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Home range and movement of juvenile black-faced spoonbill *Platalea minor* in South Korea

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Abstract

This study was conducted to clarify the size of the home range and movement distance of juvenile black-faced spoonbills from post-fledging until fall migration using a Global Positioning System (GPS)-wideband code division multiple access (WCDMA)-based telemetry system along the west coast of South Korea. The home range of juvenile black-faced spoonbills ($n = 3$) was 45.2 km^2 in size and the core area consisted of 8.4 km^2 within the Baeksu mudflat, Yeonggwang, South Jeolla Province, South Korea. Mean weekly movement distances were not significantly different (Kruskal–Wallis test, $Z = 3.47$, $P = 0.18$) among individuals, ranging from 0.1 to 23.9 km during the study period. The home range and movement of juvenile black-faced spoonbills were related to intertidal areas, especially to their use as feeding areas.

Keywords: GPS-WCDMA-based telemetry system, Feeding area, Intertidal area, Mudflat

Introduction

Understanding patterns of habitat use and distribution is essential for the conservation of a given species (Lee et al. 2010), especially, migratory birds, which have different breeding, stopover, and wintering sites throughout their life cycle. Radio-collared and satellite tracking have been used to clarify the breeding and wintering sites, habitat use pattern, distribution, and migration routes of many birds (Ueta et al. 2002, Higuchi and Pierre 2005). Such information has aided the conservation and management of species and their habitats (Higuchi et al. 1998).

Black-faced spoonbill *Platalea minor* is considered one of the rarest and least known migratory species worldwide (Wood et al. 2013). This bird is designated as "endangered" in the red list of threatened species by the International Union for Conservation of Nature (IUCN) as only ~2,700 individuals have been observed in its wintering grounds, such as Hong Kong and Taiwan. (Yu et al. 2013), and in known breeding sites along west coast of the Korean peninsula (Ueng et al. 2006). Since human disturbance seems to be one of the major causes of the reduction and disappearance of black-faced spoonbill population (Wei et al. 2005), a complete knowledge of the spatial ecology of the black-faced spoonbill is needed to efficiently conserve this species.

Habitat requirements of the black-faced spoonbill have not yet been described in detail. The habitat of this bird is known to include estuaries, tidal flats, and fishponds (Hancock et al. 1992). Here, we present results obtained from Global Positioning System (GPS)-wideband code division multiple access (WCDMA)-based telemetry systems, which are used to track juvenile black-faced spoonbills following their departure from the nests. We report specifically on the home range and movement of juvenile black-faced spoonbills along the west coast of South Jeolla Province, South Korea.

Materials and methods

Field surveys were conducted from June to October 2013 along the west coast of South Jeolla Province, South Korea. On 22 June 2013, we used mist nets to capture five post-fledging juvenile black-faced spoonbills (body mass 1582–1640 g, two males and three females) in their nests and then fitted them with GPS-WCDMA-based transmitters (Model WT-200) in Chilsando islets (35° 19′ 20″ N, 126° 16′ 33″ E), Yeonggwang, South

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Jeolla Province, South Korea (National Research Institute of Cultural Heritage 2015). Each transmitter was attached to the individual's back using a harness made of Teflon ribbon (Ueta et al. 2000). The size of the WT-200, made by the KoEco Inc., was 75 (L) × 40 (W) × 15 (H) mm. It weighed 47 g that was less 3% of body mass of the individuals.

Location data were acquired using GPS and transmitted by the public mobile phone system network. If birds were out of the area covered by the public mobile phone network, the location data were saved in the transmitter. The saved data were transmitted when the birds returned to areas that were covered. The transmitters took locations at 8-h intervals based on battery life. The location error was less than 40 m. The battery life was 4.8–5.1 months in this study. Based on the battery life of the transmitter, 8-h intervals was sufficient to cover the period from post-fledging until fall migration of the birds in South Korea.

In total, 845 GPS positions (268–294 points per bird) were used to analyze the size of the home range and movement distance from the nests departure of birds until fall migration. The proportion of successful locations (obtained locations/scheduled locations) was 97%. We estimated the home range of the birds using the fixed kernel estimator (KRE) (Seaman et al. 1999). We defined the 95% kernel home range as the general individual home range and the 50% kernel home range as the core area. We excluded a 5% outlier of fixes during the estimation of 95% KRE.

We used ArcGIS (Environmental Systems Research Institute 2009) to analyze the movement of the birds with default settings (least square cross-validation). Weekly movement distances were calculated by cumulative straight-line distances between an original point and daily range centers. To compare the movement distances among juvenile black-faced spoonbills, the Kruskal–Wallis test was used.

Results and discussion

In early July 2013, the juvenile black-faced spoonbills left their nests within the Chilsando islets. Out of the five GPS-WCDMA-based transmitters that were attached to the birds, two failed to transmit a signal because of a communication error between the transmitter and the base station. The three marked juvenile black-faced spoonbill were females. The three individuals provided data of sufficient accuracy three times per day. These individuals were mainly found on the Baeksu mudflat, 9 km from the Chilsando islets after leaving the nests. The observations and GPS positions within the home ranges on the Baeksu mudflat showed that the birds consistently remained within this area until the fall migration. They left the area in 2 and 6 November 2013.

The size of home ranges based on the 95% KRE and 50% KRE varied greatly among three juveniles, and ranged from 31.8 to 52.3 km^2 (mean 45.2 km^2) and 4.7 to 11.6 km^2 (mean 8.4 km^2), respectively. Furthermore, the size of the core area was 8.4 km^2 within the Baeksu mudflat (Table 1 and Fig. 1).

There was no difference in the weekly distance moved among the birds ($Z = 3.47$, $P = 0.18$). Mean weekly movement distances were ranging from 0.1 to 23.9 km. Patterns of weekly movement distances were different in each individual. Moreover, the peak movement distances by each bird were observed in different weeks (Fig. 2).

The home range size (95% KRE) of juvenile black-faced spoonbill was 45.2 km^2 and the core size (50% KRE) was 8.4 km^2. The size of home ranges varied among individuals, with one of the birds (individual no. 2870) occupying a small area, while the other two individuals used a wider range. We found that the home ranges of these three birds were related to intertidal areas of the Baeksu mudflat. Most of the home ranges belonged to mudflat.

Weekly movement distances greatly varied for each bird. The maximum movement distances and time differed in each individual. A juvenile black-faced spoonbill (individual no. 2675) was found to move shorter distances. The distances moved by individuals could be affected by the flight distance to foraging areas and by habitat types (Davis and Afton 2010, Chen 2014) and by changes in movement distances may be related to habitat conditions.

The black-faced spoonbill is known to be a tactile feeder while walking slowly (Yu and Swennen 2004a). This method of feeding requires shallow water depth, a flat or gradually sloping bottom, and turbidity. The Baeksu mudflat may provide a good foraging area for black-faced spoonbills because habitat conditions are particularly suitable for this species (Kim 2006). The protection and restoration of mudflat habitats around the Chilsando islets, which include tidal areas for foraging, should benefit black-faced spoonbill populations (National Research Institute of Cultural Heritage 2013). Policy makers and mudflat managers need to understand home range and movement patterns of black-faced

Table 1 Differences in home range sizes of 95% fixed kernel estimator (KRE) and 50% KRE (km^2) for juvenile black-faced spoonbills along the west coast of South Jeolla Province, South Korea

Individual no.	95% KRE	50% KRE
2256	51.4	11.6
2675	52.3	8.9
2870	31.8	4.7
Mean ± SD	45.2 ± 11.6	8.4 ± 3.5

SD standard deviation

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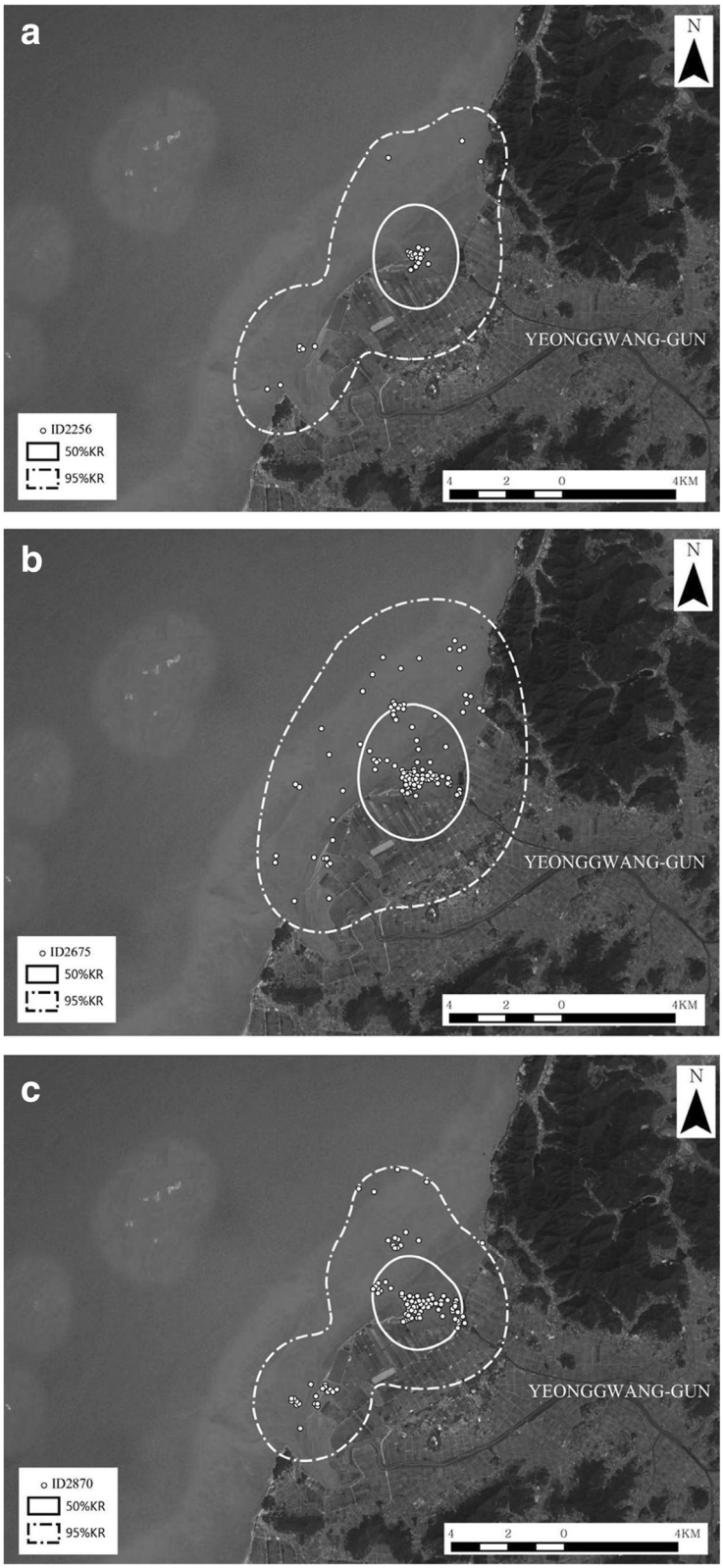

Fig. 1 95% fixed kernel estimator (KRE) and 50% KRE for home range sizes of juvenile black-faced spoonbills along the west coast of South Jeolla Province, South Korea. (**a**) Individuals no. 2256. (**b**) Individual no. 2675. (**c**) Individual no. 2870

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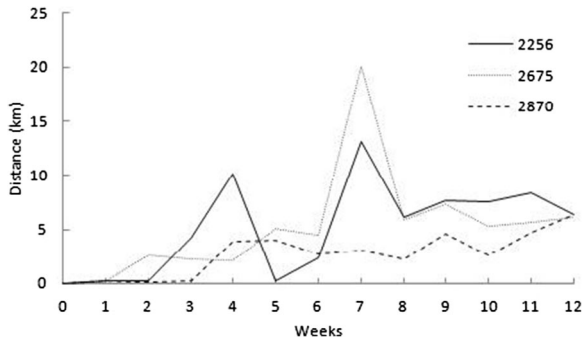

Fig. 2 Weekly movement distances (km) of juvenile black-faced spoonbills along the west coast of South Jeolla Province, South Korea

spoonbills in order to make decisions regarding its conservation (Yu and Swennen 2004b, Swennen and Yu 2005, Jin et al. 2008).

The GPS-WCDMA-based telemetry system employed in the present study is very useful, because the data are transmitted via public mobile phone networks. Moreover, the efficiency (97% of successful locations) is very high. In areas with good coverage by public mobile phone networks, more information can be easily obtained using this system for wildlife tracking.

In this study, we collected data on juvenile birds during the post-fledging stage. This time period is crucial for juvenile survival before the first migratory event. Further studies that investigate the habitat selection and threatened factors of black-faced spoonbills would be beneficial for the conservation of this endangered species.

Abbreviations

GPS: Global Positioning System; IUCN: International Union for Conservation of Nature; KER: Fixed kernel estimator; WCDMA: Wideband code division multiple access

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Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

JHK conceived and participated in the design of the study and performed the statistical analysis. IKK participated in the fieldwork and secured the funding. KSL and IKK participated in the fieldwork and analyzed the data. HL got a research project for the topic. SJR participated in the design of the study and fieldwork and edited the manuscript draft. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable

Ethics approval and consent to participate

Not applicable

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