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The potential negative impacts of the classical swine fever virus on wild boar population in Gifu prefecture, Japan

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ABSTRACT. There is a possibility that classical swine fever (CSF) virus outbreak has negative impacts on wild boar. To adequately manage native wild boar populations, wildlife managers need to gather the field data on wild boar and implement population management practices. We aimed to report the relative abundance index of wild boar before and after this outbreak. Our results showed that relative abundance index declined from 2017 (8.88 wild boars/100 trap days) to 2019 (2.03 wild boars/100 trap days), because of the negative impact of this virus and continuous culling programs. Although the eradication risk from the synergistic effect is low, wildlife managers need to consider the relationship between the trade-off between the risk of CSF and the conservation ecology risk of native species eradication.

KEY WORDS: camera trap survey, conservation ecology, population management, relative abundance index, swine industry

Conflicts between wild boars (*Sus scrofa*) and humans have been reported throughout the world, particularly the damage inflicted on agricultural crops [21] and humans [15]. In Japan, such problems have been occurring for the past several decades. In 2018, the damage to agricultural crops by wild boars in Japan was 4.7 billion yen [16], and 52–76 human injuries have been reported during 2016 and 2019 [18]. To mitigate such damage, wildlife managers have focused on damage management (i.e., fencing, capturing, and creating buffer zones) before now.

However, in September 2018, classical swine fever (CSF) was reported in Gifu Prefecture, central Japan, and CSF virus (CSFV) outbreaks were recorded in 62 pig farms in 12 prefectures and in 3,062 wild boars in 23 prefectures [17]. Regarding CSFV outbreaks in pig farms, previous studies have suggested that wild boar populations would contribute to CSFV spread [11, 12], and one study reported that wild boars are regarded as an indirect source of CSFV infection of domestic pigs in Germany [5]. To prevent serious negative consequences of CSFV originating from wild boar population on the swine industry, pig farmers started to conduct CSFV countermeasures in pig farms (i.e., improvement of biosecurity level), but it would also be necessary for wildlife managers to start implementing wild boar population management practices.

On the contrary, there is a possibility that CSFV outbreak have negative impacts on native wild boar populations as well. In a small-scale wild boar population in Gifu Prefecture, the relative abundance of boars showed a temporary drastic decline after the CSFV outbreak compared to that before the CSFV outbreak [10]. Similarly, the African swine fever virus (ASFV) also had a negative impact on the wild boar population in Poland [19]. However, few studies have compared the wild boar population size before and after CSFV and ASFV outbreaks. To adequately manage native wild boar populations during CSFV and ASFV outbreaks, wildlife managers need to gather the field data about their impacts on wild boar populations and besides implementing damage management practices, also implement population management practices. In the present study, we aimed to report the trend of the relative abundance index in large-scale wild boar populations before and after the CSFV outbreak.

A camera trap survey was conducted on 21 hunting meshes (5 km × 5 km; Fig. 1) in northern Gifu Prefecture during the period of from August 2017 to March 2020. As the first CSFV outbreak near the study area occurred in April 8, 2019 [7], we assumed that wild boar populations near the study area have been influenced by CSFV since April 2019. We found the signs of wild boar digging around all camera sites and set one infrared-triggered camera (HykeCam SP2, Hyke Inc., Asahikawa, Japan) on each mesh throughout the study period. The cameras recorded three photos per event and had a 5 min hibernation time between consecutive events. We conducted camera maintenance once every 3–6 months by checking the cameras, SD cards, and batteries.

Because there were several technical difficulties (i.e., camera thefts and malfunctions), survey efforts for each camera varied

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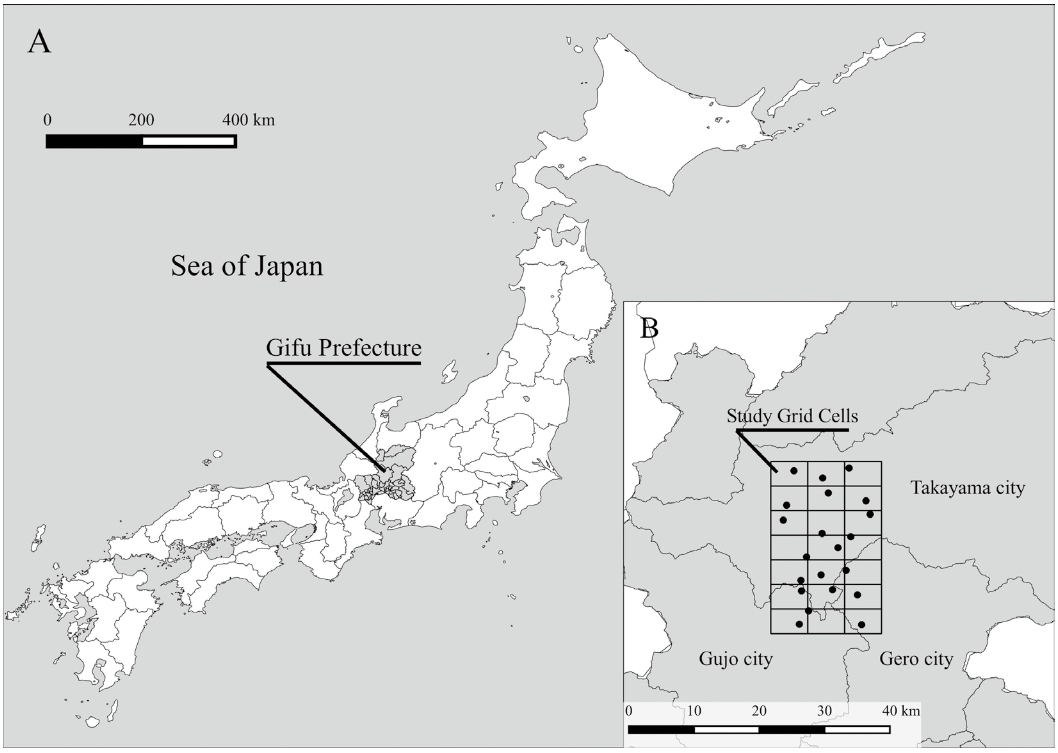

Fig. 1. Maps of the northern part of Gifu Prefecture in central Japan, showing the location of the 21 camera trap sites and study grid cells during the period of from August 2017 to March 2020. We made this map ourselves, using contour lines and roads from Geospatial Information Authority of Japan.

throughout the study period. To minimize the influence of different survey efforts on the results, we calculated the number of wild boars photographed per 100 trap days using the number of wild boars photographed and trap days for each camera. Thereafter, we excluded the data obtained in spring (April–June) for the following reasons:

(1) The results of relative abundance index (RAI) could be misinterpreted because of the photographic rates of piglets, as they are born during spring;

(2) During the spring, it is hard to distinguish whether wild boars were infected by CSFV, because first CSFV was reported in April 8, 2019.

In this study, thus, we calculated yearly RAI from July in year i (i=2017, 2018, and 2019) to March in year $i + 1$, resulting in the minimization of the seasonal influence on the results. To avoid overestimation of RAI, all photographs of wild boars taken within <1 hr were excluded from analysis following advice from a previous study [9]. To investigate the differences in the yearly RAI, we first used a generalized linear mixed model (GLMM) with a Poisson distribution in the R package lme4 [2]. Thereafter, we tested these differences using the multiple comparison test in the R package multcomp [8]. We set the total number of wild boars photographed for each year and camera as the response variable, the year as the explanatory variable, each camera as a random factor, and the trap days for each year and camera as offset terms. All statistical analyzes were performed using R version 3.4.0 [20].

We recorded 699 wild boars from 13,568 camera trap days during the period from August 2017 to March 2020. The yearly RAI in 2017 was 8.88 wild boars/100 trap days, which was higher than that in 2018 (4.83 wild boars/100 trap days; Z=−5.82, P<0.001) and that in 2019 (2.03 wild boars/100 trap days; Z=–10.02, P<0.001) (Fig. 2). In addition, the yearly RAI in 2018 was higher than that in 2019 (Z=−5.76, P<0.001) (Fig. 2).

Therefore, our results showed that wild boar population size in this study area declined from 2017 to 2019. In our twenty-one survey meshes, the number of wild boars culled in 2017, 2018, and 2019 was 279 and 282, and 93, respectively, and thus population decline in this area might be attributed to culling programs. In target survey meshes, the number of wild boars culled during 2014, 2015, and 2016 varied greatly (516, 146, and 185, respectively), while sighting per unit effort, which is one of the population indexes, was 0.19/day, 0.08/day, 0.15/day, and 0.23/day during 2014, 2015, 2016, and 2017, respectively [6]. In these meshes, in addition, yearly total number of hunting days, which regarded as hunting efforts, were 643, 606, 628, and 699 during 2014, 2015, 2016, and 2017, respectively [6]. Thus, in the study area, it would be difficult to reduce population size of wild boar only by culling and stable hunting efforts, and there is a possibility that the observed population decline was related to synergistic effect of continuous hunting activity and other factors (i.e., CSF epidemic and heavy snow).

In Gujo city, Gero city, and Takayama city, including our study area, 204 of 386 wild boars were infected by CSFV during

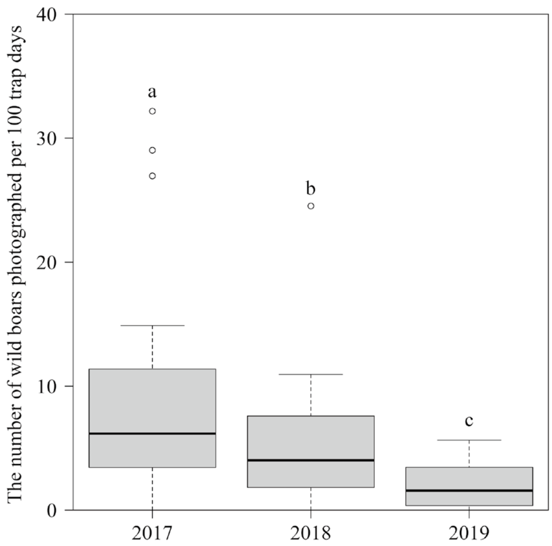

Fig. 2. The yearly relative population indexes (the number of wild boars photographed per 100 trap days) during the period of from August 2017 to March 2020 in northern Gifu Prefecture, Japan. Different letters indicate that there are significant differences in the relative population indexes.

April 2019 and March 2020 (CSFV positive rate: 52.8%) [7], and CSFV had a negative impact on the wild boar population. This result supported to the result of previous study in a small-scale wild boar population [10]. On the contrary, there is a possibility that this drastic decline can be attributed to the synergistic effect of CSFV and continuous culling programs, because 279 and 282 wild boars were culled during 2017 and 2018, respectively. A previous study in Korea showed that it is not clear whether wild boar population decline should be attributed to ASFV or to the culling programs because there was no information on wild boar monitoring data before the ASFV outbreak [14]. Thus, by monitoring the population dynamics before the CSFV outbreak, wildlife managers could evaluate the impacts of CSFV and ASFV on wild boar populations. Further studies are required to distinguish between the impact of CSFV and the impact of culling programs on the wild boar population.

In conclusion, our results showed the negative impact of CSFV on a large-scale wild boar population. To prevent CSFV outbreaks in pig farms in Japan, wildlife managers promote intensive culling programs to decrease wild boar population size, as these populations are sources of infection, and they provide CSFV oral vaccine to enhance the rates of natural immunity [11]. In the future, it would be necessary to focus on wild boar population management, because the population size of susceptible individuals is an important factor in virus transmission [1].

In this study, the synergistic effect of CSFV and continuous culling programs would lead to drastic decline in wild boar populations. On the other hand, previous reports concluded that it is difficult to manage wild boar population from an exhaustive culling or vaccination strategy, because of highly dynamics for this species, and that it is not efficient for hunting to control CSF [3]. Thus, although the eradication risk from the synergistic effect is low, wildlife managers need to consider the trade-off between the risk of CSF and the conservation ecology risk of native species eradication. Therefore, it would be necessary to implement population management measures to conserve the studied native species and mitigate the conflict between humans and wild boars. Consequently, wildlife managers should continuously study several population indexes (i.e., by hunting and camera trap surveys) and establish the monitoring system used before CSFV outbreaks.

Recently, ASF cases have been reported in Asian countries [4], and previous studies have suggested that the potential risk of ASFV outbreaks and spread might be related to the distributions and habitats of wild boar populations [13, 22]. Thus, the staff of wildlife and swine industry need to continuously obtain information on wild boar distribution, properly control the number of wild boars culled, and change the biosecurity level at farms in accordance with wild boar distribution. Finally, these programs would result not only in the suppression of CSFV and ASFV, but also in the conservation of the native species.

CONFLICT OF INTEREST. The authors declare that they have no conflict of interest.

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