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Analysis of the Summer Season Home Range of Domestic Feral Cats (*Felis catus*) - Focused on the Surroundings of Rural and Suburban Areas -

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Abstract: In order to analyze the home range of feral cats residing in the surroundings of rural and suburban areas, we collected coordination information data from five feral cats. As a result of such research, 100% MCP was defined as minimum 31,500 and maximum 351,900, and 95% KR was defined as minimum 9,400 and maximum 502,800, 75% KR was defined as minimum 3,600 and maximum 126,900, and 50% MCP was defined as minimum 1,800 and maximum 51,700. The home range of feral cats was also analyzed during daytime and nighttime, and all five individuals showed a wider home range during the nighttime than daytime. The analysis of gender shows that the average home range of female feral cats is larger than the average of males. Meanwhile, the results of information data with wide-open areas such as farm land and terrace land on the river showed that the analyzed value was increased generally, and showed variable values depending on the gender and size of each individual feral cat.

Keywords: Feral cats, Location based Telemetry System, Home range

Introduction

Most feral cats were pet cats that were abandoned and became wild. As more live in groups, its numbers grew rapidly. Recently, there has been a continuously growing interest in feral cats in relation to issues on wild animal protection and social health issues (Patronek, 1998; Slater, 2004). The increase of numbers of feral cats has a negative impact on species diversity for wild animals, and in particular small mammals and birds (Jones and Coman, 1981; Liberg, 1984; Mitchell and Beck, 1992; Woods et al., 2003). Moreover, feral cat carry many zooneses (Han, 1999). Infections of diseases caused by such feral cats are social issues and major problems that need to be addressed in terms of public health (Beaver, 1992). In addition to the parasites and pathogens that can be spread to livestock and pet cats, they can also be transferred to humans (Coman et al., 1981; Engback et al., 1984; Jane and Margaret, 1996). In particular, the rapid increase of feral cats in the outskirts of cities and rural areas has a high possibility to transmit parasites and pathogens to humans (Dubey and Frenkel, 1976). In the case of toxoplasmosis, a zoonosis that can affect a wide range of animals including birds and mammals, as well as people, cats are reported to be major medium for infection to people (Han et al., 1999). In the case of heart worms, the fact that it can be spread from feral cats to other mammals suggests a potential risk that parasites can be spread directly to other pets or people (Abbott, 1966; Bernard, 1970). Furthermore, though it has not yet been reported in Korea, in the case of SARS (severe acute respiratory syndrome), which caused many deaths in over thirty countries focusing in Southeast Asia in 2003, civets, which are a type of feral cat, were attributed as the carrier of the pathogens. Also, in the case of avian influenza that has been continuously reported in Korea for the past several years, it has been confirmed that the virus was spread by feral cats through epidemiological investigations. Furthermore, there are claims for the possibility of secondary transfers of the virus through feral cats that came into direct or indirect contact with wild birds (Animal Plant and Fisheries Quarantine and Inspection Agency, 2011).

Many studies on the ecology or diseases of feral cats have continuously been carried out and are still underway in many countries around the world. These study results make it possible to understand the habits of cats better and also enable to respond to the aforementioned problems more actively. However, in the case of Korea, there are almost no research on the ecology of feral cats making it impossible to clearly estimate the gravity of the problems caused by the feral cats, and it is not possible to search for suitable solutions due to lack of data (Ministry of Environment, 2001). This study identifies the home range of feral cats, which is the most basic element of their ecological behavior, in order to construct basic data needed.

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for follow-up research such as the biological characteristics and habitat characteristics of feral cats.

Materials and Methods

Research Area and Capturing Method

Selection of the area of studying the home range of feral cats were made by taking into consideration areas where it is judged that there will be frequent contact between feral cats and wild animals in rural areas or city outskirts; areas judged that there will be frequent contact between feral cats and residents and their pets; livestock farms where there were epidemics in the past; and areas where there are large-scale habitats for migratory birds. The selected areas were Jukchon-ri in Hwandeung-myeon, Iksan-si of North Jeolla Province, Jangshin-ri in Yongji-myeon, Gimjae-si of North Jeolla Province, Yongheung-ri in Gobu-myeon, Jeongeup-si, North Jeolla Province, Gangjaeng-ri in Damyang-eub, Damyang-gun of South Jeolla Province, and Shindae-dong in Heungdeok-gu, Cheongju-si of North Chungcheong Province. All of these regions experienced stamping out in livestock farms due to the onset of HPAI (Highly Pathogenic Avian Influenza). Gangjaen-ri in Damyang-eub, Damyang-gun of South Jeolla Province and Shindae-dong in Heungdeok-gu, Cheongju-si of North Chungcheong Province are located near the upstream of Yeongsangang (Riv.) and Geumgang (Riv.), respectively, which are both habitats for winter migratory birds. There are many people who visit the river banks and the hiking and biking trail on the terrace land of rivers, providing it higher potential for frequent contact between feral cats and wild animals or humans. Furthermore, Jukchon-ri in Hwandeung-myeon, Iksan-si of North Jeolla Province, Jangshin-ri in Yongji-myeon, Gimjae-si of North Jeolla Province, and Yongheung-ri in Gobu-myeon, Jeongeup-si, North Jeolla Province are located near fowl farms and habitats for migratory birds, giving it high possibility for contact between feral cats and wild animals, and in particular, with wild birds. Thus, these areas have higher risks of spreading diseases by feral cats.

While the capturing of feral cats were examined using their tracks in the study areas, areas frequently having movement of feral cats were selected through interviews with local residents. The capturing trap used was the Tomahawk Live Trap (25×30×81 cm) and chicken and ham were used as bait. After installing the traps, they were checked twice a day (once in the morning and once in the afternoon) and the baits were replaced. After collecting the captured cats, the traps were removed.

Attachment of tracking devices and tracking

Tracking devices are attached to captured feral cats after measuring the size, weight and checking gender. The weights of the captured feral cats were measured by weighing the trap with the captured cat and then subtracting the weight of the empty trap. Measurement of size, checking the gender, and attaching the tracking device was carried out by binding the four legs and blindfolding the cat. In the case of small mammals, the weight of the tracking device should be less than 5% of the weight of the animal to minimize any limitations in actions (Aldridge and Brigham, 1988; Choi and Park, 2006). The tracking device used in this study is about 90%, or 2 to 3% of typical cat weights in order for it to be applied on feral cats.

The tracking device used in this study applied the LBS system (Location-Based Telemetry System) that combines GPS and CDMA. The GPS of the tracking device attached to the wild animal receives and stores location information and uses and sends the location information through commercial mobile communication networks via CDMA. It can download coordinates from the Internet without requiring a researcher to wait at a specified place. Therefore, by using this method it was possible to track feral cats at similar time frames in five different regions. By dividing the location information sending pattern of tracking devices as long term (up to 21 days, 30 coordinates or more) and short term (up to 7 days, 100 coordinates or more), it aimed at collecting more diverse location information data.

Home Range Analysis

The received location information of feral cats were stored on web services through KATEC coordinates. It was converted to spherical coordination and then converted to
TM (Transverse Mercator) coordinates. The converted TM coordinates were entered in the value topographic map (1:50,000, National Geographic Information Institute) and it was converted into a shp file using AutoCAD 2007 (Autodesk Inc.) and ArcView 3.2 (Esri Inc.) programs. For home range analysis, ArcView 3.2 Animal Movement Extension 2.0 was used and the Kernel Home Range Method (KR) and Minimum Convex Polygon (MCP) Method using Moving Harmonics Means were used. In this study, the max home range and major activity regions were analyzed via 100% MCP and KR 95%, 75%, 50%.

Results

Average Home Range

A total of nine feral cats were captured and tracked in the five regions. Excluding four cats from which the coordinates could not be obtained due to device malfunctions or road-kills, home range analysis was conducted on five feral cats. Upon analyzing the home range of the five cats, 100% MCP showed a minimum of 31,200 m$^2$ to a maximum of 351,900 m$^2$, 95% KR at a minimum of 9,400 m$^2$ to a maximum of 502,800, 75% KR at a minimum of 3,600 m$^2$ to a maximum of 126,900 m$^2$ and 50% KR at a minimum of 1,800 m$^2$ to a maximum of 51,700. Excluding individual ‘E’ that showed an excessively large value compared to the others, the average home range of the four cats were 100% MCP 49,650 m$^2$, 95% KR 47,025 m$^2$, 75% KR 17,875 m$^2$, and 50% KR 6,300 m$^2$ (Table 1).

Daytime and Nighttime Home Range

Home range analysis according to the activity time of feral cats were made on ‘A’ and ‘B’ that were attached with devices set for short-term tracking (tracking period up to 7 days, 100 or more coordinates). The collected location information was categorized into daytime and nighttime to calculate the home range. The cross time of daytime and nighttime was unified as 7 A.M. and 7 P.M. for consistency of data and convenience of analysis. ‘A’ was found to have daytime 100% MCP 27,900 m$^2$, 95% KR 9,800 m$^2$, 75% KR 2,700 m$^2$, and 50% KR 1,400 m$^2$, and nighttime 100% MCP 53,900 m$^2$, 95% KR 25,200 m$^2$, 75% KR 6,500 m$^2$, and 50% KR 3,300 m$^2$, showing that there was more nighttime movement than daytime movement. ‘B’ exhibited daytime 100% MCP 44,500 m$^2$, 95% KR 37,800 m$^2$, 75% KR 12,400 m$^2$, and 50% KR 3,200 m$^2$, and nighttime 100% MCP 38,400 m$^2$, 95% KR 43,200 m$^2$, 75% KR 17,100 m$^2$, and 50% KR 6,300 m$^2$, showing that the 100% MCP value was lower than the daytime, but had overall higher movement during the nighttime. It was found that there was more movement during nighttime compared to daytime for both ‘A’ and ‘B’, while feral cat ‘A’ showed much higher activity during the nighttime than the daytime.

According to the winter season home range analysis on feral cats at the Gyeongju National Park, in the case of male cats, daytime 100% MCP 0.07 km$^2$, 95% KR 0.06 km$^2$, and 50% KR 0.01 km$^2$, and nighttime 100% MCP 0.18 km$^2$, 95% KR 0.16 km$^2$, and 50% KR 0.13 km$^2$ were displayed. In the case of female cats, daytime 100% MCP 0.23 km$^2$, 95% KR 0.20 km$^2$, and 50% KR 0.20 km$^2$, and nighttime 100% MCP 0.25 km$^2$, 95% KR 0.29 km$^2$, and 50% KR 0.07 km$^2$ were exhibited showing that both female and male cats had wider home ranges at night than in the day (Lee et al, 2009). These are the same as the results of this research and are consistent with the widely known characteristics of feral cats.

Home Range by Gender

Excluding ‘E’, the four cats captured in this study (2 females, 2 males) were compared for home ranges by gender. The average for males were 100% MCP 41,750 m$^2$, 95% KR 51,000 m$^2$, 75% KR 17,950 m$^2$, and 50% KR 5,250 m$^2$, and the average for females were 100% MCP 57,550 m$^2$, 95% KR 43,050 m$^2$, 75% KR 17,800 m$^2$, and

Table 1. Characteristics of the captured feral cats in this study

| Individual | Sex | Weight (kg) | Duration of tracking | Actual tracking days | Collected coordinates | Transmitter setting |
|------------|-----|-------------|----------------------|----------------------|-----------------------|---------------------|
| A          | Female | 3.2 | 5.4–10 | 7 | 123 | S |
| B          | Male | 3.5 | 6.9–16 | 8 | 220 | S |
| C          | Male | 3.1 | 7.13–25 | 13 | 27 | L |
| D          | Female | 2.5 | 7.14–27 | 14 | 38 | L |
| E          | Male | 6.9 | 7.15–25 | 11 | 45 | L |

S: Short-term tracking (max. 7 days, 100+ points), L: Long-term tracking (max. 21 days, 30+ points)

Table 2. Mean home range size of the five feral cats

| Individual | Sex | 100% MCP (m$^2$) | 95% KR (m$^2$) | 75% KR (m$^2$) | 50% KR (m$^2$) |
|------------|-----|------------------|----------------|----------------|----------------|
| A          | Female | 61,200 | 9,400 | 3,600 | 1,800 |
| B          | Male | 52,300 | 42,600 | 10,100 | 3,500 |
| C          | Male | 31,200 | 59,400 | 25,800 | 7,000 |
| D          | Female | 53,900 | 76,700 | 32,000 | 12,900 |
| E          | Male | 351,900 | 502,800 | 126,900 | 51,000 |

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Results of analyzing home ranges of feral cats during the winter season at Gyeongju National Park showed that males had 0.18 km$^2$ and females had 0.31 km$^2$ home ranges, which was the same as the results of this study (Lee et al., 2009). Meanwhile, in the case of Japan, home ranges of feral cats on coastal villages showed that for males it was 0.78 ha (approximately 7,800 m$^2$) and for females was 0.44 ha (approximately 4,400 m$^2$), displaying broader home ranges for male cats (Yamane et al., 1994). In a study on feral cats in urban Brooklyn of New York, males showed home ranges of 2.6 ha (approximately 26,000 m$^2$) and females displayed 1.7 ha (approximately 17,000 m$^2$), once again showing that male cats had broader home ranges than females (Haspel & Calhoun, 1989).

Table 3. Mean home range size comparison with two feral cat individuals by all day, daytime and nighttime

| Individual | Coordinates | 100% MCP (km$^2$) | 95% KR (km$^2$) | 75% KR (km$^2$) | 50% KR (km$^2$) |
|------------|-------------|-------------------|----------------|----------------|----------------|
| A          | Daytime     | 27,900            | 9,800          | 2,700          | 1,400          |
|            | Nighttime   | 53,900            | 25,200         | 6,500          | 3,300          |
|            | All day     | 61,200            | 9,400          | 3,600          | 1,800          |
| B          | Daytime     | 44,500            | 37,800         | 12,400         | 3,200          |
|            | Nighttime   | 38,400            | 43,200         | 17,100         | 6,300          |
|            | All day     | 52,300            | 42,600         | 10,100         | 3,500          |

Fig. 2. The home ranges of the Feral cat individual 'A' with MCP and KR method in all day (total), daytime and nighttime.

Fig. 3. The home ranges of the Feral cat individual 'B' with MCP and KR method in all day (total), daytime and nighttime.

Fig. 4. The home ranges of the 3 feral cats individual 'C', 'D' and 'E' with MCP and KR method

50% KR 7,350 m$^2$, displaying that the home range of female genders were generally broader than that of males.

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Discussion

In order to identify the summer home ranges of feral cats in Korea, five feral cats were captured and tracked in five different regions. Excluding one cat that showed big differences from the other cats, the average home range of four cats were calculated, showing results of 100% MCP 49,650 m², 95% KR 47,025 m², 75% KR 17,875 m², and 50% KR 6,300 m².

In the home range analysis per activity time frame, it was found that home ranges in the nighttime was broader than that in the daytime, which is consistent with the characteristics of their species. It has been reported that feral cats show more activity during the daytime during the winter and more activity during the nighttime in summer seasons (Izawa, 1981). It is consistent with past studies that they show the most activity at sunset and sunrise (Jones and Coman, 1982) and with the research results that the max home range of feral cats is in the nighttime (Ministry of Environment, 2001).

In the home range analysis by gender, it was found that the female’s home range was wider than the male. This is rather different from existing studies that reported that male feral cats typically showed wider home ranges than females (Mirmovitch, 1994; Fitzgerald and Karl, 1986). This is judged to be due to the area and method of the study, as well as differences in the number of feral cats and characteristics of each cat.

Furthermore, the five captured feral cats show very different results depending on the individual, gender and place of capture. Particularly in the case of ‘E’ that showed very wide home ranges compared with other cats, it was captured in a village near the upstream of Geumgang (Riv.), which is a habitat for migratory birds, and the location tracking results showed that it moved from around the village to nearby farmlands, roads, and terrace land on rivers, as well as the river banks. While it cannot be precisely diagnosed on the reason why it showed much higher figures than other cats, when considering that it weighed a lot more than the feral cats captured in other regions and that it was near open terrains such as rivers and farmlands, it can be assumed that the physical features and the surrounding environment of the feral cat could be an important factor in determining the feral cat’s home range.

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