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Short Communication

New perspectives on habitat selection by the Black-faced Spoonbill *Platalea minor* based upon satellite telemetry

CHRIS WOOD, HIROSHI TOMIDA, KIM JIN-HAN, KI-SUP LEE, HYONG - JU CHO, SHIN NISHIDA, JAMALUDDIN IBRAHIM, WEE-HAENG HUR, HWA-JUNG KIM, SUNG-HYUN KIM, HIROKO KOIKE, GO FUJITA, HIROYOSHI HIGUCHI and TETSUKAZU YAHARA

Summary

In 2011 the Black-faced Spoonbill *Platalea minor* census recorded a 22% drop in numbers from 2010, particularly at the known large coastal wintering sites. During this period, we discovered two new inland wintering sites for the species using satellite telemetry data, one located in China, where the individual followed the Yangtze river as far as Wuhan (500 km inland), and the other across the Vietnam-Cambodia border (70–200 km inland). Long periods of concentrated use of various freshwater habitats were in evidence for these two tagged individuals (China: 79 days, Vietnam/Cambodia: 91 Days) and in the latter case visual confirmation indicated a larger group of at least five individuals. The importance and potential of inland freshwater environments is highlighted towards the further conservation of the recovering population.

Introduction

The Black-faced Spoonbill *Platalea minor* is the smallest and rarest of the six spoonbill species and is often considered a coastal species, dependent on tidal flats for foraging (Collar *et al.* 2001). Listed as "Critically Endangered" in 1996 (BirdLife International 2008), it was once considered one of the rarest avian species worldwide (Won 1966) but partial recovery led to its reclassification as "Endangered" since 2000 (BirdLife International 2008). The lowest numbers were recorded in 1988 (Kennerley 1990) and since then most published studies relating to the recovering population have focused on the coastal zone. These studies described the migration routes along the East China Sea coast which link known breeding sites in the Yellow Sea region (particularly western coastal islands of the Korean peninsula) with wintering areas in Taiwan, Hong Kong and the East Asian coast and summering sites for non-breeding individuals in northern Taiwan and coastal Jiangsu province, China (Ueta *et al.* 2002).

When studies of Black-faced Spoonbill have focused upon these coastal locations, they have shown that the distance the spoonbills move inland is extremely limited (Yu and Swennen 2004a,b, Lee *et al.* 1995). However, Yu and Swennen (2004b) also confirm that the spoonbills have been observed in a wide range of marine, brackish and freshwater environments and other historic records include reports of inland wintering for the species (Table S1 in the online supplementary material).

Nevertheless, little attention has been placed upon the use of inland freshwater sites or the potential as suitable habitat for this species. Monitoring remains highly concentrated in coastal regions and is rarely matched by equivalent monitoring efforts inland. The lack of inland records may therefore be a consequence of the lower observation effort compared to coastal areas. One technique that avoids such observer location bias is to fit birds with satellite tags. In this study, six juvenile Black-faced Spoonbills were captured at nesting sites in Korea and fitted with GPS-ARGOS platform transmitter terminals to describe their migration routes in an unbiased manner.

Methods

PTT tag location results

In late July and early August 2009, four juvenile spoonbills were captured at nests found on or in proximity to four breeding islands in Korea. Later, in late June and early July 2010, two juveniles were captured on a further artificial island. We attached solar battery-powered GPS-ARGOS satellite transmitters that weighed 25g and were 60.95 × 20.0 6 × 13.97 mm in size (platform transmitter terminals [PTTs]; North Star Science and Technology). These were back-mounted to the birds using a Teflon-treated ribbon (5.5 mm wide). The weight of the PTT was 1.6% of the body weight of a spoonbill.

GPS positions were calculated four times per day (01h00, 05h00, 09h00, 21h00 GMT) and tags were set to transmit to the ARGOS system for eight hours, with a period of 72 hours afterwards to allow the tag battery to recharge. The on/off transmission cycle for PTT number 42994 failed to function and this PTT sent data almost every day.

After removing any obvious errors, all GPS signals and location classes (LC) 1-3 of the Argos location data were utilised in this study. Accuracy of Argos location data is less than 150 m for LC3, 150–350 m for LC2 and 350–1000 m for LC1 with one standard deviation of the positional error on both latitudinal and longitudinal axes. GPS systems have better location accuracy to within dozens of meters.

Wintering areas that had particularly high and consistent usage by spoonbills during the wintering period were identified, mapped and separated into zones of particularly concentrated use. Based on a 10 x 10 km grid system, these zones of concentrated use were calculated according to the density of the location points received by GPS and Argos signal data as plotted and analysed around each output raster cell using GIS. GPS and Argos data were counted accurately using Spatial Join Analysis. Four or more signals from GPS and Argos in the 10 x 10 km grid system were used to define zoning areas for more detailed analysis. These regions were represented with remote imaging (GIS maps and Google Earth cross-referenced) for broad identification of habitats represented at these locations.

Results

Of the six PTT tags, two failed prematurely. PTT96703 provided data of sufficient accuracy for only one day. PTT042991 sent location data for only eight days. As neither indicated movement beyond the nesting site where they were initially tagged, the data for these two individuals is not shown.

The movements of the four tagged spoonbills, including the areas of signal concentration showing the major areas of prolonged habitat use, are shown in Figure 1. Whilst these results largely confirm the coastal bias in their distribution, it also revealed that two of the tagged birds spent long periods in inland habitats confirming two new inland freshwater wintering areas for the species. The first followed the Yangtze river as far as Wuhan (500 km inland) and the second wintered in southern Cambodia and across the border into Vietnam (70–200 km inland). Three inland concentrations of points were identified, two in mainland China (PTT 96704), and one spanning the border region between Cambodia and Vietnam (PTT 042994) (Figure 2).

China Zone 1 (Figure 2: 1.1-1.2) comprised the south-western (1.1) and north-western (1.2) shore of Shi Jiu Lake, 60 km south of Nanjing and 230 km from the nearest coastline. The period

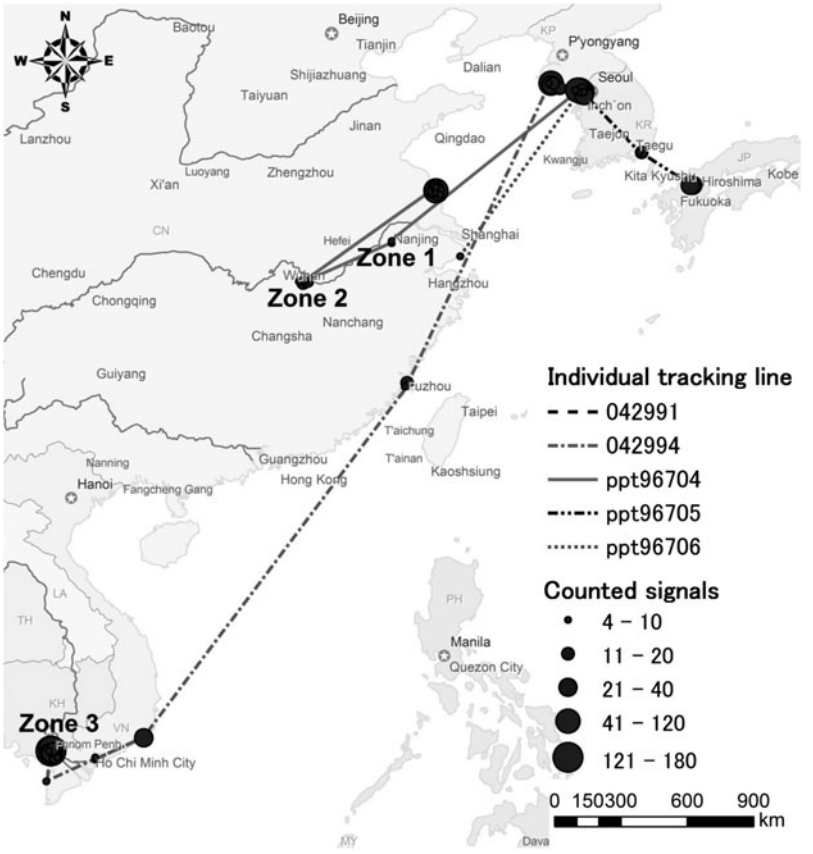

Figure 1. The movements of the four tagged Black-faced Spoonbills, including areas of signal concentration showing the major areas of prolonged habitat use, related to size of circles.

of recorded occupation was 21 days (1–22 November 2009) and in total nine locations were successfully recorded during this period covering five separate days. Google Earth and GIS maps confirmed these areas to be lake edge merging into flooded fields.

China Zone 2 (Figure 2: 2.1-2.2) comprised areas surrounding a tributary of the Yangtze, 125 km south-east of Wuhan and 550 km from the nearest coastline. Two periods of occupation were evident, (the first 8–29 December 2009 and the second 9 March–1 May 2010), totalling a period of 74 days. The December locations were concentrated within area 2.2, in March the locations received were split between 2.1 and 2.2, and April and May locations were concentrated in area 2.1. Forty locations were received during this period, covering 26 separate days. GIS maps and Google Earth indicated the use of lake and river edge, ponds, flooded fields and other associated flooded areas surrounding a major tributary of the Yangtze.

Zone 3 (Figure 2: 3.1-3.4) included areas on both sides of the Cambodia/Vietnam border 50–75 km from the nearest coastline and was occupied from 2 December 2010 to 5 March 2011. A total of 292 locations were obtained in this zone throughout this 94 day period, 86 days receiving multiple hits per day. As in China's Zone 2, the bird had changed its location throughout the season.

The bird was present in area 3.4 in early December. This was a seasonally flooded area of the Mekong delta in Vietnam. From mid-December to early January the bird was present in area

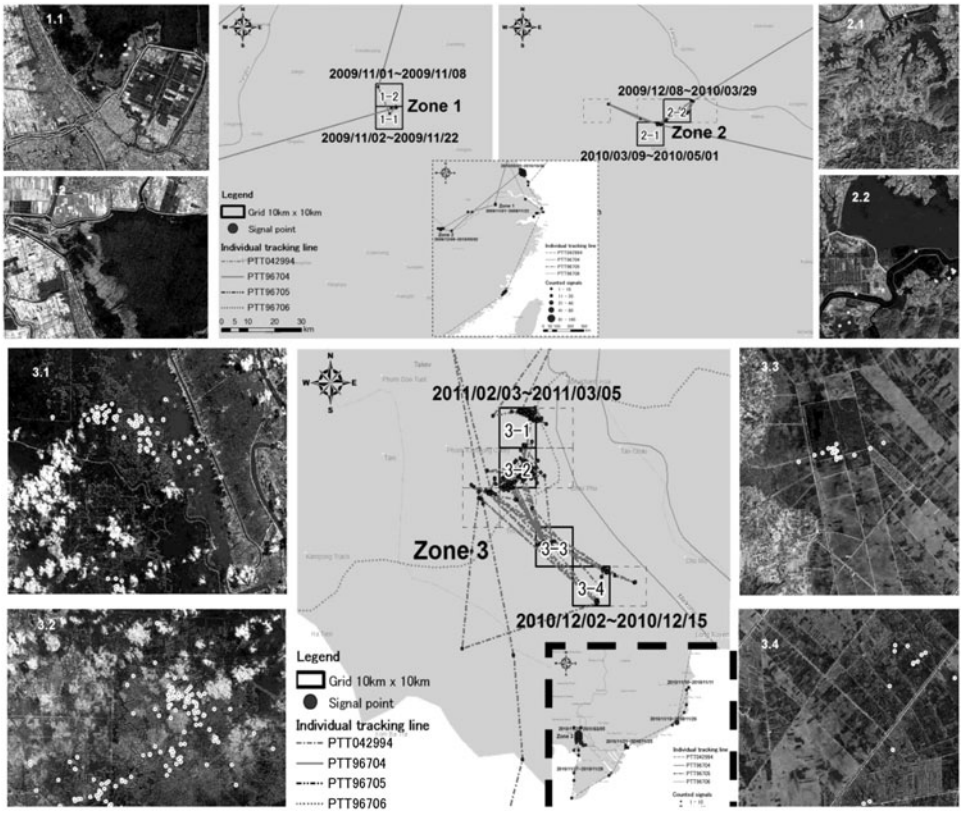

Figure 2. Zones of concentration based on the density of the location points received by GPS and Argos signal data.

3.2 (rivers, rice fields and other wetlands in Cambodia), and area 3.3 (locations were mostly within the Tra-sur Flooded Forest in Vietnam). Use of area 3.2 also persisted to mid-February and area 3.1, a mosaic area of wet forest, flooded land, wetland, wet grassland and other associated habitats, was occupied between early February and early March.

Sightings linked with observations of individuals fitted with PTTs

Observations in Cambodia confirmed at least four other Black-faced Spoonbills with the focal animal (Robert van Zalinge and Robert Evans pers. comm. 24 March 2011) and multiple birds were confirmed to be present over a period of several months. Previous sightings across the border in inland areas of the Mekong delta in Vietnam were also confirmed (Robert van Zalinge pers. comm. 24 March 2011). It is notable that the Black-faced Spoonbills had been previously unrecorded in Cambodia with the possible exception of one sighting of a spoonbill and a video record for the Prek Toal Bird sanctuary (also inland) (James Eaton pers. comm. 24 March 2011).

Discussion

The PTT tag results relate to a period where the location of a significant percentage of the Black-faced Spoonbill population was unknown. The 2011 winter census only accounted for 1,836 Black-faced

Spoonbills, a decrease of 22% from the previous year's figure (2010: 2,347 birds) (HKBWS 2011), representing a dramatic drop in numbers, particularly from the known large coastal wintering sites.

The telemetry data presented here, relating to the same period, demonstrate that at least some of these birds opted to winter in inland freshwater environments, rather than coastal areas. Two of the four tags revealed new inland wintering sites and in one of these cases observations revealed that the tagged individual was within a group of five Black-faced Spoonbills. Reports of other associated inland freshwater sightings in Thailand, and Vietnam were also received. The locations from Cambodia together with later reports of a further four individuals with the tagged bird, indicate that the comment that the species is "Regionally Extinct" in Cambodia (BirdLife International 2008) is incorrect.

Further satellite telemetry studies are to be encouraged. If a percentage of the population has moved inland, it is unlikely that conventional tagging/monitoring activities, which are highly concentrated in coastal locations, would pick this up. Areas where traditional rice agriculture is still maintained and fields are left flooded and fallow over winter (as in Figure 2: 3.2), or the large areas of the Mekong delta (as in Figure 2: 3.4) in Vietnam or the vast river and reservoir areas of inland China (as in Figure 2: 2.2), are not regularly surveyed in this manner. There remains continuing potential for bias and under-representation of freshwater ecology related to this species and its conservation.

Contrasts with previous PTT studies

Satellite telemetry has been used previously to describe migration routes (Melville *et al.* 2000, Ueta *et al.* 2002). However, in these studies there was a high degree of premature failure of these devices but Ueta *et al.* (2002) successfully described the migration patterns and identified breeding site locations using PTTs attached to birds captured in Hong Kong and Taiwan (Ueta *et al.* 2002).

Despite having fewer birds tagged compared with previous studies, our study benefitted from having a far higher signal frequency rate (four times daily, compared with every 4–6 days) which allow us to better describe habitat use over the course of a winter. The birds tagged by Ueta *et al.* (2002) did not move further south into South-East Asia, the southernmost observations there being the wintering sites in Hong Kong and Taiwan (although these birds were tagged whilst already present within those wintering sites). In contrast, our study showed some birds move as far south as Cambodia and Vietnam. Likewise, although birds were recorded at the mouth of the Yangtze by Ueta *et al.* (2002), no individuals were observed to follow the Yangtze inland as did one individual from the present study.

It currently remains unknown whether this lack of southern or inland readings was a result of the different conditions in the 1998–1999 winter; some factor of differing sub-populations, (the spoonbills in the Ueta study were tagged in Hong Kong and Taiwan whereas ours were tagged in Korea); an effect due to the tagged birds of our study being juvenile whereas adult individuals were tagged by Ueta *et al.* (2002); an actual range expansion by a recovering population, or a combination of these factors.

The Black-faced Spoonbill tends to migrate in age-related groups. Adults start migrating earlier and individuals hatched that year remain for longer in the breeding sites (pers. obs.). It may be that juveniles are more likely to stray into previously unfamiliar sites and, on discovering suitable habitat, may continue to use it.

Inland habitat use

The inland habitats used by the tagged birds were diverse in nature and included lake shores, river edges, ponds and flooded rice fields, and other associated flooded areas. The flooded forest selected in Vietnam 3.3 may have been a roosting area.

Our results suggest the movement of the spoonbills was related to changes in these highly seasonal environments. In Google Earth, the Mekong delta area 3.4, for example, shows clearly

demarcated field margins from February whereas the neighbouring image, taken in November, shows the whole area in full flood (not shown here). Such seasonal movements between habitats may complicate inland conservation efforts for this species and a broader and more complex habitat conservation approach than the demarcation of a single defined area of preferred habitat (a strategy more suited to the more easily defined areas of coastal tidal flats) may be required.

Conclusion

The feeding ecology of the species may be linked to the seasonal feeding opportunities in shallow waters of estuaries, but this does not necessarily dictate an exclusively coastal focus. Whilst the major coastal sites remain of the highest priority for the species, the coastal focus for the Black-faced Spoonbill may have been somewhat exaggerated, as the intensive coastal monitoring efforts are not always equally represented inland. The requirement for continued PTT tracking of this species is vital to further clarify the situation and may uncover further scattered groups of the Black-faced Spoonbill in inland freshwater locations. All newly discovered locations need to be highlighted for regular monitoring for any continued presence of the species.

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CHRIS WOOD[1], TETSUKAZU YAHARA*
Department of Biology, Faculty of Science, Kyushu University, Japan

[1]*College of Life Sciences, Zhejiang University, Zhe Jing Gang Campus, Hangzhou 310058, P.R. China.*

HIROSHI TOMIDA
Graduate School of System Life Science, Kyushu University, Japan.

KIM JIN-HAN, WEE-HAENG HUR, HWA-JUNG KIM, SUNG-HYUN KIM
Vertebrate Research Division, National Institute of Biological Resources, Korea.

KI-SUP LEE
Waterbird Network, Korea.

HYONG - JU CHO, SHIN NISHIDA
Department of Biodiversity Sciences, Graduate School of Social and Cultural Studies, Kyushu University, Japan.

JAMALUDDIN IBRAHIM
Department of Engineering, Kyushu University, Japan.

HIROKO KOIKE
The Kyushu University Museum, Japan.

GO FUJITA, HIROYOSHI HIGUCHI
Laboratory of Biodiversity Science, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan.

**Author for correspondence; e-mail: tet.yahara@gmail.com (But during editorial please use wopod1@yahoo.com)*

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