POPULATION DYNAMICS OF WILD BOAR (*Sus scrofa*) BASED ON CAMERA TRAP RELATED TO AFRICAN SWINE FEVER CASES IN BUKIT BARISAN SELATAN NATIONAL PARK

Undergraduate Thesis

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ABSTRACT

POPULATION DYNAMICS OF WILD BOAR *(Sus scrofa)* BASED ON CAMERA TRAP RELATED TO AFRICAN SWINE FEVER CASES IN BUKIT BARISAN SELATAN NATIONAL PARK

Citara Febriana Setiawati

Wild boar (*Sus scrofa*) is a key prey species for the sumatran tiger, with a wide distribution, including the Intensive Protection Zone (IPZ) of Bukit Barisan Selatan National Park (BBSNP). However, infectious diseases pose a threat to wild boar populations. In 2019, African Swine Fever (ASF) affected both domestic and wild pig populations in Indonesia, resulting in over 250 confirmed cases: 85% in domestic pigs, 14% in wild boars, and 1% in bornean bearded pigs. The impact of ASF on wild boars in natural habitats remains poorly understood. This study analyzed wild boar population dynamics during the ASF epidemic (2015, 2019, and 2022) using camera traps in the IPZ, under the BBSNP program in collaboration with WCS-IP. Independent Event (IE) and Relative Abundance Index (RAI) were calculated using RStudio to assess abundance and presence levels. Results showed significant population dynamics ($p < 2.2e\text{-}16$). In 2015, wild boars were relatively abundant (RAI = 3.53; IE = 310), with abundance increasing in 2019 (RAI = 11.8; IE = 1093) before declining sharply in 2022 (RAI = 0.76; IE = 52). These fluctuations are likely influenced by the ASF epidemic. Further monitoring and conservation efforts are essential to protect wild boars as critical prey species in their habitat.

Keywords: wild boar (*Sus scrofa*), dynamics population, African Swine Fever (ASF), camera trap, Bukit Barisan Selatan National Park

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LETTER OF AUTHENTICITY OF UNDERGRADUATE THESIS

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Is truly and entirely my own work, created in accordance with the applicable norms and academic ethics. Furthermore, I do not object to the use of some or all of the data from this undergraduate thesis by faculty members and/or the study program for publication purposes, provided that my name is mentioned.

If it is later proven that my statement is untrue, I am willing to accept academic sanctions, including the revocation of my bachelor's degree, as well as legal consequences.

Bandar Lampung, January 23, 2025

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CURRICULUM VITAE

The author, whose full name is Citara Febriana Setiawati, is the third of four siblings, born to the late Mr. Maryono and Mrs. Sunarsih. She was born in Pulung Kencana on February 19, 2002. The author completed her elementary education at SDN 01 Pulung Kencana in 2008, then continued her education at SMPN 01 Tumijajar in 2014, and later attended SMA S Al Kautsar Bandar Lampung, graduating in 2020. In 2020, the author continued her studies at the University of Lampung through the Joint Entrance Selection for State Universities, enrolling in the Biology Department, Faculty of Mathematics and Natural Sciences.

During her studies, the author participated in student organizations, specifically the Biology Student Association (BSA) and became a member of the management team for the 2021-2022 period as part of the Secretariat and Logistics Bureau. From January 4 to February 10, 2023, the author carried out a Field Internship at Bukit Barisan Selatan National Park (BBSNP) under the program of the Bukit Barisan Selatan National Park Authority in collaboration with the Wildlife Conservation Society-Indonesia Program (WCS-IP) Bukit Barisan Selatan Landscape. The internship was titled **“Techniques for Processing Ungulate Wildlife Data Captured by Camera Traps in the Intensive Protection Zone (IPZ) in 2019 at Bukit Barisan Selatan National Park”**. The author also real work study from July 1 to August 14, 2023, in Sinar Gunung Village, Tebat Karai Subdistrict, Kepahiang Regency, Bengkulu Province. The author has also participated in international seminars as an oral presenter at the International

Conference on Medical Science and Health (ICOMESH) organized by the Faculty of Medicine, University of Lampung on August 07, 2024.

During the seventh semester of her studies, the author participated in the Conservation Camp Program (CCP) organized by BBSNP in collaboration with WCS-IP Bukit Barisan Selatan Landscape from October 22-28, 2023, at the Way Canguk Research Station. The CCP activity was conducted as an introduction and preliminary survey for the research to be carried out. From January to August 2024, the author conducted research at BBSNP under the BBSNP program, in collaboration with WCS-IP Bukit Barisan Selatan Landscape, and wrote a thesis titled **"Population Dynamics of wild boar *(Sus scrofa*) Based on Camera Trap Related to African Swine Fever Cases in Bukit Barisan Selatan National Park"** which serves as one of the requirements for completing her studies in the Biology Department, Faculty of Mathematics and Natural Sciences, University of Lampung.

بسم الله الرحمن الرحيم

I dedicate this work with deep gratitude to:

My mother, my late father, my older sibling, and my younger sibling, who have never stopped providing encouragement, prayers, sincere love, and always accompanied me every step of the way. Without you, I am nothing and no one.

MOTTO

“Allah does not burden a soul beyond what it can bear.”
(Q.S. Al-Baqarah: 286)

“Indeed, with hardship comes ease.”
(Q.S. Al-Insyirah: 6)

“Live it, Be grateful for it, Enjoy it”

” Dream in life, don't live in a dream”
Andrea Hirata

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This thesis, titled **"Population Dynamics of Wild Boar *(Sus scrofa*) Based on Camera Trap Related to African Swine Fever Cases in Bukit Barisan Selatan National Park"** is a requirement for obtaining a Bachelor of Science degree from the University of Lampung.

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Bandar Lampung, January 23, 2025
Author

Citara Febriana Setiawati

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I. INTRODUCTION

1.1. Background

The wild boar (*Sus scrofa*) is a primary prey species for the sumatran tiger (*Panthera tigris sumatrae*) (Foulton *et al.,* 2022). It is categorized as Least Concern by the IUCN Red List of Threatened Species. Wild boars are distributed across Europe, North Africa, the Mediterranean region (including the Atlas Mountains of Central Africa), and Asia, extending to the southern regions of Indonesia (Lekagul and McNelly, 1988). These animals are highly adaptable to various ecosystems and environmental conditions, allowing them to thrive across diverse habitats. Despite significant hunting pressures, particularly in East and Southeast Asia, global wild boar populations remain robust (IUCN, 2019). However, threats to wild boars include poaching, habitat degradation, and vulnerability to infectious diseases that can significantly reduce their populations.

In 1909, an infectious disease affecting swine populations was first recorded in Kenya (Gallardo *et al*., 2015). This disease, known as African Swine Fever (ASF), is caused by a virus from the Asfarviridae family. The ASF is a hemorrhagic fever with mortality rates nearing 100%, leading to death within 6–13 days of infection (OIE, 2018). Transmission of the ASF virus can occur through direct contact with infected body fluids, such as saliva, respiratory secretions, urine, and feces, or indirectly via contaminated objects, including vehicles, food, and waste materials (Sendow *et al*., 2020).

ASF outbreaks can significantly reduce wild boar populations in their natural habitats (Baitri and Rambe, 2022). In Indonesia, ASF was first reported in North Sumatra in 2019 (Araujo *et al*., 2023).

According to data from FAO, OIE, and mass media, 279 confirmed cases of ASF were documented (OIE, 2021b). These cases were reported not only in North Sumatra but also in Bali, East Nusa Tenggara, West Java, and Papua as of 2021.

ASF outbreaks among wild boars have been recorded not only in domestic pigs but also in wild populations, with mortality rates reaching 100% (OIE, 2018). In Southeast Asia, ASF-related wild boar deaths were reported in Laos, Vietnam, and Malaysia during 2019 (Denstedt *et al.*, 2020; Promed, 2021).

Among the 279 ASF cases reported in Indonesia, approximately 85% involved domestic pigs, 14% wild boars (*Sus scrofa*), and one case involved a Bornean bearded pig subspecies (*Sus barbatus barbatus*). Notable ASF-related wild boar fatalities occurred in West Sumatra in 2019, North Sumatra and Riau in 2020 (including within Batang Gadis National Park and Bukit Tigapuluh National Park), and Kerinci Seblat National Park in 2021. Testing conducted at the Bengkulu Veterinary Center confirmed ASF-positive results in 12 deceased wild boars from Kerinci Seblat National Park (Santosa, 2021).

If not addressed promptly, ASF cases may result in the widespread transmission of the virus to both domestic and wild boars. A significant potential impact of ASF is a decline in wild boar populations within natural habitats, which could subsequently affect apex predators like the sumatran tiger. A reduction in wild boar populations could have cascading effects on sumatran tiger populations in conservation areas, such as Bukit Barisan Selatan National Park (BBSNP).

Bukit Barisan Selatan National Park, located in Lampung, is a key conservation area. The BBSNP collaborates with wildlife conservation organizations, such as the Wildlife Conservation Society-Indonesia Program

(WCS-IP), to monitor animal populations using camera traps. The BBSNP area is home to 122 mammal species, including wild boars (WCS BBSNP, 2010).

Wild boars are particularly abundant within the Intensive Protection Zone (IPZ) of BBSNP, an area established in 2015 through collaboration between local communities, regional governments, and conservation stakeholders. The IPZ spans 1,000 km² and includes seven resorts: Sukaraja, Pemerihan, Ngambur, Biha, Balai Kencana, Balik Bukit, and Suoh. This zone prioritizes the protection of critical species, including the sumatran rhinoceros (*Dicerorhinus sumatrensis*), sumatran elephant (*Elephas maximus sumatranus*), and sumatran tiger, alongside their prey species. Since 2015, camera trap monitoring in central BBSNP, overlapping 51% of the IPZ, has been implemented to safeguard endangered wildlife and monitor prey populations (Pusparini *et al*., 2018).

Limited studies have been conducted on the impact of ASF outbreaks on wild boar populations in Indonesia. Monitoring wild boar populations through camera traps in conservation areas, such as BBSNP, is essential to understanding population dynamics during ASF outbreaks.

1.2. Research purpose

The objectives of this research are:

1. To know dynamics of wild boar population based on camera data IPZ BBS trap in 2015 (prior to ASF), 2019 (ongoing ASF occurs), and 2022 (post ASF occurs).
2. To know relatedness dynamics of wild boar population as prey potential sumatran tiger with ASF cases in Indonesia.

1.3. Benefits of research

This project is expected to yield data and information about wild boar populations. Regarding the dynamics of the wild boar population during the pandemic, ASF-based camera traps can be used as a reference for tiger conservation efforts in BBSNP and disease spread in animals.

1.4. Framework

The wild boar (*Sus scrofa*) is a mammal belonging to the Artiodactyla order (even-toed ungulates) and serves as a key prey species for the sumatran tiger (*Panthera tigris sumatrae*). The presence and population dynamics of wild boars have a functional impact on the survival of the sumatran tiger, as the availability of prey is a critical factor influencing tiger conservation. A stable wild boar population helps maintain the ecological balance and supports the conservation of the critically endangered sumatran tiger. Bukit Barisan Selatan National Park (BBSNP) is a biologically rich conservation area hosting diverse mammal species, including the wild boar. Wild boars are frequently observed in the BBSNP, particularly in the Intensive Protection Zone (IPZ), where periodic monitoring of sumatran tigers and their prey is conducted using camera traps.

Since the outbreak of the African Swine Fever (ASF) epidemic in Indonesia in 2019, numerous ASF cases have been reported, including those within conservation areas such as national parks. In 2021, wild boar fatalities suspected to be caused by ASF were documented in Kerinci Seblat National Park in Bengkulu. Laboratory tests conducted by the Bengkulu Veterinary Center confirmed ASF as the cause of death in 12 wild boars (Santosa, 2021). The ASF virus has since spread extensively throughout Bengkulu Province, from Mukomuko Regency to the Bengkulu-Lampung border. Reports of sudden wild boar deaths in these areas were submitted to the Bengkulu Natural Resources Conservation Agency (BKSDA) (Media Indonesia, 2021). However, there remains limited information regarding the current population status of wild boars in national parks and other conservation areas.

The northern boundary of BBSNP directly borders Bengkulu, raising concerns about the potential transmission of the ASF virus to wild boars in the BBSNP area due to its rapid spread. In efforts to conserve sumatran tigers within BBSNP, it is crucial to gather information on their prey species, particularly wild boars, which represent a significant component of the tigers diet. Understanding changes in wild boar populations before, during, and after the ASF outbreak is essential to evaluate the impact of the disease on prey availability and inform future conservation strategies. This research can also provide insights into managing ASF cases to ensure the continued existence of the sumatran tigers prey species.

II. LITERATURE REVIEW

2.1. Wild boar biology

Wild boar (*Sus scrofa*) is an animal that is classified as Artiodactyla are even-toed ungulates. Characteristics morphology wild boar in general is the whole body is covered by colored hair black brownish (Figure 1) and in the section the tail no hairy. New wild boar born own hair on the body colored chocolate dark with white line elongated longitudinally (Figure 2) along the length body (Lekagul and McNeely, 1988). Wild boars weigh up to 200 kg in adult males and have a body length of up to 1.8 m (Utami *et al*., 2012).

Figure 1. Wild boar caught camera trap (Source: BBSNP and WCS-IP).

Figure 2. Young wild boar (Source: pxhere.com).

Wild boars are notable for possessing five pairs of mammary glands and canine teeth that lack roots, allowing for continuous growth, particularly in males. These canine teeth, both upper and lower, can grow in a curved manner, serving as a defensive mechanism against predators (Lekagul and McNelly, 1988).

In Indonesia, several species of wild boars can be observed. The Javan wild boar (*Sus verrucosus*) is endemic to Java Island and inhabits the lowlands of Java, Madura, and Bawean. This species is distinguished by three pairs of warts located on the lower part of the face: at the corner of the jaw, beneath the eyes, and on the snout, which are prominent in adult males (Figure 3). Another notable species is the bearded pig (*Sus barbatus*), found across the Malay Peninsula, Sumatra, and Kalimantan. The bearded pig is characterized by a distinctive beard on the lower part of its snout (Figure 4) (Riyandi, 2012). Additionally, the babirusa (*Babyrousa babyrousa*) is endemic to Sulawesi and is known for its unique canine teeth, which grow continuously and can eventually penetrate the facial skin (Figure 5) (Zainuri *et al*., 2022).

Figure 3. Javan wild boar (Source: Biolib.cz)**.**

Figure 4. Bearded pig (Source: National Geographic Indonesia)**.**

Figure 5. Babirusa (Source: idntimes.com).

Wild boar classification according to Lekagul and McNelly (1988) are as following:

Kingdom	: Animalia
Phylum	: Chordata
Class	: Mammalia
Order	: Artiodactyla
Family	: Suidae
Genus	: *Sus*
Species	: *Sus scrofa* (Linnaeus, 1758)

According to the IUCN (2019), wild boars are categorized as "Least Concern," indicating a low risk of extinction. This status reflects their abundant population and minimal conservation concerns. Wild boars exhibit high abundance, tolerance to habitat disturbance, and are prevalent in conservation areas (Keuling and Leus, 2019).

The habitat of wild boars ranges from lowland to mountainous forests. They prefer lowland plains with secondary forest vegetation, characterized by a large area with a mix of trees and dense bush thickets (Payne *et al*., 2000). Wild boars are commonly found in dense forests with wet soil, such as swamp edges.

Wild boars are terrestrial animals that live entirely on the ground. In their natural habitat, wild boars form groups, with a single group potentially consisting of up to 20 individuals, including females and their offspring. Males are typically solitary except during the mating season (Lekagul and McNelly, 1988). Wild boars are usually active in the morning and evening for foraging but can become nocturnal if disturbed or threatened by predators (Lekagul and McNelly, 1988).

Wallowing is a behavior exhibited by wild boars, involving the smearing of mud on their bodies. This activity serves multiple purposes, including protection from flies, temperature regulation, cleansing of ectoparasites, and sexual signaling, such as competition among males (Albert *et al*., 2014). Wild boars also display anti-predator behaviors to avoid predators. These behaviors include fleeing to maintain a safe distance from potential predators, keeping a distance in shaded areas, and monitoring predators to assess the risk of attacks and expulsions (Rustiati, 2010). Another anti-predator behavior is mobbing, an aggressive behavior aimed at protecting the group, offspring, and nests, thereby safeguarding their young and diverting predator attention (Rustiati, 2010; Vaughan *et al*., 2000).

Wild boars are omnivorous animals. Their diet includes mushrooms, fruits, seeds, tubers, earthworms, and small vertebrates (Junaidi *et al*., 2012). Although their vision is not exceptional, wild boars possess an excellent sense of smell, leading to behaviors such as sniffing and scratching the ground in search of food (Riyandi, 2012).

Wild boars can reproduce at a young age and have a high reproductive rate. Female wild boars begin reproducing at 8-10 months, with some starting as early as six months. The average gestation period is 140 days, with each litter consisting of 4-8 individuals (Nowak and Paradiso, 1983). The lifespan of wild boars can reach up to 20 years, with an average of 10-12 years (Lekagul and McNelly, 1998).

The presence of wild boars in conservation areas significantly influences the survival of the sumatran tiger. Wild boars serve as a potential prey for the sumatran tiger, and the carrying capacity of the environment, particularly the food source, is crucial for the tiger population (Kemal *et al*., 2022). Adequate food sources in a habitat ensure the continued existence of the sumatran tiger.

2.2. African Swine Fever (ASF)

African Swine Fever (ASF) is a viral disease that affects pigs, commonly known as African swine fever. The ASF virus is a double-stranded DNA virus belonging to the Asfarviridae family, genus Asfivirus (Bulu, 2022). This virus causes hemorrhagic fever and high mortality rates in both domestic pigs and wild boars, with death occurring 2-10 days post-infection (Nugraha *et al*., 2022). The first reported case of ASF was in Kenya in 1909 (Gallardo *et al*., 2015), and it has since spread to Asia, including Indonesia in 2019 (Gelolodo *et al*., 2021).

In Indonesia, the first official announcement of an ASF outbreak was made in the Decree of the Minister of Agriculture Number 820/KPTS/PK.320/M/12/2019, declaring an outbreak in North Sumatra. Following this incident, ASF cases were also reported in Bali. In early 2020, a significant number of pig deaths occurred in Malaka Regency, East Nusa Tenggara, attributed to ASF originating from Timor-Leste (Toha *et al.*, 2021). The transmission of ASF can occur through bites from ticks (*Ornithodorus* sp.) infected with the ASF virus (Boinass *et al.*, 2011).

ASF is not a zoonotic disease and poses no risk to human health. The ASF virus can survive for extended periods in blood, feces, and body tissues (Sendow *et al*., 2020). The clinical symptoms of ASF in pigs manifest in four forms: peracute, acute, subacute, and chronic. These symptoms vary depending on the virulence of the infecting strain, the pigs breed, and its immune status. Generally, wild boars are more susceptible to ASF virus infection and may not exhibit typical clinical symptoms but can act as carriers of the virus (Cabezón *et al.*, 2017).

The peracute form of ASF results in sudden and rapid death. Acute ASF symptoms include high fever (40.5-42ºC), anorexia, lethargy, cyanosis, incoordination, increased pulse and respiratory rate, erythema around the ears and body, diarrhea, vomiting, coughing, and shortness of breath (Chenais *et al.*, 2017; Sánchez-Vizcaíno *et al.*, 2015). Pigs infected with the subacute form of ASF typically exhibit mild fever, loss of appetite, and depression. Chronic ASF symptoms include loss of appetite, absence of fever, rapid breathing, skin necrosis, chronic skin ulcers, and joint swelling (Balyshev *et al.*, 2018).

The mortality rate of ASF varies depending on the disease form. Peracute ASF has a mortality rate of up to 100%, with death occurring 1-3 days post-infection. The acute form has a mortality rate of nearly 100% after 6-13 days post-infection. The subacute form results in a 30-70% mortality rate after 7-20 days post-infection, and the chronic form has a lower mortality rate of 30% after 14-21 days post-infection (Primatika *et al.*, 2021).

Transmission of the ASF virus between wild boars and domestic pigs can occur through the disposal of infected carcasses, contaminated food remains, or interactions between hunters and domestic pigs. The ASF outbreaks in Indonesia have threatened the domestic pig population, causing high mortality rates (Rinca *et al.*, 2023). The rapid transmission of the ASF virus in infected pigs poses a significant threat to wild pig populations, particularly wild boars.

Wild boars are a potential prey for the sumatran tiger, and their presence influences the tiger's survival. Conservation efforts for the sumatran tiger include monitoring prey populations, such as wild boars in BBSNP area. The BBSNP, in collaboration with WCS-IP, conducts monitoring activities to assess the sumatran tiger population in the BBSNP area using camera traps. As a priority conservation species with an extensive exploration range, monitoring the sumatran tiger also covers other animals, including wild boars as potential prey. In this context, monitoring changes in the wild boar population during an ASF epidemic can provide valuable data and information on population dynamics.

2.3. Camera Traps and Monitoring Animals in BBSNP

A camera trap (Figure 6) is a tool that has motion sensors and heat sensors that can record the presence of wild animals in an area. Diversity of animal species and monitoring population can also be identified by using camera traps. Camera traps are specially designed and used for inventory and studying wildlife behavior, and can work automatically if they detect the presence of animals (Mustari *et al*., 2015).

Figure 6. Camera traps and their parts (Source: Bushnell©).

One of the key advantages of using camera traps is the ability to conduct observations continuously for 24 hours without the need for physical presence in the area. This method is more efficient and safer compared to direct observations and is less likely to disturb animals in their natural habitat due to the small size of the cameras (Putri *et al*., 2017).

Monitoring wildlife, particularly the sumatran tiger, is crucial for preservation and conservation efforts in their natural habitats. The current lack of data, information, and supporting technology for monitoring the sumatran tiger hinders effective conservation efforts (Riansyah, 2007). One effective approach is the implementation of camera trap techniques to record and monitor the distribution of sumatran tigers (Andreas, 2016). This monitoring method using camera traps was first implemented in Gunung Leuser National Park and later in BBSNP (Griffiths and van Schaik, 1993; O'Brien *et al*., 2003).

Sumatran tiger monitoring using camera traps in BBSNP began in 1998-1999 (O'Brien *et al*., 2003) and was resumed in the southern part of BBSNP in 2002 (Wibisono, 2005; Pusparini *et al*., 2017). In 2012 and 2018, camera trap installations in BBSNP were conducted by Luskin *et al*. (2017). Additionally, camera trap installations were carried out in the Intensive Protection Zone (IPZ) area in 2015, 2019, and 2022, with the primary objective of monitoring the presence of sumatran tigers. The sumatran tiger is a priority species and serves as an umbrella species due to its extensive exploration range. Therefore, efforts to protect the sumatran tiger also contribute to the conservation of the natural ecosystem and the biodiversity within it, including the wild boar, which is a potential prey for the sumatran tiger (Haidir *et al*., 2017).

2.4. Bukit Barisan Selatan National Park

Bukit Barisan Selatan National Park (BBSNP) is one of the national parks in Lampung. The BBSNP area has an area of ± 3 13572.48 ha stretching from the southern tip of the western part of Lampung to the south of Bengkulu (Figure 7) (BBSNP and WCS- IP, 2020).

Geographically, BBSNP is located at 4º29'-5º57'S and 103º24'-104º44'E with the following area boundaries:

1. North : Kaur Regency
2. East : West Lampung Regency
3. South : Sunda Strait
4. West : Indian Ocean

(WCS.org BBSNP, 2010)

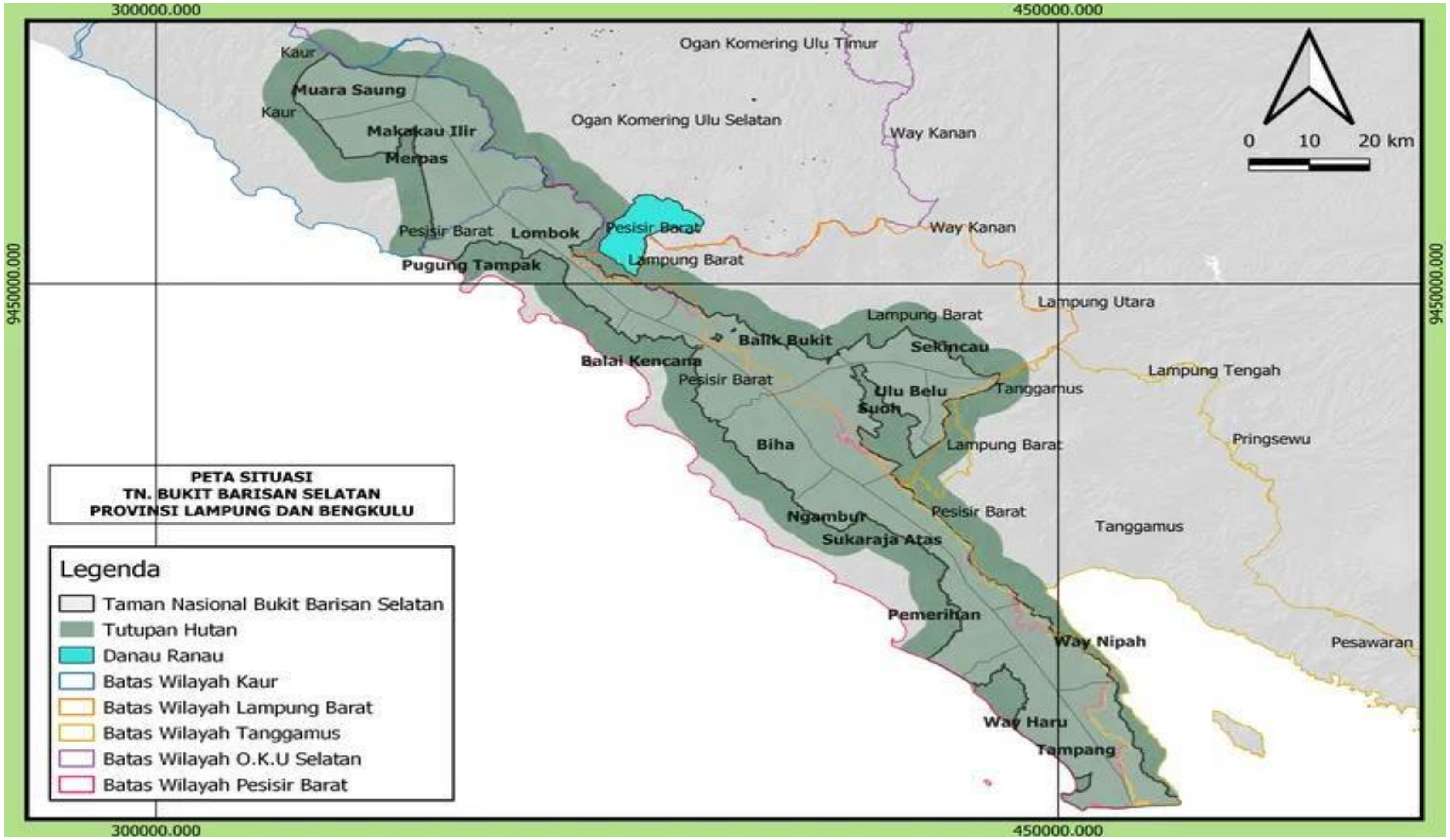


Figure 7. Map of the Bukit Barisan Selatan National Park area (Data source: BBSNP and WCS-IP).

The BBSNP area features a diverse landscape with altitudes ranging from 0 to 196.4 meters above sea level. The ecosystems within BBSNP include beach forests, lowland plains forests, mangrove forests, and mountain forests. This variety of ecosystems makes BBSNP a habitat for numerous species of flora and fauna (WCS.org, BBSNP, 2013).

The flora found in BBSNP includes Rafflesia, the largest rare flower in the world, and the corpse flower (*Amorphophallus* spp.), the tallest flower in the world. Additionally, the park is home to 514 species of trees and undergrowth, 126 species of orchids, 26 species of rattan, and 25 species of bamboo.

The BBSNP is home to 122 mammal species, including six endangered species listed on the IUCN Red List of Threatened Species: the sumatran elephant (*Elephas maximus sumatranus*), sumatran rhinoceros (*Dicerorhinus sumatrensis*), malayan tapir (*Tapirus indicus*), sumatran tiger (*Panthera tigris sumatrae*), sun bear (*Helarctos malayanus*), and dhole (*Cuon alpinus*). The park also hosts 123 species of herpetofauna (reptiles and amphibians, including turtles), 53 species of fish, 221 species of insects, and 450 species of birds, including nine species of hornbills (WCS.org, BBSNP, 2010).

Bukit Barisan Selatan National Park has implemented a management policy aimed at protecting habitats and enhancing the population of the sumatran rhinoceros. A key component of this policy is the development of the Intensive Protection Zone (IPZ). The establishment of the IPZ is a collaborative effort between BBSNP and various stakeholders, including local communities, regional governments, and other relevant parties. The IPZ is designed to provide intensive protection for the sumatran rhinoceros and its habitat, with additional monitoring efforts for other priority species such as the sumatran elephant and the sumatran tiger. The IPZ encompasses seven resorts, which serve as the smallest management units and are at the forefront of conservation efforts in the area.

The development of the IPZ policy has been implemented across seven resort areas within BBSNP: Sukaraja Atas Resort, Ngambur Resort, Pemerihan Resort, Biha Resort, Balai Kencana Resort, Balik Bukit Resort, and Suoh Resort (Pusparini *et al*., 2018). Through these resorts, forest protection and security within the IPZ are systematically enforced using the SMART (Spatial Monitoring and Reporting Tools) patrol application. In its conservation activities, BBSNP collaborates with local community institutions involved in wildlife preservation, such as the Wildlife Conservation Society - Indonesia Program (WCS-IP).

III. RESEARCH METHODS

3.1. Time and Place of Research

The research titled "Population Dynamics of wild boar (*Sus scrofa*) based on Camera Trap Data Related to African Swine Fever Cases in Bukit Barisan Selatan National Park" was conducted from January to August 2024 in Bukit Barisan Selatan National Park (BBSNP). This study was part of a program by the Bukit Barisan Selatan National Park in collaboration with Wildlife Conservation Society-Indonesia Program (WCS-IP). Data collection, processing, and analysis were carried out from January to February 2024, followed by data interpretation.

The data used in this study consisted of photographic records from camera traps installed in the Intensive Protection Zone (IPZ) (Figure 8) in 2015, 2019, and 2022 by BBSNP and WCS-IP, with the primary objective of monitoring the sumatran tiger population in BBSNP. Camera traps were installed across 65 grids, each measuring 3x3 km^2, covering five resorts: Biha Resort (10 grids), Suoh Resort (11 grids), Ngambur Resort (17 grids), Sukaraja Atas Resort (17 grids), and Pemerihan Resort (6 grids). Additionally, four grids were located in the protection forest bordering BBSNP, under the jurisdiction of the Lampung Forestry Office.

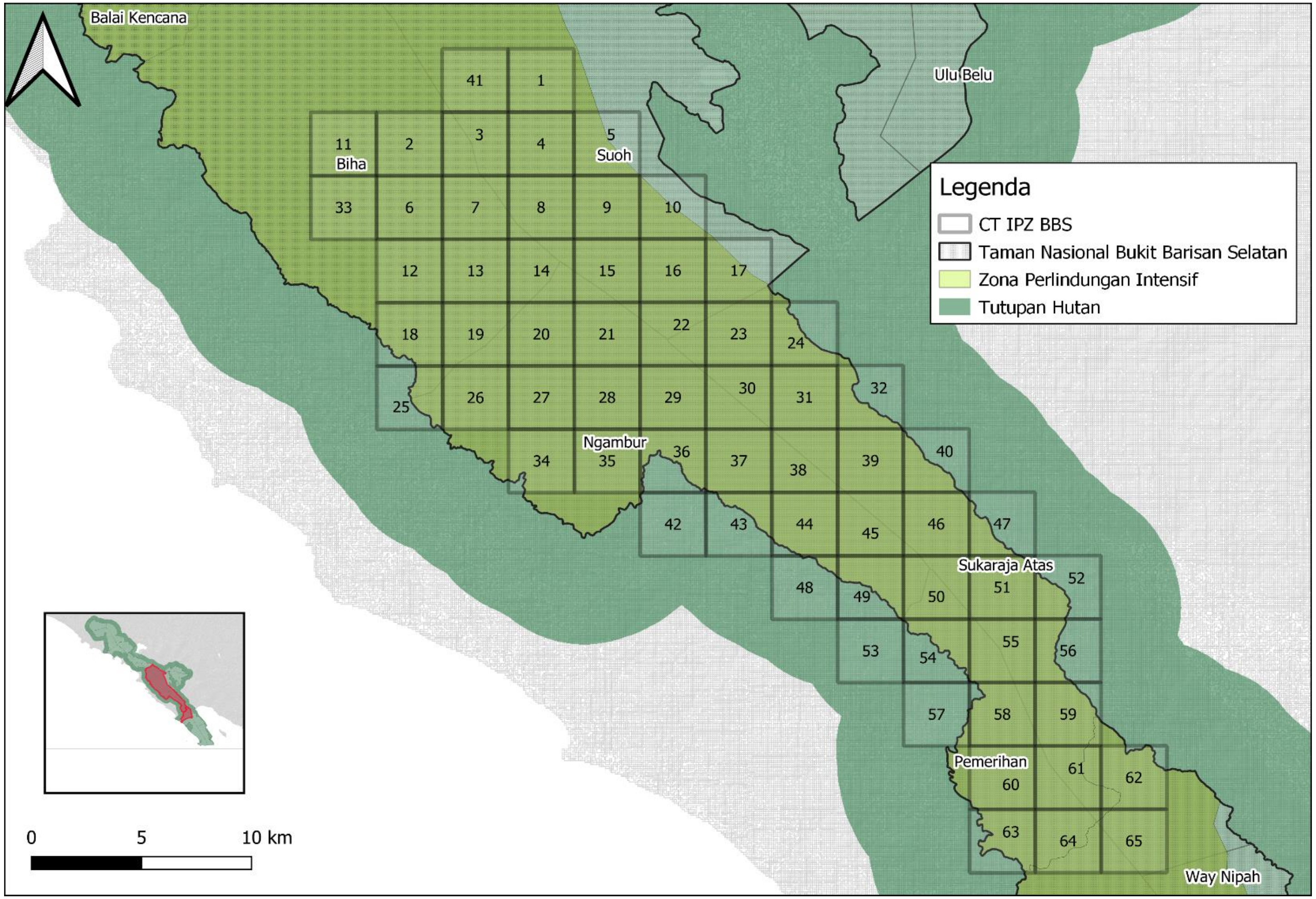


Figure 8. Grid of camera trap installations in the IPZ area in 2015, 2019, and 2022 (Data source: BBSNP and WCS-IP).

The camera trap installation in 2015 was conducted from May 21 to November 20, 2015. In 2019, the camera trap installation was carried out in two phases: Phase I from May 21 to May 30, 2019, at Sukaraja Atas Resort, Pemerihan Resort, and Ngambur Resort, and Phase II from June 26 to July 6, 2019, at Ngambur Resort, Biha Resort, and Suoh Resort. In 2022, camera trap installation was also conducted in two phases: Phase I from May 28 to June 5, 2022, and Phase II from July 19 to July 30, 2022.

The camera traps were installed in pairs within each grid, totaling 130 cameras. The cameras were positioned facing each other and installed at a height of approximately 45 cm from the ground (Figure 9) to capture recordings of tiger stripes from both sides. The distance between the cameras was about 4-5 meters from active animal tracks, positioned perpendicularly to the animal tracks (WCS-IP, 2022).

Figure 9. Installation of camera traps in IPZ, BBSNP (Source: BBSNP and WCS-IP 2022).

3.2. Tools and materials

The tools used in this study were Bushnell Tropy Cam and Reconyx type camera traps. The cameras used to record and capture images of animals crossing the installation area. Memory card in camera trap used to store data captured animal cameras, and laptops are used as tools for processing and analyzing data. The RStudio application is used for data processing and analysis.

The materials used in this study were photos of wild boar caught in camera traps installed in IPZ, BBSNP in 2015, 2019 and 2022.

3.3. Research Progress and Work

The research titled "Population Dynamics of wild boar (*Sus scrofa*) based on Camera Trap Data Related to African Swine Fever Cases in Bukit Barisan Selatan National Park" was conducted in four stages as follows:

1. **Administration**

   The paper works began with submitting a letter of introduction and permission to conduct the study from the Department of Biology to the Faculty of Mathematics and Natural Sciences. This was followed by submitting the letter to the BBSNP and WCS-IP to obtain a research recommendation letter. Upon receiving the recommendation letter, the next step was to acquire the Conservation Area Entry Permit (SIMAKSI). This process involved presenting/exposing the research proposal and topic, "Population Dynamics of wild boar (*Sus scrofa*) based on Camera Trap Data Related to African Swine Fever Cases in Bukit Barisan Selatan National Park" at the BBSNP and the WCS-IP Kotaagung office. Following the presentation, the SIMAKSI, research pernit was issued by BBSNP (SIMAKSI number: SI.37/T.7/BIDTEK/KSA.1/10/2023).

2. Literature Study and Introduction to Data Analysis Methods

The literature study and introduction to data analysis methods were conducted through the Conservation Camp Program (CCP) organized by BBSNP and WCS-IP. The CCP activities took place from October 22 to October 28, 2023, at the Way Canguk Research Station (SPWC) and the WCS-IP Kotaagung office in Tanggamus. Activities at SPWC included vegetation analysis to determine tree diameter growth, phenology to assess tree development and growth through calculations of interest, fruit quantity, percentage of ripe fruit, and new leaves. Additionally, a siamang census was conducted to count the siamang population in SPWC, and a hornbill census was performed to count the population and species of hornbills found in SPWC. Simulations of camera trap installations were also carried out, starting with camera operation methods and direct installation techniques conducted at SPWC in collaboration with the WCS-IP team. Training in data processing was conducted at the WCS-IP Kotaagung office using RStudio, aligning with the data needs for subsequent analysis.

3. Data Retrieval

Data collection in the field was carried out by the WCS-IP field team after the camera traps were installed for 180 days, with active camera times arranged for 90 days. Camera checks were conducted in two stages, each occurring 45 days after installation. The retrieval of camera traps in 2015 was conducted in November, with a total of 63 camera grids collected. During this process, two pairs of cameras were lost in Grid 11 and Grid 35. In 2019 and 2022, the camera trap sampling was conducted in two phases. In 2019, Phase I retrieval was carried out from October 15 to October 24, 2019, at Sukaraja Atas Resort, Pemerihan Resort, and Ngambur Resort, while Phase II was conducted from November 13 to November 22, 2019, at Ngambur Resort, Biha Resort, and Suoh Resort. A total of 65 camera grids were collected, comprising 130 cameras. In 2022, Phase I retrieval was implemented from October

17 to October 28, 2022, and Phase II from December 5 to December 16, 2022, with a total of 59 camera grids collected. Six grids (Grid 6, Grid 7, Grid 12, Grid 16, Grid 17, and Grid 23) were reported lost. The data obtained from the camera memory cards were transferred to a laptop for further processing and analysis.

4. Data Processing

Data processing was carried out using Picture Information Extractor (PIE), a tool for renaming, sorting, and editing photo files. Additionally, RStudio, an application using R programming language, was employed for data analysis (Sihombing *et al*., 2019). Animal data captured by the camera traps were entered into PIE software to manage, sort, and rename the photo data based on the camera trap installation location and capture time. This facilitated the identification process. After data entry using PIE, the data were transferred to a Microsoft Excel database for identification. The identification process was conducted using the guidebook entitled "Identification Guide Sumatran Animals Based on Camera Trap Results" to aid in distinguishing animal morphology. Following the identification of recorded animal data, the next step involved analyzing the wild boar data captured by the camera traps using RStudio.

3.4. Data Analysis

The data analysis process is conducted using RStudio to determine the number of photographs and Independent Events (IEs) for wild boars. An Independent Event (IE) refers to the number of individual animals or groups recorded in a single series of photographs captured by the camera trap. An IE is considered valid if it meets the following criteria:

1. Sequential photographs originate from different individuals of the same species or from different species in sequence.
2. Sequential photographs feature different individuals of the same species with a time interval of at least 30 minutes, or if the individuals can be clearly differentiated.

3. Photographs of the same individual that are not sequential (O'Brien *et al*., 2003).

Calculation mark Independent Event (IE) according to O'Brien *et al*. (2003) is as following.

$$\%IE = \frac{Number\ of\ individuals\ i}{total\ independent\ event}\ x\ 100$$

Relative Abundance Index (RAI) Calculation or index abundance relatively is index that provides estimation abundance based on amount photos and business so that can see comparison between different areas and studies (O'Brien *et al*., 2003) with the calculation formula:

$$\frac{\sum IE}{\sum trapnights/100}$$

Note:

IE	: Independent Event
Trapnights	: Number of days the camera is active

The RAI calculations are carried out to obtain the value of the wild boar discovery rate/ capture rate during camera installation. The data is presented in the form of tables and graphs which will interpreted in a way descriptive, namely the explanation and description of the data obtained.

Steps data analysis used with application RStudio is as following:

1. Prepare and determine Working Directory for the data calling process (Figure 10) in the script RStudio. Activation package done before call data for ensure that package can used and appropriate with need.
2. Preparation of general data to be processed (Figure 11) in the RStudio script in accordance with placement file location and year of data in the database on the laptop device, then done data reading.

3. Showing deployment data (Figure 12) on each database based on year for read total data.

```
# Load required packages
library(sp);
library(sf);
library(terra);
library(raster);
library(camtrapR);
library(readxl);
library(tidyverse);

getwd()
setwd("D:/TUGAS AKHIR CITARA/Data Skripsi")

```

Figure 10. Activation package and determine working directory for data call.

```
### Prepare general data ####

# Camera trap photo data
images2015 <- read_excel("Data Citara_IPZ_15.xlsx",
                          sheet="Image",guess_max = 10000) %>%
  dplyr::select(Grid, LocationID=`Location ID`,`Photo Type`, `Genus Species
  mutate(Year = 2015)

images2019 <- read_excel("Data Citara_IPZ_19.xlsx",
                          sheet="Image",guess_max = 10000) %>%
  dplyr::select(Grid, LocationID=`Location ID`,`Photo Type`, `Genus Species
  mutate(Year=2019)

images2022 <- read_excel("Data Citara_IPZ_22.xlsx",
                          sheet="Image",guess_max = 10000) %>%
  dplyr::select(Grid, LocationID=`Location ID`,`Photo Type`, `Genus Species
  mutate(Year=2022)
```

Figure 11. General data preparation to be processed.

```
allimages <- bind_rows(images2015, images2019, images2022)

# CT deployment data
deploy2015 <- read_excel("Data Citara_IPZ_15.xlsx",
                          sheet="Deployment",guess_max = 10000) %>%
  dplyr::filter(`Camera Failure Details`=="OK") %>%
  dplyr::select(DeploymentID=`Deployment ID`,Grid,LocationID=`Location ID`, X,Y,
                Begin=`Camera Deployment Begin Date`,
                End=`Camera Deployment End Date`) %>%
  dplyr::filter(!is.na(End)) %>%
  mutate(Year=2015)

deploy2019 <- read_excel("Data Citara_IPZ_19.xlsx",
                          sheet="Deployment",guess_max = 10000) %>%
  dplyr::filter(`Camera Failure Details`=="Functioning") %>%
  dplyr::select(DeploymentID=`Deployment ID`,Grid,LocationID=`Location ID`, X,Y,
                Begin=`Camera Deployment Begin Date`,
                End=`Camera last picture date`) %>%
  mutate(Year=2019)

deploy2022 <- read_excel("Data Citara_IPZ_22.xlsx",
                          sheet="Deployment",guess_max = 10000) %>%
  dplyr::filter(`Camera Failure Details`=="Functioning") %>%
  dplyr::select(DeploymentID=`Deployment ID`,Grid,LocationID=`Location ID`, X,Y,
                Begin=`Camera Deployment Begin Date`,
                End=`Camera last picture date`) %>%
  mutate(Year=2022)
```

Figure 12. Reading Deployment of data on each database to be used.

4. Data deployment changed to in the form of matrix (Figure 13) based on grid, location, point coordinates, time beginning and end installation camera, and year installation camera.

```r
# Camera operation matrix
CTmatrix2015 <- cameraOperation(CTtable = deploy2015,
                                stationCol = "LocationID",
                                cameraCol = "DeploymentID",
                                setupCol = "Begin",
                                retrievalCol = "End",
                                hasProblems = FALSE,
                                byCamera = FALSE,
                                allCamsOn = FALSE,
                                camerasIndependent = FALSE,
                                dateFormat = "%Y-%m-%d",
                                writecsv = TRUE,
                                outDir = getwd()
                                )

CTmatrix2019 <- cameraOperation(CTtable = deploy2019,
                                stationCol = "LocationID",
                                cameraCol = "DeploymentID",
                                setupCol = "Begin",
                                retrievalCol = "End",
                                hasProblems = FALSE,
                                byCamera = FALSE,
                                allCamsOn = FALSE,
                                camerasIndependent = FALSE,
                                dateFormat = "%Y-%m-%d",
                                writecsv = TRUE,
                                outDir = getwd()
                                )

CTmatrix2022 <- cameraOperation(CTtable = deploy2022,
                                stationCol = "LocationID",
                                cameraCol = "DeploymentID",
                                setupCol = "Begin",
```

Figure 13. Deployment changed data to in the form of matrix**.**

5. Calculation mark Independent Event (IE) (Figure 14) to earn level presence wild boar.

```r

#Number of independent events
allimages %>% dplyr::filter(`Genus Species` %in% susscrofa) %>%
  mutate(`Genus Species`=factor(`Genus Species`,levels=susscrofa)) %>%
  group_by(Year,`Genus Species`) %>%
  summarise(n=n(),
            IE = sum(IE))
```

Figure 14. Calculation of IE value

6. Calculation (Figure 15) is based on amount day active camera (trap night) on each database based on year and total amount calculation day active camera in 2015, 2019, and 2022.
7. The RAI calculation for wild boar species (Figure 16) to know level density relatively of wild boar on camera trap.

```
                        writecsv = TRUE,
                        outDir = getwd()
                        )

#### Calculating RAI ####
# Calculate trap nights
trapnights2015 <- data.frame(Year=2015,
                      LocationID=rownames(CTmatrix2015),
                      tn=rowSums(CTmatrix2015,na.rm=T),
                      row.names = NULL)

trapnights2019 <- data.frame(Year=2019,
                      LocationID=rownames(CTmatrix2019),
                      tn=rowSums(CTmatrix2019,na.rm=T),
                      row.names = NULL)

trapnights2022 <- data.frame(Year=2022,
                      LocationID=rownames(CTmatrix2022),
                      tn=rowSums(CTmatrix2022,na.rm=T),
                      row.names = NULL)

alltnights <- bind_rows(trapnights2015,trapnights2019,trapnights2022)
```

Figure 15. RAI and trapnights calculations from each data.

```

# including locations with 0 detections
yeargrid <- tibble(Year = c(rep(2015,63*1),rep(2019,65*1),rep(2022,59*1)),
                   LocationID = c(rep(unique(deploy2015$LocationID),times=1,each=1),
                                  rep(unique(deploy2019$LocationID),times=1,each=1),
                                  rep(unique(deploy2022$LocationID),times=1,each=1)),
                   `Genus Species`= factor(c(rep(susscrofa,times=63),rep(susscrofa,times=65),rep(susscrofa

RAIprey <- left_join(yeargrid, RAIspgrid) %>%
  dplyr::select(Year, LocationID, `Genus Species`, RAI)
RAIprey$RAI[is.na(RAIprey$RAI)] <- 0
View(RAIprey)
```

Figure 16. RAI calculation in wild boars.

Further statistical testing was conducted to determine if there were significant differences in the Relative Abundance Index (RAI) values obtained. The statistical tests employed were the Kruskal-Wallis test and the Wilcoxon matched-pairs signed-rank test.

The Kruskal-Wallis test (Figure 17) is a nonparametric test used to compare and determine if there are significant differences among more than two independent, mutually exclusive sample groups. The conditions for the Kruskal-Wallis test are as follows (Rozi *et al*., 2022):

1. The data obtained are not normally distributed.
2. The samples consist of more than two independent, mutually exclusive groups that do not influence each other.
3. The samples are measured on an ordinal or interval scale.

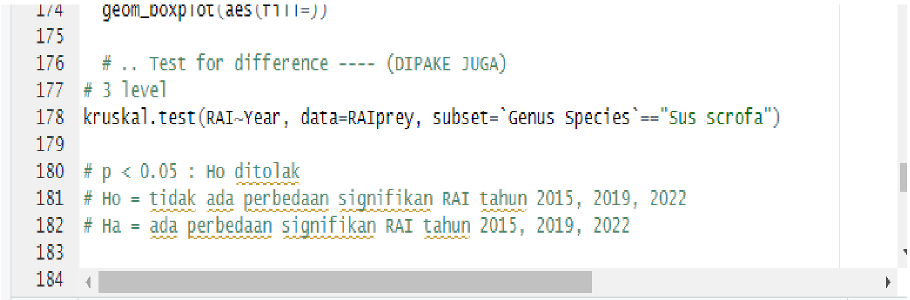
The Wilcoxon matched-pairs signed-rank test (Figure 18) is a nonparametric test used to assess whether there are significant differences between two dependent, mutually exclusive sample groups. The conditions for the Wilcoxon matched-pairs signed-rank test are as follows (RPubs, 2020):

1. The sample data are not normally distributed.
2. The two groups of samples are paired.
3. The samples are measured on an ordinal or interval scale.
4. The sample sizes in both groups are the same.

Both tests own condition if the p value <0.05, then H0 is rejected, with information:

H0 = there is not difference significant RAI value in 2015, 2019, and 2022.

H1 = there is difference significant RAI value in 2015, 2019, and 2022.



```
  geom_boxplot(aes(fill=))

  # .. Test for difference ---- (DIPAKE JUGA)
# 3 level
kruskal.test(RAI~Year, data=RAIprey, subset=`Genus Species`=="Sus scrofa")

# p < 0.05 : Ho ditolak
# Ho = tidak ada perbedaan signifikan RAI tahun 2015, 2019, 2022
# Ha = ada perbedaan signifikan RAI tahun 2015, 2019, 2022
```

Figure 17. Statistical test using the Kruskal-Wallis test.

```r

# 2 level (2015 vs 2019)
RAIprey2 <- RAIprey %>% dplyr::filter(Year %in% c(2015,2019))

wilcox.test(RAI~Year, data=RAIprey2, subset=`Genus Species`=="Sus scrofa", paired=F) #

# p < 0.05 : Ho ditolak
# Ho = tidak ada perbedaan signifikan RAI tahun 2015 dan 2019
# Ha = ada perbedaan signifikan RAI tahun 2015 dan 2019

# 2 level (2015 vs 2022)
RAIprey3 <- RAIprey %>% dplyr::filter(Year %in% c(2015,2022))

wilcox.test(RAI~Year, data=RAIprey3, subset=`Genus Species`=="Sus scrofa", paired=F) #

# p < 0.05 : Ho ditolak
# Ho = tidak ada perbedaan signifikan RAI tahun 2015 dan 2022
# Ha = ada perbedaan signifikan RAI tahun 2015 dan 2022

# 2 level (2019 vs 2022)
RAIprey4 <- RAIprey %>% dplyr::filter(Year %in% c(2019,2022))

wilcox.test(RAI~Year, data=RAIprey4, subset=`Genus Species`=="Sus scrofa", paired=F) #

# p < 0.05 : Ho ditolak
# Ho = tidak ada perbedaan signifikan RAI tahun 2019 dan 2022
# Ha = ada perbedaan signifikan RAI tahun 2019 dan 2022
```

Figure 18. Statistical test using the Wilcoxon matched-paired signed test.

V. CONCLUSION AND SUGGESTIONS

5.1. Conclusion

1. Population of wild boars in the IPZ area, BBSNP experienced dynamics at the moment before, when happened, and after existence ASF outbreak in Indonesia. In 2015 showed level sufficient presence height and abundance relatively speaking low, then experience increased in 2019 and decreased drastically in 2022 which could allegedly related with ASF epidemic.
2. Population dynamics of wild boar related ASF outbreak suspected can influential to existence sumatran tiger as potential prey animal.

5.2. Suggestion

Study on follow up and surveillance related to ASF in natural habitats of wild boar as effort maintain availability prey potential of sumatran tiger in BBSNP is needed.

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