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Territory Size of Breeding Chinese Sparrowhawks(*Accipiter soloensis*) in Korea[1a]

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붉은배새매(*Accipiter soloensis*)의 번식기 세력권 추정[1a]

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ABSTRACT

The Chinese Sparrowhawk(*Accipiter soloensis*) is the most common breeding raptor in Korea, but its spatial use in the breeding season has been poorly documented. Therefore, to estimate the territory and home range sizes of breeding sparrowhawks, six territorial males(four in 2005 and two in 2006) were observed from June to July in Gyeonggi Province, the Republic of Korea. Main perches, which were used repeatedly(more than three times) or where apparent territorial behaviors were observed, were identified and the locations were analyzed by GIS software. According to the 100% Minimum Convex Polygons which were identified from 25.2±5.3 perches, Chinese Sparrowhawks occupied 4.62±0.90 ha for breeding territories and used 22.57±5.12 ha for their home ranges. These estimates showed larger spatially occupied areas than those in one previous report, but this study suggests that Chinese Sparrowhawks intensively use small areas throughout the breeding season. This result also implies that the sparrowhawks have the potential to be significantly affected by any habitat changes and resource exploitation in the small areas(particularly in small rice paddies of 0.6-2.0 ha) which they largely rely on for food. Although this study was based on observations solely for territory size estimations, this study may be worthwhile as preliminary pilot research for Chinese Sparrowhawk conservation, management, and further studies.

KEY WORDS: HOME RANGE, MINIMUM CONVEX POLYGON(MCP), SPATIAL USE

요 약

붉은배새매(*Accipiter soloensis*)는 국내에서 가장 흔히 번식하는 맹금류에 해당함에도 불구하고, 이 종의 번식기 공간이용에 대한 정보는 부족한 실정이다. 붉은배새매의 번식기 세력권과 행동권을 파악하기 위하여 국내에서 번식하는 6쌍(2005년 4쌍, 2006년 2쌍)의 수컷을 6월부터 7월까지 관찰하였다. 이를 통해 수컷이 3회 이상 반복적으로 이용하는 주요 지점과 명확한 세력권 방어 행동을 보이는 지점을 확인하고, 이를 GIS 프로그램으로 분석하였다. 확인된 25.2±5.3

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개 지점을 중심으로 100% 최소다각형법(minimum convex polygon)을 이용하여 분석한 결과, 붉은배새매의 번식기 세력권은 4.62±0.90 ha, 행동권은 22.57±5.12 ha에 해당하는 것으로 나타났다. 본 연구에서 확인된 붉은배새매의 세력권과 행동권은 비록 기존에 보고된 값보다 넓었으나, 전체 번식기에 걸쳐 이용하는 절대적인 공간 규모가 여전히 작다는 점을 보여준다. 이는 붉은배새매가 먹이를 제공할 수 있는 좁은 서식지, 특히 0.6-2.0 ha에 불과한 논에서 발생할 수 있는 환경 변화나 자원 고갈에도 상당히 취약할 수 있다는 것을 의미한다. 본 연구는 관찰을 통한 세력권 추정에 해당하지만, 붉은배새매의 보전과 관리, 향후 연구를 위한 기초연구로서의 중요성이 있다고 판단된다.

주요어: **공간이용**, **최소다각형법**(minimum convex polygon), **행동권**

INTRODUCTION

The Chinese Sparrowhawk(*Accipiter soloensis*) is one of the most common breeding raptors in the Republic of Korea(Gore and Won, 1971; Lee *et al*., 2000). It breeds mainly in the lowlands and foothills on forest edges around various types of wetlands such as rice paddies, marshes and swamps(Tomek, 1999; Lee *et al*., 2000; Ferguson-Lees *et al*., 2001), and is widely distributed all over the Korean Peninsula except in the north-eastern part of North Korea(Won, 1963). Kwon and Won(1975) reported the breeding biology of Chinese Sparrowhawks through observation of eight breeding pairs in the central part of Korea, and the estimated territory and home range were 1.05 ha(ranging from 0.9 to 1.3 ha) and 2.95 ha(ranging from 1.9 to 4.6 ha) in size, respectively. However, except for this report, no further information is available about their space use during the breeding season.

Understanding the organization of animals in space and time is a key issue of ecology; the best method to answer this question, especially regarding space use and movements, is through direct observation of the animals of interest, in spite of the many disadvantages and limitations(Kernohan *et al*., 2001). In particular, raptors, as top predators in many natural and disturbed ecosystems, have become an animal group of conservational interest, and the spatial behavior of raptors has been understood to have implications for their conservation as well as for the understanding of their ecological characteristics. Therefore, in this preliminary study, we estimate the territory and home range sizes of Chinese Sparrowhawks through direct observation to understand their space use, and discuss the implications of the results for their conservation in the Republic of Korea.

MATERIALS AND METHODS

Based on counts of occupied home ranges and active nests(Hardy *et al*., 2006), the breeding density of the Chinese Sparrowhawk was initially estimated in 2005 and 2006 at Musu-ri(N 37° 26'～28', E 127° 16'～17') which is under the administrative jurisdiction of Gwangju City in Gyeonggi Province, the Republic of Korea(Figure 1). The study area at Musu-ri is located in a small valley with villages, streams, rice paddies, and secondary forests. This area is in the vicinity of the Gyeongan River(Gyeongan-cheon), and many pairs of the Chinese Sparrowhawk breed here annually at a high density.

The traditional method used to determine the size of the territory(defended area) or home range(in case the area is not defended) has been to plot the location of the male or the pair directly on a map(Odum and Kuenzler, 1955). To estimate the territory and home range sizes of breeding Chinese Sparrowhawks in this study, we observed territorial males, plotted the locations of males on maps, and searched for nests and main perching sites throughout the breeding season from June to July. In particular, main perches such as electricity poles and tall trees were identified, which were used repeatedly(more than three times) or where apparent territorial behaviors were observed.

Territories were estimated from 100% Minimum Convex Polygons(MCPs) based on the identified main perches. The MCP method makes no assumptions regarding the statistical independence of tracked locations(De Solla *et al*., 1999; Rutz, 2006). Moreover, it is one of the most commonly used techniques enabling robust cross-study comparisons, and it gives an intuitive approximation of the total area used by an animal(Mohr, 1947; White and Garrott, 1990; Kenward, 2001; Kernohan *et al*., 2001; Rutz 2006). Home range sizes were also

estimated by 100% MCPs based on locations where the Chinese Sparrowhawk soared without any interaction with other species(i.e., predation, competition).

To determine whether adequate sample sizes or sampling saturation were achieved, we used an incremental analysis based on observation-area curves(Odum and Kuenzler, 1955; Kenward, 2001; Börger *et al*., 2006). Observation-area curves(mean MCP area by the number of locations) were plotted from 500 bootstrap re-sampling estimates, and the definition of an asymptote(each additional observation will produce less than a 1% increase in the area) was used to calculate the MCP territory sizes(Odum and Kuenzler, 1955).

We used the Animal Movement extension 2.04(Hooge and Eichenlaub, 1997) in ArcView 3.2 software(ESRI, Redlands, CA, USA) for the spatial and bootstrap analyses. All area values are given as means and standard deviations, and these are referred to as the mean±SD hereafter.

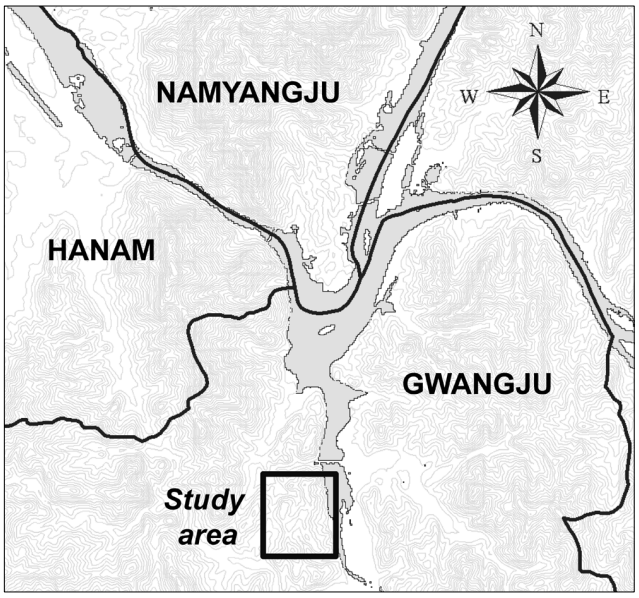

Figure 1. Location of the study site in Gwangju, Gyeonggi Province, in the Republic of Korea

RESULTS

We identified the occupied territories and main perches of 12 males(nine in 2005 and three in 2006); however, more than 15 perches were identified only in the occupied areas of six males.

Based on the observation-area curves calculated from the bootstrapping analyses, five males reached the minimum number of perches sufficient to estimate the MCP territories, while one male(M2) did not(Figure 2). Nevertheless, we included this male in further analyses to compensate for the small sample size, because the curve nearly approached the asymptote(1.9% increase in the MCP area with the additional location).

Based on the estimates of six territorial males, the Chinese Sparrowhawks, which bred in 2005 and 2006 at Musu-ri, occupied 4.62±0.90 ha for 100% of the MCP territory(Table 1, Figure 3). The size of rice paddies, which were the dominant type of freshwater wetlands, in the territories was 1.10±0.47 ha and ranged from 0.61 to 1.97 ha(Table 1). Home range sizes estimated from the soaring flights of two males were 18.95 and 26.19 ha(Table 1).

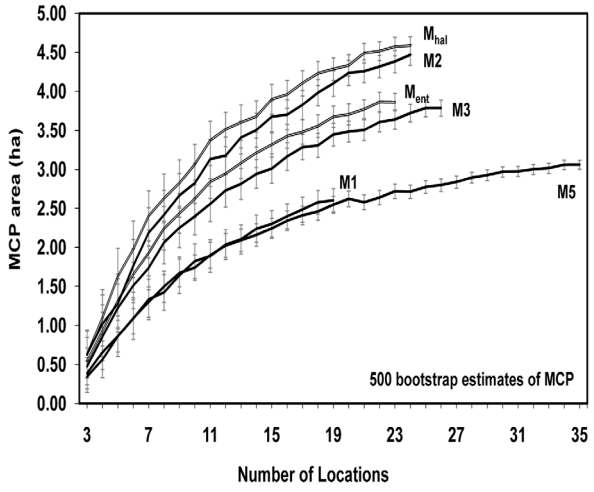

Figure 2. The changes in the mean MCP areas according to the number of locations (observation-area curve) estimated by 500 bootstrap re-samplings. Vertical bars indicate standard errors(SEs)

DISCUSSION

In the study area at Musu-ri, the breeding sparrowhawks occupied 4.62±0.90 ha(ranging from 3.58 to 5.61 ha) for

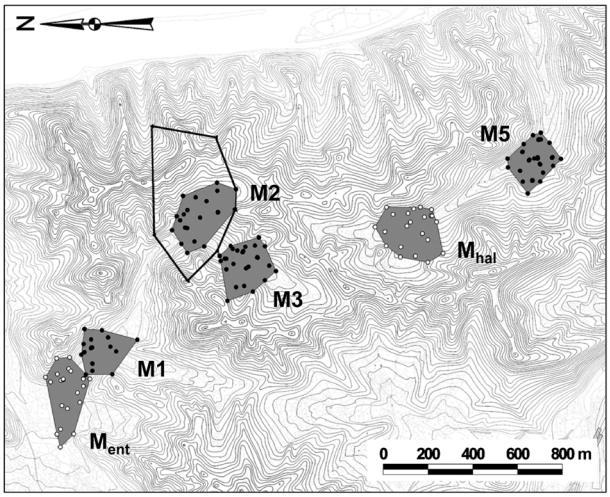

Figure 3. Territories(gray maximum convex polygons) of four males in 2005 and two males in 2006 in Musu-ri, Gwangju, in the Republic of Korea. Main perches are plotted as filled circles for 2005 and open circles for 2006. An open convex polygon indicates the home range of one male(M2) based on aerial movements outside its identified territory

their breeding territories. The sizes of the home ranges as estimated from the soaring flights of two males were 22.57±5.12 ha(18.95 and 26.19 ha). Considering the small home range of 2.95 ha and the territories of only 1.05 ha reported by Kwon and Won(1975), this estimate showed larger sizes. Although Kwon and Won(1975) used a method similar to that used in this study, they may have included all interspecies interactions, thus including not only territorial behaviors but also predatory behaviors. Since we believe that interactions with small birds like tits and flycatchers should be regarded as predatory behavior rather than territorial behavior, their estimation was possibly too strict to explain the true territorial activities.

A territory is generally defined as any defended area, an exclusive area, and a fixed exclusive area with the presence of defense that keeps out conspecific rivals(Odum and Kuenzler, 1955; Hardy *et al*., 2006); however, the general applicability of this definition to all animals is somewhat questionable(Saitoh, 1985). The most fundamental nature of a territory is its exclusiveness, which may be maintained by audio-visual communication in birds(Saitoh, 1985). Nonetheless, it is in practice difficult to identify territories from home ranges in many cases because the opportunities of observing actual defending behaviors are limited. Defining territories and home ranges is beyond the scope of this study, and the identified major perches showed a spaced-out distribution without any spatial overlap. Therefore, we simply regarded the exclusive spacing of breeding adjacent males as a territory, though there were few direct observations of defending behaviors. At the same time, the spaces used during unusual or occasional soaring flights without defending or predatory behaviors over hills were

Table 1. Territory sizes of breeding Chinese Sparrowhawks estimated by the 100% MCP(minimum convex polygon) method in Musu-ri, Gwangju, in the Republic of Korea

Year	Breeding pairs	No. of perches	Territory(ha)	Rice paddies in territory(ha)	Mean bootstrap territory(ha)	Home range(ha)
2005	M1	19	3.58	1.24	2.74±0.57	-
2005	M2	24	5.61	0.61	4.47±0.65	18.95
2005	M3	26	4.57	1.03	3.87±0.49	-
2005	M4	4	-	-	-	-
2005	M41	3	-	-	-	-
2005	M42	5	-	-	-	-
2005	M5	35	3.59	0.80	3.05±0.42	-
2005	M6	4	-	-	-	-
2005	M7	3	-	-	-	-
2006	Ment	23	4.78	1.97	3.88±0.57	-
2006	Mhal	24	5.57	0.96	4.65±0.51	-
2006	Mriv	6	-	-	-	26.19
Mean±SD(n)			4.62±0.90(6)	1.10±0.47(6)		22.57±5.12(2)

considered as home ranges. However, the definition and ecological meanings of territory and home range should be more discussed in further studies on the spatial use of breeding Chinese Sparrowhawks.

Because breeding males hold breeding territories within which nesting, courtship, mating and most foraging took place, the number of breeding birds per unit area is limited(Saitoh, 1985). Moreover, the habitat quality as well as breeding density may affect the territory and home range sizes(Dunk and Cooper, 1994; Whitfield *et al*., 2007). The territory and home range sizes calculated in the study area were possibly smaller than those elsewhere due to the high breeding density in a small spatial space. However, the findings of this study suggest that Chinese Sparrowhawks are dependent on only small areas(smaller than 6 ha) throughout their breeding seasons, though these size values are in contrast with those of a previous study(Kwon and Won, 1975). Given that frogs are the most important food sources in the breeding season(Kwon and Won, 1975), maintenance of small territories by breeding sparrowhawks also implies that their patterns of resource use are highly dependent on small restricted spaces(particularly on small rice paddies as a dominant wetland type in their territories) that may sustain high habitat quality by supplying enough foods for nesting. Raptors, that are constrained by neighboring pairs and cannot compensate for some habitat loss, may abandon the territory(Whitfield *et al*., 2007). Therefore, any habitat loss, change and resource exploitation in their small areas(and particularly in rice paddies of 0.6-2.0 ha), even though these seem to be minor and negligible, may significantly affect the breeding status of Chinese Sparrowhawks which often breed nearby.

One male with 24 identified perches could not reach an adequate sample size, and its territory size may be slightly underestimated. However, this study showed that 19 perches may produce a reliable territory size in many cases(five of six). This study was based on observations solely for territory size estimates, and we might cause several types of biases(i.e. lower vision-based detectability in forested areas) in the space use estimation of the sparrowhawks. However, given that direct observation is the most basic but effective method to understand spatial behaviors of animals(Kernohan *et al*., 2001), this study may be valuable as preliminary pilot research for Chinese Sparrowhawk conservation, management, and for further studies using advanced techniques like radio-telemetry.

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