Regular Article
pISSN: 2288-9744, eISSN: 2288-9752
Journal of Forest and Environmental Science
Vol. 38, No. 2, pp. 128-132, June, 2022
https://doi.org/10.7747/JFES.2022.38.2.128

JFES
Journal of Forest and Environmental Science

Long-Term Monitoring of the Barrier Effect of the Wild Boar Fence

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Abstract

Wild boars (*Sus scrofa*) not only cause crop damage and human casualties, but also facilitate the spread of many infectious diseases in domestic animals and humans. To determine the efficiency of a fencing system in blocking the movement of wild boars, long-term monitoring was performed in a fenced area in Bukhansan National Park using camera traps. Upon monitoring for a period of 46 months, there was a 72.6% reduction in the number of wild boar appearances in the fence-enclosed area, compared to that in the unenclosed area. For 20 months after the fence installation, the blocking effect of the fence was effective enough to reduce the appearance of wild boars by 92.6% in the fence-enclosed area, compared to that in the unenclosed area. The blocking effect of the fence remained effective for 20 months after its installation, after which its effectiveness decreased. Maintaining a fence for a long time is likely to lead to habitat fragmentation. It can also block the movement of other wild animals, including the endangered species - the long-tailed goral. This study suggests a 20-month retention period for the fences installed to inhibit the movement of wild boars in wide forests such as Gangwon-do in South Korea. To identify how long the blocking effect of the fences lasts, further studies are needed focusing on the length and height of the fence, and the conditions of the ground surface.

Key Words: wild boar, African swine fever, fence, long-term monitoring, camera trap

Introduction

The wild boar (*Sus scrofa*) not only causes crop damage and human casualties (Herrero et al. 2006; Meng et al. 2009; Pandey et al. 2016), but also facilitates the spread of many infectious diseases in domestic animals and humans (Jo and Gortázar 2020; EFSA et al. 2021). The appearance of wild boars in urban areas and agricultural lands causes serious social and economic problems, such as human casualties, traffic accidents, and crop damage (Schley et al. 2008; Thurfjell et al. 2009; Kose et al. 2011; Kim et al. 2014; Lee et al. 2018). Recently, there has been an increasing number of cases of such issues caused by wild boars in residential areas that are adjacent to forests such as national parks, the Baekdudaegan Mountains, and private forests (Yoon 2007). In particular, in urban national parks, such as Bukhansan National Park, Gyeryongsan National Park, and Gyeongju National Park, causalities due to wild boars have increased, owing to the increase in number of visitors who enjoy outdoor activities such as hiking and climbing.

Received: January 14, 2022. Revised: January 29, 2022. Accepted: January 30, 2022.

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In addition to crop damage and human casualties, wild boars can act as carriers of many important infectious diseases in domestic animals and humans (Meng et al. 2009). African swine fever (ASF) is a deadly and infectious viral disease that affects pigs and wild boars. It has recently been spreading in South Korea as well as in a wide range of areas in the northern hemisphere, including Europe and Asia (EFSA et al. 2021). It is likely that domestic pigs will become infected directly by the African swine fever virus (ASFV)-infected wild boars and indirectly by other wildlife such as raccoons, rodents, vultures, and crows that come into contact with ASFV-infected wild boar carcasses (Probst et al. 2019; EFSA et al. 2021). Although humans are not infected by ASFV, infection of domestic pigs with ASFV is causing enormous economic issues (Mason-D'Croz et al. 2020; Tian and von Cramon-Taubadel 2020) because vaccines, or treatments, have not been developed.

Various methods including capturing, hunting, feeding, fencing, and spraying repellents have been used to prevent the damage and propagation of infectious disease caused by wild boars (Geisser and Reyer 2004; Santilli and Stella 2006; Schley et al. 2008; EFSA et al. 2021). Fencing is an effective means of preventing wild boars from moving to agricultural or residential areas, or to prevent ASFV-infected wild boars from moving to ASFV-free areas. Previous studies on the effectiveness of a fencing system have focused on electric fences (Geisser and Reyer 2004; Santilli and Stella 2006), including the evaluation of the electric fence system design (Hone and Atkinson 1983; Schley et al. 2008) and the effective installation of fences to control wildlife diseases (Lavelle et al. 2011; Mysterud and Rolandsen 2019). However, there are few studies on the effect of blocking the movement of wild boars using iron fences and the persistence of the blocking effect. In the present pilot study, we investigated the effect of an iron fence in inhibiting the movement of wild boars and monitored how long the movement-restricting effect of the fence lasted.

Materials and Methods

Study area

The Bukhansan National Park in Seoul and Gyeonggi-do covers an area of 79.92 km^2. Wild boars have frequently appeared in human residences near Uijeil Church, located in the middle of the eastern edge of Bukhansan National Park, due to the dumping of food waste (Fig. 1A). Therefore, an iron fence (300 m long and 2 m high) was installed within 2 months (November and December 2017) to prevent wild boars inhabiting the inner forests of Bukhansan National Park from descending toward Uijeil Church (Fig. 1B). Region A is isolated by a fence from the inner forests of Bukhansan National Park and has an area of 0.035 km^2, which is too narrow for wild boars to inhabit. Thus, the temporary stay of wild boars is possible there, but long stays are likely to be unsuitable. The movement of wild boars to this area is also likely to be very limited by the fence. Region B is connected to the forests inside Bukhansan National Park and the movement of wild boars to this area is not expected to be restricted.

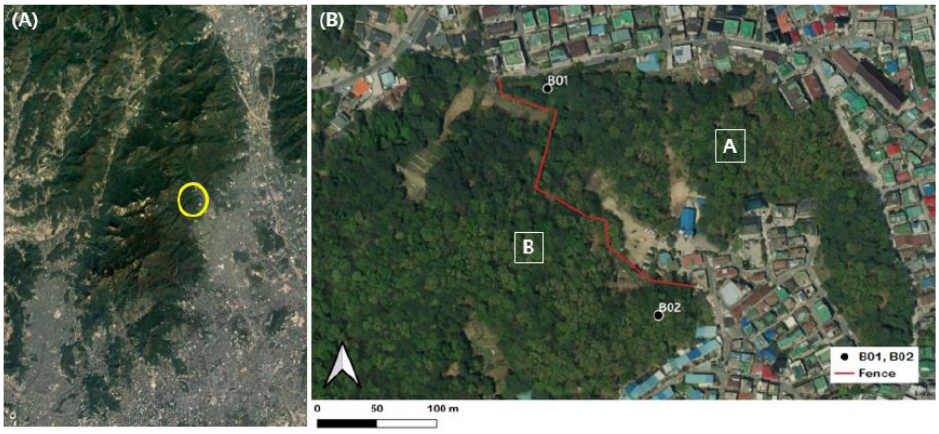

Fig. 1. Location of the study area (yellow circle) at the middle part of the eastern area of Bukhansan National Park (A) and the fence-installed area (B). In (B), region A (boxed A) is enclosed by fence and human residences (called fence-enclosed), and region B (boxed B) is connected to the inner forests of the national park (unenclosed). B01 and B02 indicate camera-installed sites near the fence (red line).

Camera trap data collection and statistical analysis

The camera traps (Browning BTC-8A; Browning, USA) featured a motion sensor that automatically captures an image of the wildlife when it passes in the front of the camera. Camera traps were mounted vertically on trees at a height of 100 cm. The interval for taking photographs was set to allow three consecutive photographs, with a time delay of 1 min. To exclude the influence of replicated photographs triggered by one individual, if multiple photos were taken during a visit, only one photograph was used for analysis (Otis et al. 1978).

When multiple individuals of the same species were photographed in one photo, the number of photos was multiplied by the number of individuals in the picture.

On May 15, 2017, before the fence was installed, the camera traps were installed in two locations (B01 and B02) around the route where the fence was scheduled to be installed. The camera trap monitoring was performed for 53 months from June 1, 2017, to October 30, 2021. The monitoring data for 51 months, excluding November and December 2017 when the fence installation work was carried out, were used in the analysis of wild boar appearances. The cameras were installed around places where evidence of the presence of wild boars, such as feces, fur, and trees that were rubbed, were frequently found. The cameras were checked every 2 months to change the batteries and to download the data. Statistical analysis of the camera trap data was conducted using IBM SPSS Statistics 28.01.0.

Results and Discussion

Appearance frequency of wild boars

During the 51 months of camera trap monitoring, excluding November and December 2017 (Fig. 2) when the fence was installed, wild boars appeared 365 times in B01 and 1,135 times in B02. During the 5 months before the fence was installed, from June 1 to October 30, 2017, wild boars appeared 66 times in B01 and 42 times in B02. The average number of appearances per month was 13.2±14.6 times (n=5, r=0-35) in B01 and 8.4±6.3 times (n=5, r=1-18) in B02. The number of appearances was 1.57 times higher in B01 than in B02, but the difference was not statistically significant (Mann–Whitney U test: n=5, z=-0.315, $p > 0.05$). However, for 46 months of camera trap monitoring, after the installation of the fence, wild boars appeared 299 times in B01 and 1,093 times in B02. The average number of appearances per month was 6.5±10.5 (n=46, r=0-48) in B01 and 23.8±17.7 (n=46, r=0-89) in B02. The number of appearances was significantly lower in B01 than in B02 (t test: n=46, $p < 0.05$). Compared to the number of appearances in B02, the number of appearances was 3.66 times lower in B01, indicating a 72.6% reduction, presumably due to the fence.

During the 20 months from January 2018, after the installation of the fence, to August 2019 (Fig. 2), wild boars appeared only 19 times (15 times in July 2018, 1 time in August 2018, and 3 times in May 2019) in B01. Meanwhile, during this period they appeared a total of 258 times in B02. Therefore, for 20 months after the fence installation, the blocking effect of the fence in region A was strong enough to reduce the appearance of wild boars by 92.6% compared with region B. After September 2020, the wild boars also showed an increasing trend in the number of appearances in B01, which was isolated by the fence.

The annual change in the average number of wild boar appearances per month in B02 (Fig. 3) well reflected the trend of changes in the density of the wild boar population from 2018 to 2020, which was recorded throughout Bukhansan National Park in a previous study (Choi et al. 2021). Since 2018, the trend of wild boar appearances in B01 has been similar to that of B02 (Fig. 3). The average number of appearances per month was 1.57 times higher in B01 than in B02 in 2017, before the fence was installed, but much lower in B01 since 2018 when the fence was installed

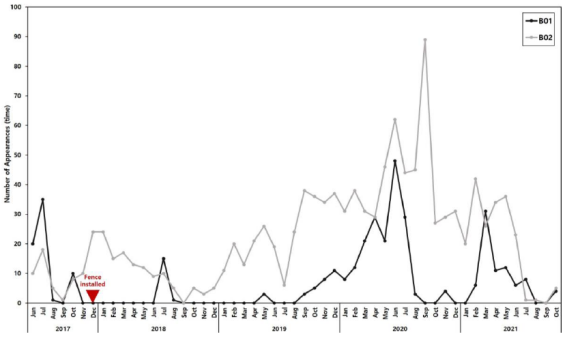

Fig. 2. The number of wild boar appearances in B01 and B02 from June 1, 2017 to October 30, 2021.

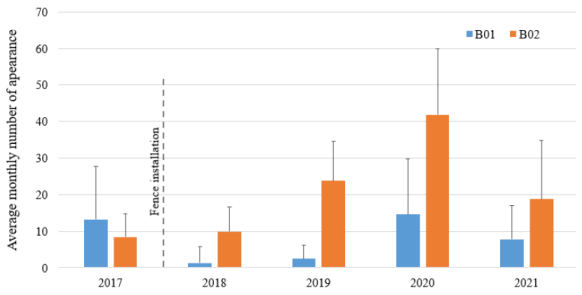

Fig. 3. The average number of wild boar appearances per month in B01 and B02 from 2017 to 2021 (the average number of wild boar appearances per month for 5 months from June 1 to October 30 in 2017 and for 10 months from January 1 to October 30 in 2021).

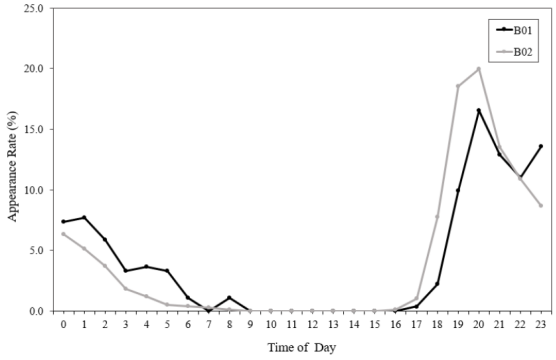

Fig. 4. Appearance rate of wild boars by time of day in B01 (n=272) and B02 (n=761). Camera trap data were gathered for 1 year from November 1, 2019, to October 31, 2020.

(Supplementary Table 1). The average number of appearances per month was 0.13 times in 2018, 0.1 times in 2019, 0.35 times in 2020, and 0.41 times in 2021, in all the years mentioned, compared to that in B02 (Supplementary Table 1, Fig. 3).

Daily activity

Camera trap data (272 photos in B01 and 761 photos in B02) taken for one year from November 1, 2019, to October 31, 2020, were analyzed to identify the daily activity of wild boars near the fence. Wild boars did not appear during the day time (9:00 a.m. to 4:00 p.m.) in the two sites near fenced areas (Fig. 4). However, wild boars appeared more frequently in B01 than in B02 from 11 p.m. to 6 a.m. and in B02 than in B01 from 5 p.m. to 9 p.m. The daily appearance patterns of wild boars were similar across the two sites separated by the fence (Fig. 4).

Implication of management

In B02, the number of wild boar appearances, which have been increasing since October 2018, decreased sharply in October 2020 and since then it has continued to exhibit a decreasing trend. In South Korea, ASF first occurred in a domestic pig fam in Paju-si on September 16, 2019, and the carcass of an ASFV-infected wild boar was discovered in Yeonchon-gun on October 2, 2019. Since then, wild boars have been hunted nationwide to prevent the spread of ASFV within their population. Nationwide activity to reduce the density of the wild boar population is likely to have affected the decline in wild boar numbers in Bukhansan National Park since October 2020, as shown in our study and the previous study (Choi et al. 2021).

Fences have been effective tools for reducing crop damage caused by wild animals because they inhibit the movement of wild animals (Hone and Atkinson 1983). In addition, fences make it possible to prevent human casualties by reducing the opportunities for contact between visitors and wild animals in urban national parks. In South Korea and other countries where ASF occurred, along with the removal of ASFV-infected carcasses and the reduction of the density of wild boars, fencing has been regarded as a powerful means for blocking the transmission of ASFV between wild boars or reducing the potential risk of ASFV-infection by restricting the movement of wild boars (EFSA 2014). In South Korea, 1,710 ASFV-infected sites were found in Gangwon-do, Gyeonggi-do, and northern Chungcheong-do by November 20, 2021. Three layers of fences were installed to avoid the southward spread of ASF. First, an electrical fence was installed within 1-2 km surrounding the site where ASFV-infected carcasses have been found; the second fence of a semi-rigid 1.5 m-high wire mesh was installed approximately 5-10 km around the electrical fence; and, finally, the third fence 250 km-long was built crossing from east to west, 20-30 km south of the second fence (Jo and Gortázar 2020; Kim et al. 2021).

Despite the installation of fences in such a large area, studies on the effectiveness of the installed fence and the duration of its effectiveness were relatively insufficient. According to the results of this study, the fence was very effective for 20 months after its installation. Maintaining a fence for a long time is likely to lead to habitat fragmenta-

tion through inhibiting the movement of other wild animals, including the endangered species - the long-tailed goral. As a pilot study, we suggest a 20-month retention period for the fences installed to block wild boars. To determine how long the blocking effect of the fences lasts, further studies are needed to also consider the length and height of the fence, and the conditions of the ground surface.

Acknowledgements

This work was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through Animal Disease Management Technology Development Program, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (320067-02-1-CG000) and Korea National Park Research Institute (Research Title: A Study on the Habitat Condition of Wild boars in National Park in the Urban Area).

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