Mammal fauna detected by camera-trap method around ponds near the alpine forest line in the Northern Japanese Alps

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Abstract. Lakes and ponds in alpine regions are ecologically important elements for not only aquatic organisms but also terrestrial organisms. Nevertheless, there is limited information on how terrestrial animals use ponds and the surrounding vegetation in alpine regions. In this study, we recorded visiting animals using camera traps at three ponds located in the alpine and upper subalpine zones of the southern Northern Japanese Alps for approximately 1 year. Seven mammal species were recorded, including the sika deer (*Cervus nippon*), Japanese macaque (*Macaca fuscata*), and Asiatic black bear (*Ursus thibetanus*). The duration of the snow-free period and the vegetation around the ponds differed between the pond at the bottom of a cirque valley and ponds at the bottom of the linear depressions on main ridges, and differences were also observed in the mammals trapped using the camera around the ponds. The pond on the cirque valley floor, free from snow cover only in the fall season, was used by mammals during this time of year when water resources are most scarce in the alpine region..

Key words: alpine pond, camera trap, *Cervus nippon*, mammal, forest line

1. Introduction

The increase in the population of wild animals and the expansion of their habitat has caused damage to agriculture and forestry. Furthermore, an increase in the number of sika deer (*Cervus nippon*) has been causing changes in natural vegetation in mountainous regions (e.g., Ohashi et al., 2007). The impact of sika deer on vegetation has extended to high-altitude areas, with its invasion in the alpine and subalpine zones of the Southern Japanese Alps beginning in the late 1990s and believed to have become established around 2000 (Izumiyama, 2017). Subsequently, a large portion of the alpine plant community, including some rare species among the component species, was lost in a short time period up to around 2010. In recent years, the population of sika deer has begun expanding into the Northern Japanese Alps (Hotta and Ozeki, 2014), where they have not been previously detected, and there is a concern that foraging may cause the loss or modification of alpine vegetation (e.g., Kuroe et al., 2019).

We are conducting a geoecological study of alpine ponds in this region of changing fauna. Lakes and ponds in alpine regions are ecologically important elements within the regions, and their significance to terrestrial animals is considered not small in alpine regions with limited water resources. In addition to sika deer, the Japanese macaque (*Macaca fuscata*) (Izumiyama, 1999) and Asiatic black bear (*Ursus thibetanus*) (Izumiyama and Shiraishi, 2004) are seasonal migratory residents in the Northern Japanese Alps, which use the alpine and upper subalpine environments during summer.

Nevertheless, there is a scarcity of information on how terrestrial animals use ponds and the surrounding vegetation in alpine regions.

We recorded animals visiting the ponds using camera traps in the alpine and upper subalpine regions of the upper reaches of the Azusa River, located in the southern part of the Northern Japanese Alps. We describe the fauna recorded in our survey in this paper.

2. Study area and methods

The study area is characterized by subalpine vegetation dominated by evergreen coniferous trees. The forest line is located at approximately 2,500 m above sea level, and the subalpine zone is dominated by coniferous forests with vegetation such as *Abies mariesii*, *Abies veitchii*, and *Tsuga diversifolia*. The alpine zone is covered with *Pinus pumila* shrublands and herbaceous vegetation, as well as gravelly and rocky lands.

Ponds are scattered throughout the alpine and subalpine zones. We installed camera traps (Bushnell, models: 119537) at three of these ponds, including Youseino-ike Pond (2,604 m), Kinugasano-ike Pond (2,219 m), and Tengu-ike Pond (2,507 m), located near the forest line (Figure 1). Youseino-ike Pond is located at the bottom of a linear depression in an evergreen coniferous forest in the uppermost part of the subalpine zone. Remaining snow can be seen around the pond until the end of June. The pond is surrounded by vegetation dominated by Gramineae grass and broad-leaved herbs (Figure 2a). Camera traps were installed at four locations around this pond (Figure 3a).

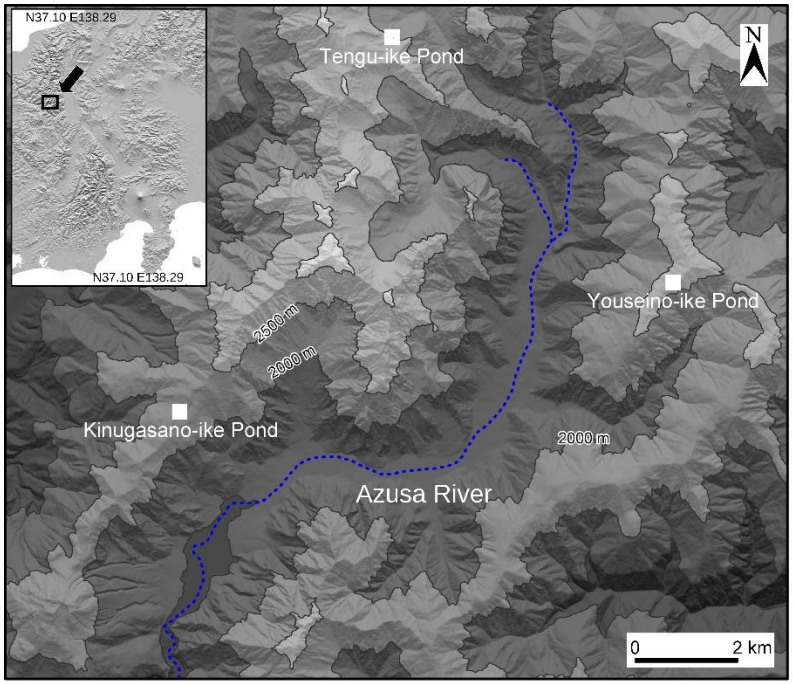

Figure 1 Study area

Background shading relief maps based on 10- and 250-m digital elevation models provided by the Geospatial Information Authority of Japan

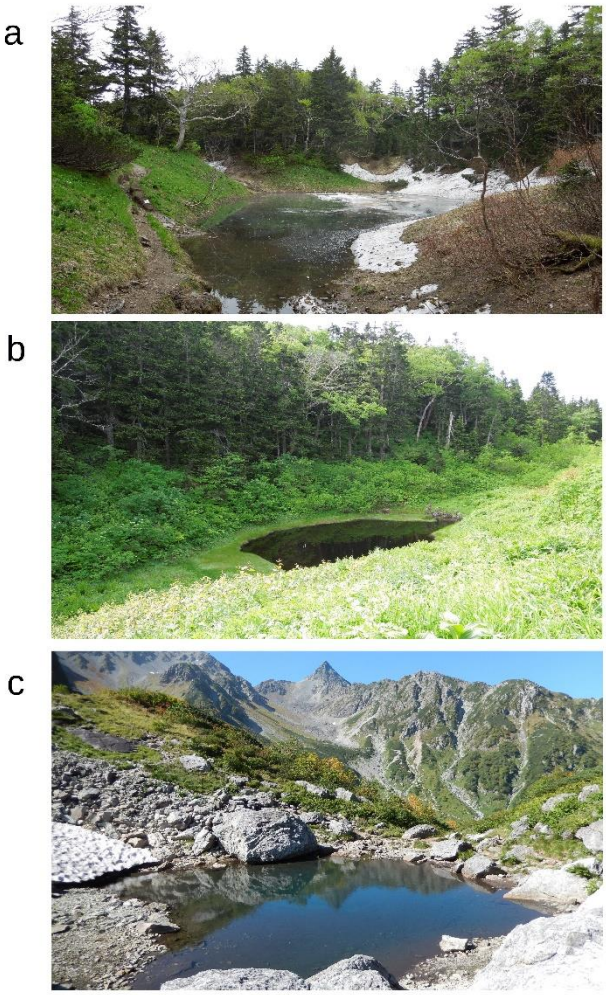

Figure 2 The ponds surveyed by camera traps
a, Youseino-ike Pond (photographed on June 29, 2013); b, Kinugasano-ike Pond (photographed on July 21, 2013); c, Tengu-ike Pond (photographed on September 19, 2013)

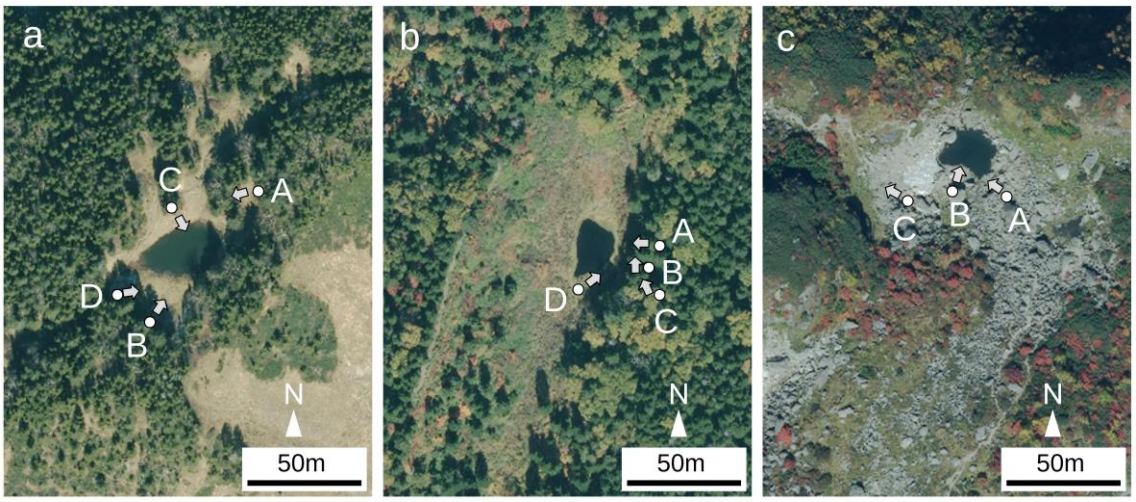

Figure 3.Camera locations in each pond.
a, Youseino-ike Pond; b, Kinugasano-ike Pond; c, Tengu-ike Pond
White dots indicate installation locations, and arrows indicate shooting directions. The aerial photos were taken in 2014 by the Geospatial Information Authority of Japan.

Kinugasano-ike Pond is also located at the bottom of a linear depression in an evergreen coniferous forest. Remaining snow can be seen around the pond until the end of June. This pond is surrounded by broad-leaved shrubs and mesic meadows, and marshy vegetation can be seen along the pond's shore (Figure 2b). Camera traps were installed at four locations around this pond (Figure 3b).

Tengu-ike Pond is located in a depression in the interior of a cirque valley floor above the forest line, and remaining snow can be seen on the pond's shore in mid-September. Convex slopes around the pond are covered by *P. pumila*-dominated shrub, whereas concave slopes and the area adjacent to the pond are covered by rock debris (Figure 2c). Camera traps were installed at three locations around this pond (Figure 3c).

The camera traps were placed for approximately 1 year, from November 2017 to November 2018 (Table 1). Because Tengu-ike Pond has a short snow-free period, camera traps were placed only during the fall season. There are periods of missing data for the cameras because they get buried in snow cover or become malfunctional (Table 2).

Table 1 Period of each camera shooting

Pond	Camera	Shooting period	
		Start	End
Youseino-ike	A	2017-11-07	2018-10-25
	B	2017-11-07	2018-06-05
		2018-08-15	2018-10-25
	C	2017-11-07	2018-10-25
	D	2018-06-05	2018-08-15
Kinugasano-ike	A	2017-11-09	2018-06-18
	B	2017-11-09	2018-11-08
	C	2017-11-09	2018-11-08
	D	2018-06-18	2018-11-08
Tengu-ike	A	2018-09-23	2018-11-02
	B	2018-09-23	2018-11-02
	C	2018-09-23	2018-11-02

Table 2 Periods of missing data for each camera

Pond	Camera	Missing-data period	
		Start	End
Youseino-ike	A	2017-12-22	2018-05-20
	B	2017-11-19	2018-06-05
	C	2017-12-20	2018-06-05
		2018-08-15	201810-25
Kinugasano-ike	A	2018-01-14	2018-04-25
	B	2017-12-23	2018-06-18
	C	2017-12-14	2018-05-21

Table 3 List of animal species recorded in the camera-trap survey

Pond	Youseino-ike				Kinugasano-ike				Tengu-ike		
Camera	A	B	C	D	A	B	C	D	A	B	C
Ursus thibetanus	11	-	1	1	-	5	1	1	-	-	-
Cervus nippon	-	-	-	-	3	7	4	3	-	-	-
Lepus brachyurus	21	42	2	1	6	16	2	10	-	2	-
Martes melampus	-	-	-	-	2	-	1	-	-	-	-
Macaca fuscata	-	-	-	-	-	-	-	-	1	-	-
Eothenomys sp.	-	-	-	-	-	-	-	-	-	-	1
Vulpes vulpes	1	-	-	-	-	-	-	6	-	-	-
Garrulus glandarius	-	-	-	-	37	-	-	-	-	-	-
Corvus corone	-	-	6	-	-	-	-	-	-	-	-
Syrmaticus soemmerringii	-	-	-	-	-	3	-	5	-	-	-
Buteo japonicus	-	-	-	-	-	-	-	4	-	-	-
Nucifraga caryocatactes	-	-	4	-	7	-	-	1	-	-	-
Somatochlora sp.	-	-	-	-	-	-	-	1	-	-	-
Aeshna juncea	-	-	-	-	-	-	-	1	-	-	-
Unknown	7	5	-	-	5	11	3	3	-	-	-
Nothing captured or with humans	558	8017	7417	13119	777	74	122	3422	1346	553	316
Total	598	8064	7430	13121	837	116	133	3457	1347	555	317

3. Results

Animals detected using camera traps during the study period included seven species of mammals, five species of birds, and two species of dragonflies (Table 3). At Youseino-ike Pond, three mammal species were recorded, viz., the Asiatic black bear, Japanese hare (*Lepus brachyurus*), and red fox (*Vulpes vulpes*), among which the Japanese hare was recorded from May to November. The Asiatic black bear was recorded 13 times on seven days, viz., June 13, June 18, July 23, July 24, July 26, August 4, and October 22.

At Kinugasano-ike Pond, five mammal species were recorded, viz., the Asiatic black bear, sika deer, Japanese hare, Japanese marten (*Martes melampus*), and red fox, among which the Japanese hare was recorded from May to October. The sika deer was recorded 17 times, but on five different days, viz., June 10, August 20, September 1, September 6, and September 9. Asiatic black bears were recorded only 7 times, but they were recorded each month from June 26 to October 7. Regarding birds, the Eurasian jay (*Garrulus glandarius*) was recorded 37 times, all on June 17, 2018, during the daytime for approximately 20 min.

At Tengu-ike Pond, three mammal species were recorded during 41 days from September 23 to November 2, including a Japanese macaque on October 16. Meanwhile, no Asiatic black bears or sika deer were recorded.

4. Discussion

Alpine ponds are used by a variety of mammals, including the sika deer, during the period when the ponds are snow-free. The pond on the cirque valley floor, free from snow cover only in the fall season, was used by mammals during this

time of year when water resources are most scarce in the alpine region.

We observed differences in the camera-trapped mammals between ponds below the forest line (Youseino-ike Pond and Kinugasano-ike Pond) and the pond above the forest line (Tengu-ike Pond). Nevertheless, because of the short time period of camera-trap sampling at all three ponds, and sampling at Tengu-ike Pond was limited to the fall season, it is not clear whether the differences in the characteristics of the recorded mammals reflect differences in pond environments.

Numerous ponds are scattered on the bottom of cirque valleys and linear depressions from the alpine zone to the upper subalpine zone in this region (Takaoka, 2015), and the environment of each pond is diverse in terms of the timing of snowmelt, vegetation around the pond, and seasonal drying up. Therefore, it is necessary to conduct long-term camera-trap sampling in a larger number of ponds to understand the relationship between these differences in pond environments and the mammals that use these ponds.

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