Autumn and spring migration of the Taiga Bean Goose *Anser fabalis middendorffii* in northern Japan from 2002 to 2012, with implications for site conservation

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Abstract

The Taiga Bean Goose *Anser fabalis middendorffii* is classified as "near threatened" (NT) on Japan's Red List with *c.* 9,000 birds wintering in the country. The Sarobetsu Plain, northern Hokkaido, is an important staging area for the geese migrating between northeast Russia and Honshu, Japan. Over the period 2002–2011, peak numbers staging at Sarobetsu each autumn ranged from 6,178–9,230 birds (mean ± s.e. = 7,272 ± 267), suggesting that most Taiga Bean Geese wintering in Japan migrate through Sarobetsu. The duration of autumn staging ranged from 51–87 days (mean = 74 ± 3) across the years. Lakes Kabuto and Penke and the Teshio Oxbow Lakes were the main autumn roost sites. In spring, peak numbers at the site varied from 1,486–2,776 individuals (mean = 2,048 ± 140; 2002–2012), and the geese were present for 23–50 days (mean = 35 ± 2). Peak numbers were significantly greater and staging periods were always longer in autumn than in spring. The main spring roost sites were the Furaoi Oxbow Lake and Lakes Penke and Kabuto, confirming the latter two sites as the most important roosts in both autumn and in spring, whereas Furaoi Oxbow Lake was used only in spring. Farmland surrounding these roosts is also important to the birds, as the geese feed mostly in fields close to the roost sites. Two core roosts, Lake Penke and the Furaoi Oxbow Lake, are suffering siltation and adverse effects of fishery activities, which could adversely affect Taiga Bean Geese wintering in Japan.

Key words: *Anser fabalis middendorffii*, Hokkaido, Sarobetsu, staging.

The Taiga Bean Goose *Anser fabalis middendorffii* is designated as "near threatened" (NT) on Japan's Red List (Ministry of the Environment of Japan 2006). The population breeds in the east Transbaikal, Siberia and Kamchatka regions of Russia and migrates to winter in eastern China, Korea and Japan (Brazil 2009). Of

the world population of *c.*70–80,000 individuals (Delany & Scott 2006; Syroechkovskiy 2006), *c.* 9,000 winter in Honshu, Japan (Syroechkovskiy 2006; Ikeuchi 2010). The Sarobetsu area in northern-most Hokkaido is considered to be one of the key staging sites for Taiga Bean Goose along the East Asian flyway (Miyabayashi & Mundkur 1999), yet little information has been available on the numbers and distribution of geese using the area (Japanese Association for Wild Geese Protection 2002).

In 2002, after preliminary observations in 1998–2001, regular counts were initiated to clarify the abundance and distribution of Taiga Bean Geese in the Sarobetsu area and to understand their staging behaviour. The spring and autumn surveys aimed to describe the birds' migration phenology, for informing conservation measures for the species. This paper presents information on the number of staging birds counted at Sarobetsu in autumn and spring, and on their spatial distribution within the area. Likely numbers and staging periods of Taiga Bean Geese migrating through Sarobetsu and the conservation implications for this near-threatened population are discussed.

Study Area and Methods

The Sarobetsu Plain (45°05'N, 141°42'E) covers 216 km^2 in the Soya region of northernmost Hokkaido, Japan (Fig. 1). Habitat on the plain is predominantly of moorland and fresh water lakes, with the main lakes of Kabuto (1.46 km^2), Penke (1.3 km^2) and Panke (3.47 km^2) being surrounded by farms given mostly to pasture. The study area, which is located within the plain, is *c.* 31 km from north to south (from Lake Kabuto to the Teshio River basin), and extends *c.* 7 km from east to west (Fig. 2). Lake Penke, in the middle of the study area, was designated a Ramsar site in 2005 partly because of its importance as a key staging site for the Taiga Bean Goose and Bewick's Swan *Cygnus columbianus bewickii* along the East Asian flyway (Wetlands International 2005). Greater White-fronted Geese *A. albifrons frontalis* and Tundra Bean Geese *A. f. serrirostris* also occur in smaller numbers in the Sarobetsu area in autumn, and nationally important numbers of Lesser White-fronted Goose *A. erythropus* are also observed annually (Ikawa & Ikawa 2009). In spring, oxbow lakes and pastures on the lower reaches of the Teshio River are the first to be used by various species of waterbirds, mainly by Taiga Bean Geese and Greater White-fronted Geese, with large numbers of Whooper Swans *Cygnus cygnus* and Bewick's Swans also occurring in the area. As the ice melts, waterbirds occur at other sites within the Sarobetsu staging area as well.

The study area was divided into five zones from north to south, based on the main roost sites used by Taiga Bean Geese: A) Kabutonuma and Asaru districts in Toyotomi Town (main roost = Lake Kabuto); B) Ochiai and Hotoku districts in Toyotomi Town (main roosts = Lake Kabuto and Lake Penke); C) Nishitoyotomi and Shinsei districts in Toyotomi Town and Shimonuma district in Horonobe Town (main roost = Lake Penke); D) Akebono and Oiwake districts in Horonobe Town and Furaoi district in Teshio Town (main roost = Furaoi Oxbow Lake); and E)

Figure 1. Map showing the location of the Sarobetsu Plain and other autumn and spring staging sites of Taiga Bean Goose in Hokkaido (Sorachi, Tokachi and Iburi), as well as the main wintering sites in Honshu (Niigata and Miyagi), Japan.

Kamihoronobe district in Horonobe Town and Ubushi district in Teshio Town (main roost = Teshio Oxbow Lakes) (Fig. 2).

As the study area is so large, there is no single location from which all of it can be seen. There is, however, an observation tower in the Shimonuma district, 2.5 km from Lake Penke. Part of the lake is visible from the tower and both the Shimonuma and Shinsei districts (zone C) can also be

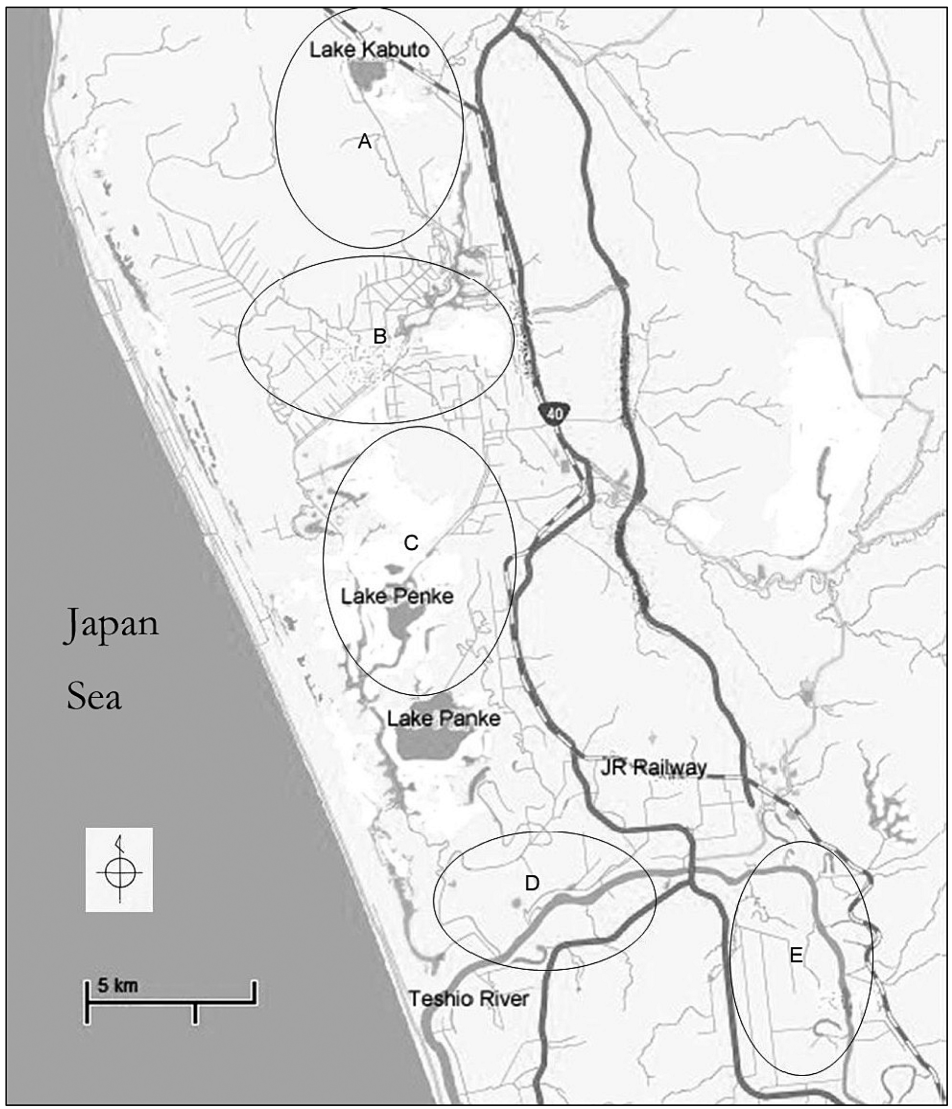

Figure 2. Detailed map showing the Sarobetsu Plain and the staging habitat of Taiga Bean Geese which mostly falls within the five major areas shown: zone A = Lake Kabuto and nearby pasture; zone B = pasture; zone C = Lake Penke and nearby pasture and corn fields; zone D = an oxbow lake and pasture along both sides of the Teshio River, and; zone E = the outskirts of the Sarobetsu Plain associated with oxbow lakes.

viewed to the north. From the top of the tower, it is possible to watch geese flying to and from feeding sites in the Ochiai and Nishitoyotomi districts (zones C and D) and moreover, in autumn, geese moving to zone E and/or leaving the Sarobetsu area

for the Tokachi or Sorachi regions, can also be seen. In addition to observations from the tower, fixed route surveys were made repeatedly of the whole area by vehicle.

Taiga Bean Geese were caught and fitted with neck collars during the 1990s by Russian researchers and members of the Japanese Association for Wild Geese Protection. A total of 159 birds were marked in 1990, 98 in 1991, 36 in 1994 and 52 in 1999, all in Kamchatka, with four marked in Niigata Prefecture in 1997 and eight in 1999 (Japanese Association for Wild Geese Protection 2012). The presence of banded geese passing through Hokkaido made it possible to follow individual movements within and through the Sarobetsu area. At peak, up to 52 banded birds were found in a single season (autumn 2001), although numbers of marked individuals had fallen to just one bird at Sarobetsu by autumn 2012.

All observations in the Sarobetsu area were made jointly by the two authors using binoculars (10×), and tripod-mounted telescopes (30×, 50× and 75× magnification), typically at 200–400 m from the geese. In autumn, geese flying out from their roost site on Lake Penke were observed from the tower in zone C at daybreak (from 04:50 h in late September; 06:40 h by early November). After sunrise, and once geese could be seen clearly feeding on pasture, a fixed route was driven slowly by vehicle along a combination of paved roads and farm tracks, beginning in zone C, then moving into zones B and A, before finishing in zone E, during which geese were counted, and any band codes read. The survey from the observation tower to zone E took 4–5 h each morning. In spring, observations commenced at the Furaoi Oxbow Lake (zone D) at 05:00 h, counting geese still staying in the lake, then continued along unpaved paths on riverside embankments and on roads through zone D to zones E, C, B and A, taking *c.* 4 h on each occasion. The morning surveys used the same methods in both spring and autumn, followed the same route (albeit in reverse in spring), and were undertaken promptly to avoid duplicating counts.

Taiga Bean Geese sometimes formed large flocks of > 1,000 birds in which a few individual Tundra Bean Geese (1–10 birds on each occasion, two or three times in a season) were observed. As the identification of individual Tundra Bean Geese in large flocks of Taiga Bean Geese is difficult, we counted them as Taiga Bean Goose unless they formed discrete flocks and could be identified as Tundra Bean Geese by their stubbier bill, thicker lower mandible, rounder head, strongly sloping profile and contrasting exposed culmen/length of head ratio (Kurechi *et al.* 1983).

In autumn 2002–2011, 282 visits were made to the Sarobetsu study area, at least once in the last ten days of August and thereafter twice or more during each 10-day period until late November. In spring, 142 visits were made, at least once in late March and in mid May and twice or more during each 10-day period from early April to early May. Mann-Whitney U tests assessed differences in peak number of birds, staging period and individual length of stay between autumn and spring. Means are given ± s.e. values throughout.

Results

General goose use of the area

Taiga Bean Geese staging in the Sarobetsu area used three main roost sites in autumn: Lake Kabuto (zone A) especially at the beginning of the season, Lake Penke (zone C) during the whole season and oxbow lakes along the Teshio River (Teshio Oxbow Lakes) situated in zone E during the whole season, albeit less frequently than zone C (Fig. 3a). Almost all of the birds feeding on Lake Kabuto and in adjacent pasture in zone A in the daytime appeared to roost on the lake whereas the birds feeding in zone C roosted on Lake Penke and in marshes nearby throughout. Some geese that fed in zone B roosted on Lake Kabuto until mid-season with others roosting on Lake Penke. On 21 September 2002 for example, 1,554 Taiga Bean Geese were counted in pasture situated in zone B at 17:15 h, 329 birds of which flew away in the direction of Lake Kabuto between 17:30–18:00 h and a large flock of geese, presumably the rest, took off and flew away in the direction of Lake Penke at 18:04 h. On 12 September 2009, 280 Taiga Bean Geese were counted in pasture situated in zone B at 15:09 h, 245 birds of which flew away in the direction of Lake Kabuto at 17:34 h. Zone D was used only in spring during the study period: most of the birds occurring in this zone roosted on Furaoi Oxbow Lake, while some geese roosted on the Teshio River itself. In spring, zone D was used earlier than all the other roost sites. (Fig. 3b). The majority of Taiga Bean Geese feeding in zone E roosted on the Teshio Oxbow Lakes. Geese were never observed to roost on Lake Panke, despite its close proximity to Lake Penke.

The migratory geese staging in this region of northern Hokkaido feed primarily on grass obtained from agricultural fields, and aquatic plants available in the lakes: Water Chestnuts *Trapa japonica* in Lake Kabuto and Lake Penke and Water Chestnuts and Water Oats *Zizania latifolia* in the Furaoi Oxbow Lake. However, as the price of maize has soared in recent years, and as the local climate has become milder, an increasing number of farmers in the study area have begun to cultivate maize as cattle feed. The post-harvest waste from this crop has provided an additional food source for the geese, and dense flocks of Taiga Bean Geese can now be found visiting freshly harvested maize fields in zone C in autumn.

Taiga Bean Goose numbers

Taiga Bean Goose numbers in autumn

Seasonal peak numbers of Taiga Bean Geese ranged from 6,178 (2002) to 9,230 birds (2004), averaging 7,272 birds (s.e. = 267). Maxima recorded during each 10-day period, were used to indicate the seasonally changing pattern in numbers (Fig. 4a), as numbers varied on a daily basis depending on the birds' behaviour. For instance, on some days, a number of geese would remain out of sight on Lake Penke rather than flying to feed on the fields, and on other occasions the birds were disturbed by factors ranging from White-tailed Eagles *Haliaeetus albicilla* to ultra-light planes.

The lowest and highest peak counts recorded during the 10-day observation periods each autumn over the 10-year study were, respectively: 409 and 6,500 (2002), 670

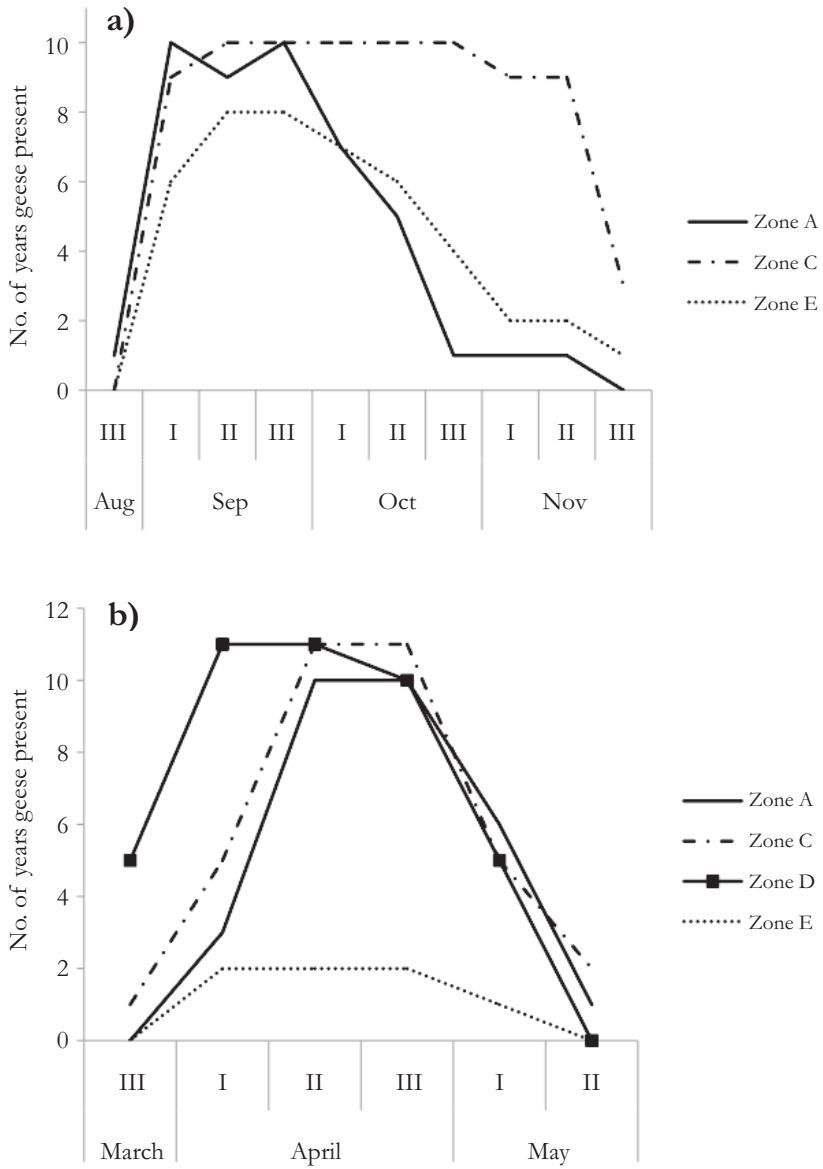

Figure 3. Frequency of Taiga Bean Goose presence in a) autumn (in zones A, C and E; for autumn 2002–2011; *n* = 10 years), and b) spring (in zones A, C, D and E; for spring 2002–2012; *n* = 11 years). Frequency of use of zone A declined drastically in mid-autumn (Taiga Bean Geese were observed in zone A throughout September for 9–10 years of the 10-year study, in mid October for five years, and in late October only in one year), whereas geese were almost always present in zone C until mid-November. Zone D was used more frequently than the other roost sites in early spring.

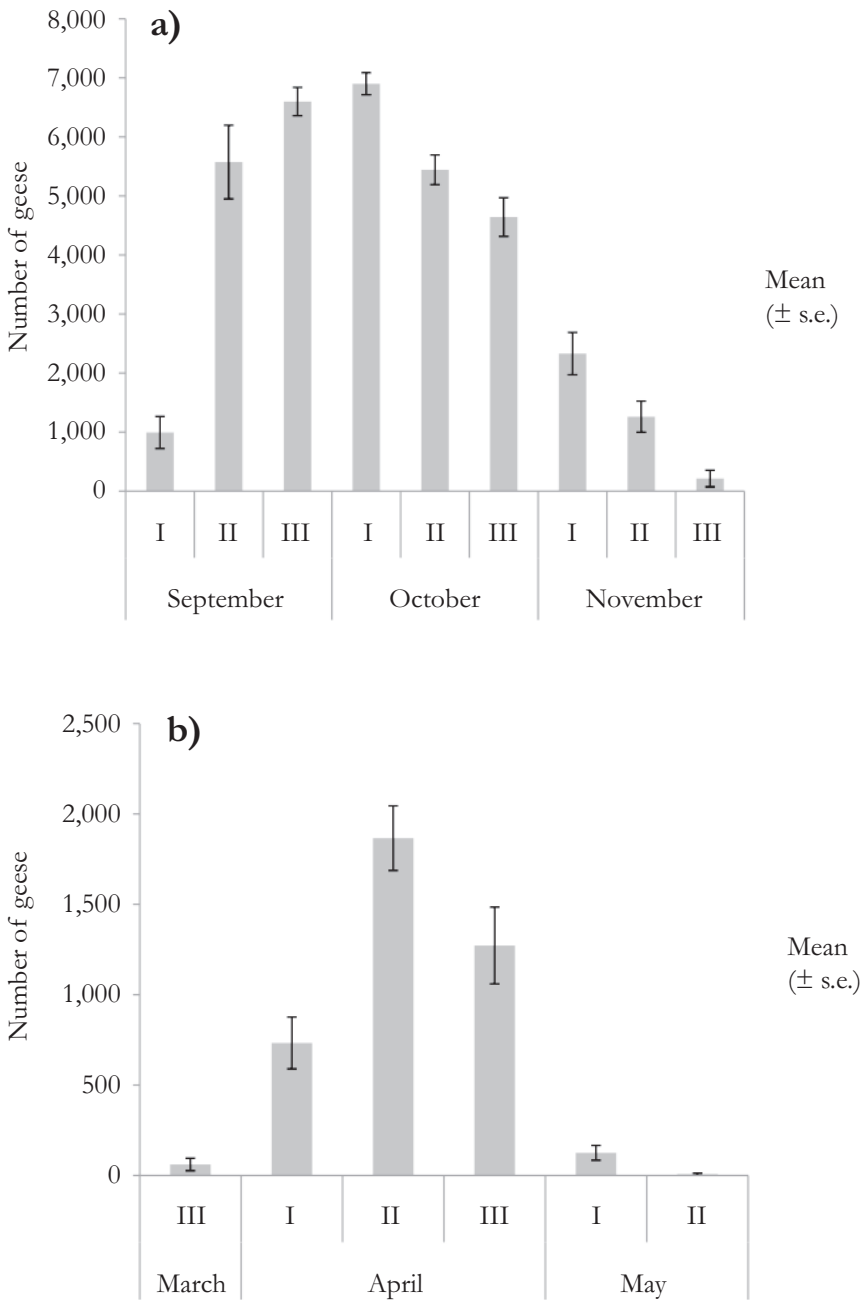

Figure 4. Maximum numbers of Taiga Bean Goose counted for each 10-day period at Sarobetsu (mean ± s.e. bars) in (a) autumn 2002–2011, and (b) spring 2002–2012.

and 7,594 (2003), 146 and 9,230 (2004), 1,000 and 7,456 (2005), 531 and 6,751 (2006), 2,014 and 6,178 (2007), 4 and 6,837 (2008), 122 and 7,077 (2009), 665 and 7,559 (2010) and 40 and 7,545 (2011). Numbers reached their autumn peak in late September or in early October throughout study (Fig. 4a).

The mean peak count of 7,272 birds represented 80% of the geese wintering in Japan, suggesting that most of the population migrates through Sarobetsu. Zone C alone supported at least 65% (mean = 5,857 birds, s.e. = 181) of the population in autumn (Fig. 5a).

Observations of marked individuals showed that certain Taiga Bean Geese left Sarobetsu during the course of the season, but because these departures were not always associated with decreases in total numbers of geese in the area, this suggests associated immigration. For example, a goose with red collar A5Z was present in mid September 2002, when the total number of geese was 4,000, whereas by late September when numbers had increased to 5,300 A5Z (and, given that geese typically travel in family groups, presumably also its associates) had already moved on.

Taiga Bean Goose numbers in spring

Maximum counts during each 10-day observation period were again used to indicate the seasonally changing pattern in numbers in spring (2002–2012), as numbers varied on a daily basis for the reasons described under autumn staging (Fig. 4b).

Peak numbers of Taiga Bean Geese at Sarobetsu during spring migration were recorded in mid April in seven of 11 years, and in late April on four occasions. The maximum spring count was of 2,776 geese in 2008, and the lowest of the seasonal peak numbers was 1,486 in 2012, indicating relatively stable peak counts during the study period. The mean peak value over 11 springs was 2,048 (s.e. = 140), which alone represents > 20% of the total Taiga Bean Geese wintering in Japan and *c.* 30% of the mean seasonal peak number in autumn. The difference in mean peak value between autumn and spring was significant ($U = 0$, $n_1 = 10$, $n_2 = 11$, $P < 0.001$).

Duration of staging

Duration of the autumn staging period

Each autumn, the first geese were observed in early September (2–8 September), except in 2008 when they were first encountered on 30 August. The last birds of the season were seen each year between late October and late November (ranging from 27 October 2002 to 28 November 2005). The extreme duration of goose presence in the Sarobetsu study area varied from 51–87 days (mean ± s.e. = 74 ± 3 days) each autumn. In 2002, when heavy snowfalls abruptly ended the staging of geese at Sarobetsu, the geese were present for an exceptionally short period of 51 days. In the other nine years, the length of stay ranged from 65–87 days (mean = 76 ± 2 days) from early September to mid November.

Observations of banded geese (13 different individuals; total autumn sightings $n = 79$ from 2002–2009) revealed minimum lengths of stay in the Sarobetsu study area which varied considerably from individual to individual, and from year to year, ranging from 1–64 days. The first marked geese to arrive were not necessarily either the first or

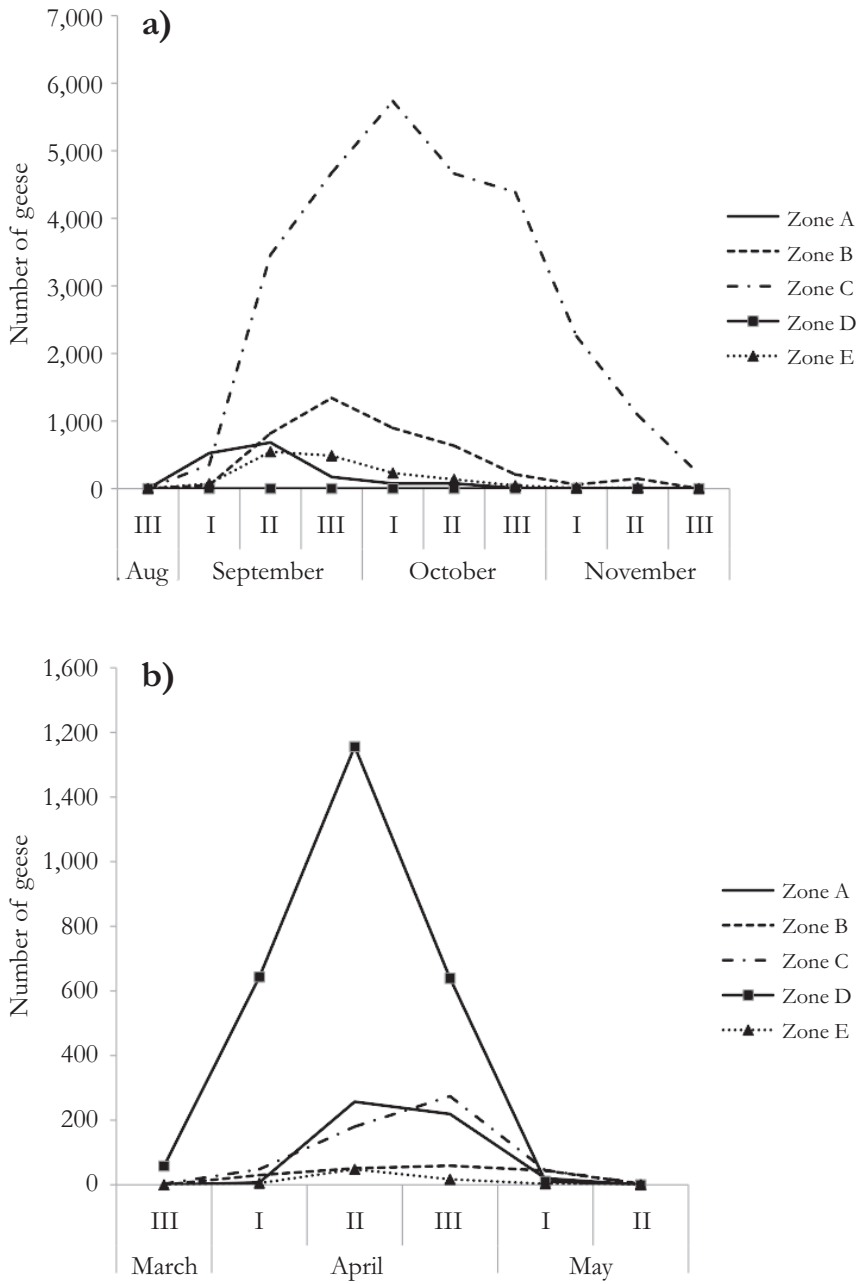

Figure 5. Mean of the maximum numbers of Taiga Bean Goose counted for each 10-day period in each zone in (a) autumn 2002–2011, and (b) spring 2002–2012.

last to leave. Red A3Z, for example, appeared as early as 4 September and remained until 11 October in 2004, but arrived late (18 September) and remained only until 1 October in 2005. Nor did late arriving birds necessarily leave Sarobetsu early. Red A5Z was first observed on 18 September, but remained until 24 October in 2004. Red collared K22 was first observed on 21 September and last observed on 26 October in 2003. There was no correlation between arrival and departure dates among these 79 birds (Spearman Rank $r_{77} = 0.045$, n.s.). We also found no difference in the lengths of stay between the geese that occurred first in zone A and those that occurred first in zone C ($U = 171$, $n_1 = 7$, $n_2 = 48$, n.s.). The former stayed in the Sarobetsu area for 1–57 days (mean = 29 ± 9 days), and the latter for 1–64 days (mean = 33 ± 3 days). Among geese that occurred first in zone A, red A6F stayed only eight days in 2005, whereas red A5M remained for 44 days in 2002. Similarly, among those that occurred first in zone C, A3Z stayed only nine days in 2006 but 49 days in 2007. It is clear that geese that occurred first in zone A and left the Sarobetsu study area without moving to zone C remained only a short period of time, *e.g.* A5Z in 2002 (one day) and A6F in 2005 (eight days) and in 2007 (two days). Nevertheless it is impossible to establish a ratio of short-staying birds within the total number of birds that occurred first in zone A. Lengths of stay varied significantly between individuals (ANOVA: $F_{12,66} = 4.86$, $P < 0.001$); for instance, A6F stayed for only short periods (1–23 days, $n = 5$ years) each year, whereas A5M (44–64 days, $n = 6$ years), K22 (35–59 days, $n = 8$ years), K34 (16–53 days, $n = 7$ years), and red P66 (18–55 days, $n = 7$ years, with the exception of 2005 when it remained only one day) were long-staying visitors. Some individuals remained for almost the whole season, such as K33 in 2004, when it stayed for 58 days during a total staging period of 65 days. The mean staging duration for these 13 banded geese over the 8-year period was 29 days (s.e. = 2).

Duration of the spring staging period

The date on which the first Taiga Bean Geese were seen each spring ranged from late March (earliest arrival date = 27 March) to early April (latest arrival date = 8 April). The last day on which geese were known to be present was in late April for the years 2002–2005 and in May from 2006 onwards: four times in early May (2006, 2008, 2010 and 2011) and three times in mid May (2007, 2009 and 2012). The duration of the spring staging period (*i.e.* geese known to be present in the study area) ranged from 23 (2003) to 50 days (2009), with a mean length of stay of 35 days (s.e. = 2), or about half (46%) of the length of the autumn staging period. The difference between autumn and spring in the length of the staging period was statistically significant ($U = 5$, $n_1 = 10$, $n_2 = 11$, $P < 0.001$).

Observations of banded geese (19 different individuals; total spring sightings $n = 44$), revealed that individuals stayed in the Sarobetsu study area for at least 1–18 days (mean = 4 ± 1 days) in spring, with most (40 geese; 91% of birds identified) remaining at the site for < 10 days, indicating a rapid movement of individuals through the site during spring migration. Duration of

staging was markedly shorter than in autumn (when the mean staging period was 29 ± 2 days) and the difference was significant ($U = 4$, $n_1 = 13$, $n_2 = 19$, $P < 0.001$). Unlike during autumn staging, no geese remained for most of the season.

Spatial distribution

Autumn distribution

Taiga Bean Geese occurred in zone C throughout the autumn staging period each year, with peak counts exceeding those of the other four zones combined, confirming zone C as the core zone within Sarobetsu for the population in autumn (Fig. 5a). Zone A was used mainly in early autumn, particularly in early September when numbers there often equalled those in zone C (maximum September count = 2,072 birds, mean = 468 ± 94; Fig 5a), with no geese encountered in only one 10-day period out of 30 during 2002–2011. Zone A held a maximum of 625 (mean = 53 ± 24) in October, with no geese encountered in 17 10-day periods and in November held a maximum of 86 (mean = 4 ± 3) with no geese encountered in 28 10-day periods (Fig. 3a). Zone A therefore can be considered as an auxiliary site within the Sarobetsu staging area, but one that is of particular importance at the beginning of the season. In both 2010 and 2011, zone A attracted considerably more geese than zone C in early September, but it is too early to know whether this represents a new trend or if this was an irregular phenomenon. Geese were found regularly in zone B whenever geese were also present in zone C, but the numbers there were always lower. Zone B therefore is an important feeding area for the geese, and can be considered as an extension to zone A at the beginning of the season and to zone C throughout the whole season. Zone D was not used in autumn during the study period. Although zone E represents the southernmost part of the study area, geese were observed there in early September each year.

Spring distribution

In spring, zone D attracted more geese in the early part of the season than did zone C (Fig. 3b). Geese were found in zone D in late March in five years (2002, 2007, 2008, 2009 and 2012) in comparison with only one year (2008) in zone C, and the number of birds using zone D was much greater than in zone C (Fig. 5b). Zone D alone supported about 16% (mean = 1,427 ± 70) of the geese wintering in Japan during the peak spring migratory period. As the spring thaw proceeds during April, snow and ice melt enlarges the area of available open water, so Lake Penke and the surrounding farmland in zone C become increasingly attractive to geese, but only after mid-month. Zone D therefore is of prime importance for the population until then. As the spring staging season progresses, zone C attracts increasing numbers of geese. The geese also occur regularly in zone A in spring, but in smaller numbers than in zone D. Goose use of zone B was irregular in spring. Zone E has attracted geese more and more regularly from 2010 onward.

Discussion

The large numbers of geese counted (mean annual maxima = 7,272 ± 267 in autumn; 2,048 ± 140 in spring), together with the

turnover of marked individuals through the site, indicate that a high proportion of the Taiga Bean Geese wintering in Japan (*c.* 9,000 individuals) use Sarobetsu as a staging area in both autumn and spring. The movements of marked geese suggest that the seasonal peak numbers fall well short of the total numbers migrating through the area. The shorter migration period and more rapid passage of individuals in spring suggests that there is greater scope for the seasonal peak numbers to underestimate total staging numbers in spring than in autumn. In any event, it is reasonable to conclude that the seasonal peak numbers represent most of the population wintering in Japan in autumn and at least one-fifth of these birds in spring. Sarobetsu therefore is not only a staging area of prime importance in Hokkaido, but is of considerable national and international conservation significance. By supporting *c.* 10% of the global population (estimated at 70–80,000 birds; Delany & Scott 2006) it easily meets Criterion 6 (i.e. regular occurrence of > 1% of a biogeographic population of a species or subspecies of waterbird) required for designating a site as a wetland of international importance under the Ramsar Convention (Ramsar Convention on Wetlands 2009).

In mild autumns, geese remain at Sarobetsu at least until mid November, and occasionally late into the month, but there has been no obvious earlier or later extension of autumn staging beyond the main early September–late November migration period in relation to local or global climate change. As for springs, geese use Sarobetsu for about one month, tending to remain longer since 2006.

The Japanese population of Taiga Bean Geese passes through not only Sarobetsu but also Sorachi and either Iburi or Tokachi on Hokkaido in autumn, to winter in Honshu, mostly in Niigata Prefecture (*e.g.* Lake Fukushima) and in Miyagi Prefecture (*e.g.* Lake Kabukuri) (Miyabayashi & Mundkur 1999) (Fig. 1). In spring, geese returning north from Honshu make their first stop-over in Hokkaido in the Iburi region. From Iburi, they move north to Sorachi or northeast to Tokachi. The geese using the Sorachi region are thought to occur afterwards in the Sarobetsu area, but no banded Taiga Bean Goose that visited the Tokachi region has subsequently been observed at Sarobetsu in spring.

Since the Sarobetsu staging area in autumn seems to support almost the entire Japanese wintering Taiga Bean Goose population, and since in spring Sarobetsu also supports very significant numbers, the maintenance of their habitat in the area is essential for their conservation. The three autumn roosting sites – Lake Kabuto, Lake Penke and the Teshio Oxbow Lakes – are crucially important. The farmland surrounding these roost sites is also of great significance for feeding during staging. Zone C, including Lake Penke and the surrounding farmland, supports the geese throughout the autumn staging season, and numbers there are considerably greater than in the other zones. At the beginning of the autumn staging season Lake Kabuto and adjacent pasture in zone A are as important as zone C for the population. Although zone E is used by fewer geese than zone C, it constitutes an integral part of the Sarobetsu staging area. These three zones are not

interchangeable; one zone cannot be replaced by another, as each one has its own characteristics that attract geese. For example geese never used Lake Panke during the 10-year study period, despite its close proximity to Lake Penke. Lake Panke seems to have no attraction for geese, although some swans use it. The habitat in each of zones A, C and E , including Furaoi Oxbow Lake (the core spring staging site within Sarobetsu), should be surveyed and assessed to help develop appropriate conservation measures for the area. The tiny lake of *c.* 0.15 km^2 and the surrounding farmland in zone D are used throughout the season, and has supported 16% of the Taiga Bean Geese wintering in Japan each spring, at the peak of the migratory period.

The Sarobetsu Plain was designated as a National Park (Rishiri-Rebun-Sarobetsu National Park) in 1974 (Ministry of the Environment of Japan 2012). Part of zone B is situated within the Special Protection Zone (a zone of special importance within a Special Area) designated within the National Park, with Lake Penke and part of zone C occurring within the Special Area (*i.e.* the area where the environment should be conserved within a National Park). Protection under National Park legislation does not extend to the zones A, D or E. Lake Penke, Lake Panke and its surrounding wetland (2.56 km^2) were additionally designated as a National Special Wildlife Protection Area in 1992 (Konno 1998) and as a Ramsar site in 2005. Wildlife therefore is protected there. Sediment accumulation is contributing to the silting up of Lake Penke, however, with the lake shrinking from 1.9 km^2 in 1957 to 1.5 km^2 in 1976, 1.4 km^2 in 1995, and 1.3 km^2 in 2005, and predicted to be just a stream by 2100 (Maruyama 2007).

The Hokkaido Prefectural Government designated Lake Kabuto as a Wildlife Protection Area in 2005 until 2017 (Hokkaido Prefectural Government 2012). Lake Kabuto (like Lake Penke) is decreasing in size; its present area is about half of that recorded in 1947, mainly due to drainage of the surrounding farmland (Saito *et al.* 2008). The Furaoi and Teshio Oxbow Lakes have no protection measures and a recent government-funded development project installed a sluice between the Teshio River and Furaoi Oxbow Lake to reproduce a brackish environment in the lake. Tons of sand were poured into the lake over an area of 0.096 km^2 (more than half of the water surface), including the emergent plant habitat, in February and March 2010 with a view to covering the muddy bottom and to altering the water quality to a sufficient degree to support production of Corbicula Clams *Corbicula japonica* (Hokkaido Regional Development Bureau, unpubl. data). Rumoi Development and Construction Department of Hokkaido Regional Development Bureau removed sand from the emergent plant habitats to deeper parts of the lake in June 2010 after protests by the Japanese Association for Wild Geese Protection. It is too early at present to estimate the impact of the work done so far. Nevertheless, research for *Corbicula* reintroduction is still ongoing. *Corbicula* only occurs in brackish environments which are unfavourable for Water Chestnuts and Water Oat, both of which are important natural food sources for Taiga Bean Geese (Miyabayashi *et al.* 1994).

The habitat of the two core roosting sites of Taiga Bean Geese in the Sarobetsu staging area, Lake Penke in autumn and Furaoi Oxbow Lake in spring, are both being lost to environmental degradation which is likely to have a direct and severe influence upon the attractiveness of the entire Sarobetsu Plain to the "near threatened" Japanese population of the Taiga Bean Geese. The conservation of habitat for this population is therefore critical and urgently requires further investigation.

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References

Brazil, M. 2009. *Birds of East Asia*. Princeton University Press, Princeton, UK.

Delany, S. & Scott, D. 2006. *Waterbird Population Estimates Fourth Edition*. Wetlands International, Wageningen, the Netherlands. (Available online at: http://www.wetlands.org/?TabId=56&mod=1570&articleType=ArticleView&articleId=2028.)

Hokkaido Prefectural Government. 2012. Daijuichiji Hokkaido chojuhogojigyo keikaku. Environment Bureau, Sapporo, Japan. (Available online at: http://www..pref.hokkaido.lg.jp/ks/skn/11jikeikaku/keikakusaisyuu24.4.10.pdf.)

Ikawa, M.J. & Ikawa, H. 2009. Lesser White-fronted Goose *Anser erythropus* at Sarobetsu in northern Hokkaido, Japan: a preliminary report on numbers in autumn. *Ornithological Science* 8: 131–138.

Ikeuchi, T. 2010. *Ohishikui Q & A 50*. Gan no satooya tomonokai, Osaki, Japan.

Japanese Association for Wild Geese Protection. 2002. Ohishikui toraijokyo chosa kiroku. Totaru Media Kenkyusho, Tokyo, Japan. (Available online at: www.jgoose.jp/iiss/bunseki/oohishi3.pdf.)

Japanese Association for Wild Geese Protection. 2012. Ashu ohishikui kubiwa hyoshiki ichiranhyo. Totaru Media Kenkyusho, Tokyo, Japan. (Available online at: http://www.jgoose.jp/iiss0409/asyuoohishi0412.htm.)

Konno, T. 1998. Sarobetsu shitsugengun hozen puran. Hokkaido Prefectural Government, Sapporo, Japan. (Available online at: http://www.hokkaido-ies.go.jp.)

Kurechi, M., Yokota, Y. & Otsu, M. 1983. Notes on the Field Identification of *Anser fabalis serrirostris* and *A. f. middendorfi*. *Tori* 32: 95–108. [In Japanese with English summary.]

Maruyama, H. 2007. Sarobetsu-chiku koshoshitsugen chosa hokokusho. Geospatial Information Authority of Japan, Tokyo, Japan. (Available online at: www1.gsi.go.jp/geowww/lake/sarobetsu-pdf/.)

Ministry of the Environment of Japan. 2006. Reddo risuto. Japan Integrated Biodiversity Information System, Tokyo, Japan (online: www.biodic.go.jp/rdb/rdb_f.html).

Ministry of the Environment of Japan. 2012. Rishiri Rebun Sarobetsu kokuritsukoen. Natural Environment Bureau, Tokyo, Japan. (Available online at: http://www.env.go.jp/park/rishiri/intro/index.html.)

Miyabayashi, Y., Sugawa, H. & Kurechi, Y. 1994. Ganrui toraichimokuroku no sakusei to soreniyotte akirakaninatta toraichihogo no kadai. *In* Y. Miyabayashi (ed.), *Ganrui toraichimokuroku daiichiban*, pp. 5–27. Japanese Association for Wild Geese Protection, Kurihara, Japan.

Miyabayashi, Y. & Mundkur, T. 1999. *Atlas of key sites for Anatidae in the East Asian flyway*. Wetlands International, Wageningen, the Netherlands. (Available online at: www.jawgp.org.)

Saito, T., Watanabe T. & Shinnishi, M. 2008. Hokkaido Sarobetsu-chiku kosho shitsugen chosa. *Kokudochiriin Jiho* 116: 9–18.

Syroechkovskiy, E.E. Jr. 2006. Long-term declines in Arctic goose populations in eastern Asia. *In* G.C. Boere, C.A. Galbraith & D.A. Stroud (eds.), *Waterbirds around the world*, pp. 649–662. The Stationery Office Limited, Edinburgh, UK.

The Ramsar Convention on Wetlands. 2009. *What are the criteria for identifying Wetlands of International Importance?* Ramsar Secretariat, Gland, Switzerland. (Available online at: http://www.ramsar.org/.)

Wetlands International. 2005. *Information Sheet on Ramsar Wetlands*. Wetlands International, Wageningen, the Netherlands. (Available online at: www.wetlands.org).

Photograph: Taiga Bean Geese feeding on pasture near Lake Penke (study area zone C), by Hiroshi and Marie-Jo Ikawa.

