats. This makes sense, since the local government had the greatest responsibility in preparing to become a World Natural Heritage Site. Invasive species is one of the main threats to biodiversity conservation on islands, thus, proper invasive species management is a common requisite to become a World Natural Heritage Site. As Verbrugge et al. (2013) noted, raising public interest is essential to effectively manage invasive species, including outdoor cats.

Figure 4 shows two interesting findings. First, during the second period the network of articles regarding cat management became separate from that regarding World Natural Heritage Sites and invasive species. This indicates that the local government introduced new information provisions about World Natural Heritage Sites and invasive species management alongside existing information concerning cat management that had already been reported. This suggests that the government, while encouraging residents, especially cat owners, to continue properly caring for their cats, were also highlighting the importance of managing invasive species, including outdoor cats, in the context of becoming a World Natural Heritage Site. It is also interesting to note that the network of articles regarding pet cats overlapped with those pertaining to outdoor cats and those mentioning various conservation-related words, such as “red-headed wood pigeon.” This may have been a breakthrough in the communication with residents about outdoor cat issues: pet cats, if not cared for properly, are major sources of outdoor cats (Wald et al., 2013). It is important for residents to understand the necessity of spaying and neutering cats, not only to have healthier pets, but also for biodiversity conservation. In other words, during this second

time period, the local government communicated that cat owners had a responsibility to manage the population of outdoor cats.

The most interesting part of the network during the third time period (Figure 5) is the connection between the words “invasive species” and “community.” This implies that the local government attempted to encourage residents to participate in invasive species management and to address invasive species as community issues. These findings are supported by the connection between the words “invasive species” and “pet.” It is well known that invasive species, including outdoor cats, cannot be effectively managed without stakeholders’ cooperation (Ford-Thompson et al. 2012). Thus, the findings indicate that cooperation among citizens of the islands helped invasive species management, which IUCN requested (Yoshida 2012), especially around the time the islands were designated as World Natural Heritage Sites. Furthermore, during this time periods, the local government regarded the management of both pet and outdoor cats as ecosystem management; Figure 5 shows key words, including “ecosystem,” all appeared as a lump. This implies that the government intended to connect separate stories through cat management. In other words, residents were informed that proper cat care supported improvements in animal welfare, biodiversity conservation, and the enhancement of island ecosystems. As Simberloff et al. (2013) noted, since decision makers need to be aware of ecosystems, not just individual species, to effectively conduct invasive species management, this process of information provision in the islands over 21 years has been regarded as a successful case (Figures 3–5). Like previous studies (Mack et al. 2000; Niemiec et al. 2016), the present study demonstrates that information provided by the local government has shifted from a model of pest management, or controlling the cat population, to management an ecosystem that includes cats.

5. Conclusion

The present study empirically demonstrates the shift in long-term information provision concerning cats in the Ogasawara Islands and shows how the information corresponds with relevant policy events. Previous studies found that stakeholders’ attitudes toward cats and their management depended on their position and context (e.g., Mameno et al. 2017). Visualizing the long-term information provisions enables stakeholders to relatively easily recall their communication efforts and enhance future cooperation in this regard. While the present study focuses on the information provided by the local government over the long-term, to effectively gain public support further studies need to assess other stakeholders’ perceptions and understanding of information. This would contribute to better conservation, which requires stakeholders’ cooperation to identify the gap between demands and supplies concerning information about the management of invasive species and conservation.

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Figure Legends

Fig. 1

The Ogasawara Islands are located 1,000 km south of the main Japanese archipelago and consist of more than 30 small islands, most people live on Chichijima and Hahajima

Fig. 2

The frequency of the word “cat” every fiscal year from 1996 to 2016 and a count of the number of articles concerning cats each year (n = 150), our study broke the 21-year timespan into three periods, each containing seven years

Fig. 3

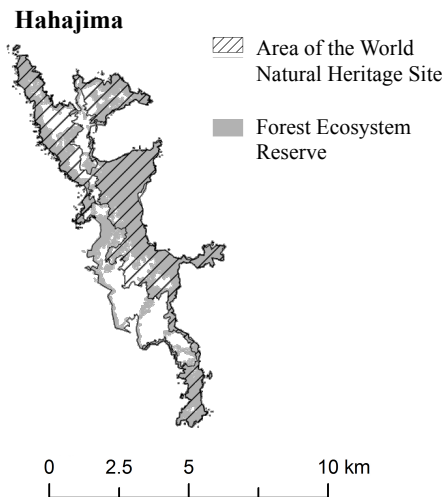
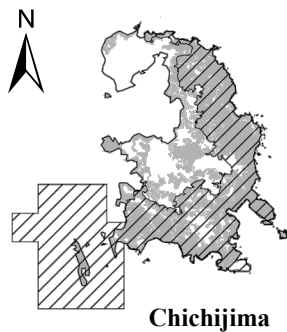
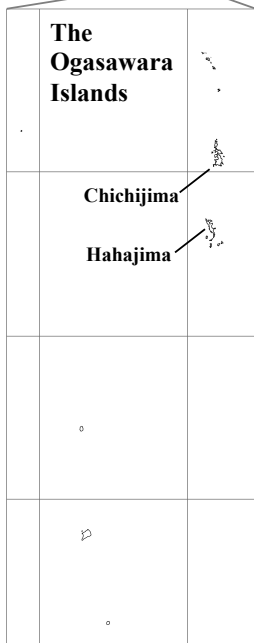
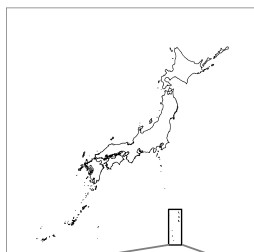
Co-occurrence network diagrams of words included in articles on cats during the first period. We drew 50 lines in descending order of co-occurrence frequency in the figures. Larger circles are words that appeared more frequently based on the previous studies (Higuchi, 2004). The words were divided into three groups: 1A is characterized “outdoor cats” and consists of connections with the words “capture,” “surgery,” and “cooperation.” 1B is characterized “cat” and consists of connections with the words “keeping,” “owners,” and “breeding.” 1C is characterized “medical” and has connections with the words “reservation,” “term,” and “animal”

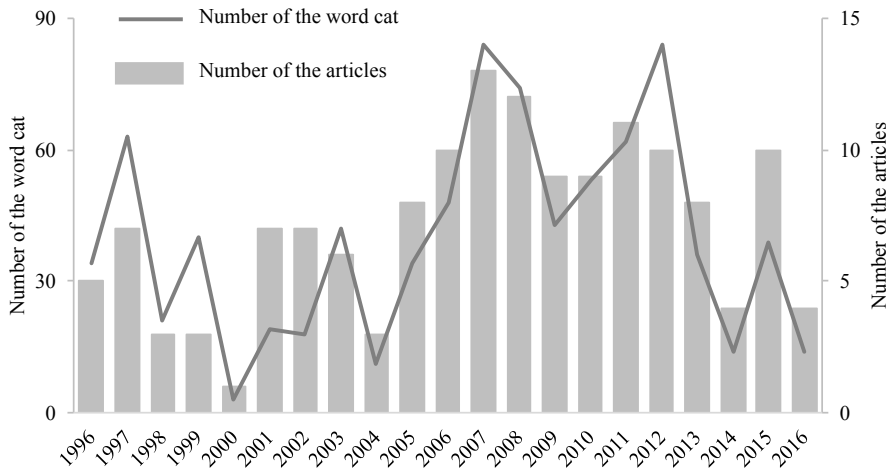
Fig. 4

Co-occurrence network diagrams of words included in articles on cats during the second period. The words are divided into two groups. The first group 2A is characterized “cat” and consists of connections with the words “outdoor cat,” “capture,” “cooperation,” and “red-headed wood pigeon.” The second group, 2B, is characterized “World Natural Heritage Site” and consists of connections with the words “designation,” “sightseeing,” and “invasive species”

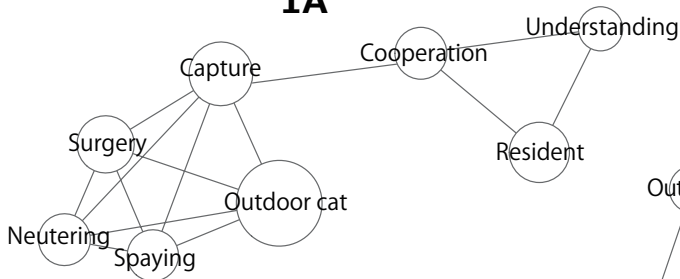
Fig. 5

Co-occurrence network diagrams of words included in articles on cats during the third period. The single group can be characterized as “cat” and consists of connections with the words “capture,” “outdoor cat,” “mountain,” “settlement,” and “World Natural Heritage Site.” There are also links between the words “pet,” “invasive species,” and “community”

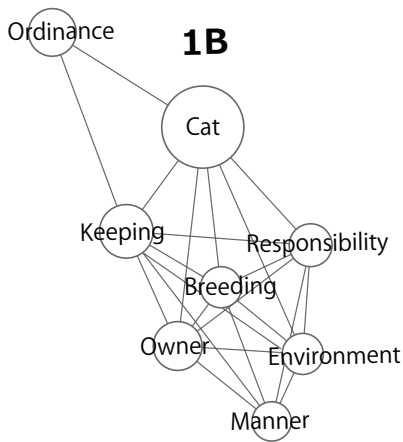




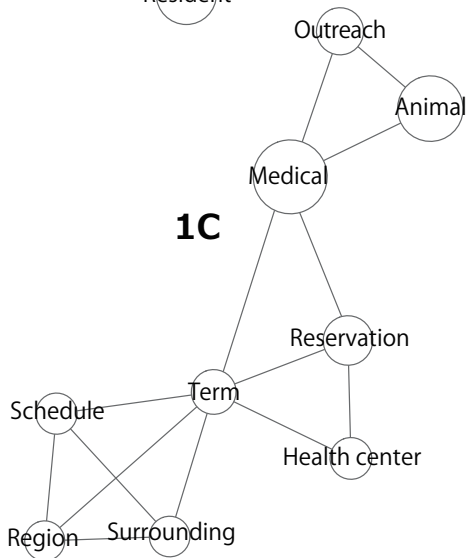
1A



1B



1C



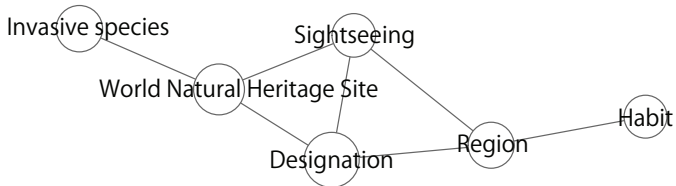
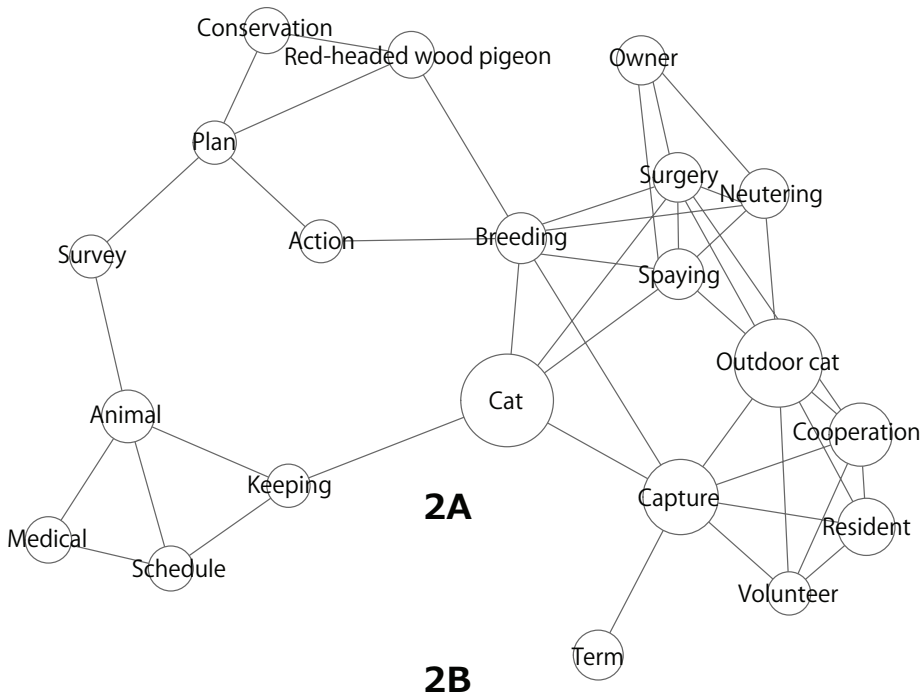


Table 1: Cat management in the Ogasawara Islands

Fiscal year	Event
1996	The trap-neuter-release (TNR) project begins in Hahajima village.
1997	Ogasawara village holds discussion meetings with residents to enforce the ordinance regarding the proper keeping of pet cats. These meetings are held six times between 1997–1998.
1999	The TNR project begins in Chichijima village. An ordinance is passed to promote the proper care of pet cats in Ogasawara village.
2003	Capturing outdoor cats is carried out in specific mountainous areas of Hahajima. The Ogasawara Islands are selected as a candidate for World Natural Heritage designation in Japan.
2005	Capturing outdoor cats is carried out in the specific mountainous areas of Chichijima.
2007	The “Red-Headed Wood Pigeon Population and Habitat Viability Assessment Workshop” is held in January 2008
2008	A veterinary care program is started by Ogasawara village and the Tokyo Metropolitan Veterinary Association.
2009	The Japanese government submits a recommendation statement to the UNESCO World Heritage Centre in January 2010.
2010	The ordinance to promote the proper care of pet cats is revised and implemented. A system starts to send captured outdoor cats to the main Japanese archipelago for adoption. The TNR program expands from specific areas to all of Chichijima.
2011	The Ogasawara Islands are inscribed in the list of World Natural Heritage Sites.
2012	The capturing procedure expands to wider mountainous areas of Hahajima.
2016	A website is established to find new owners for captured cats.