Daily and seasonal activity patterns of wild boar (sus scrofa) from Croatia

Hoffart, Philipp Julian

THE UNIVERSITY OF ZAGREB

FACULTY OF VETERINARY MEDICINE

INTEGRATED UNDER-GRADUATE AND GRADUATE UNIVERSITY STUDIES IN
VETERINARY MEDICINE

Philipp Hoffart

Daily and seasonal activity patterns of wild boar (*Sus scrofa*) from Croatia

Zagreb, 2024

Philipp Hoffart

Department for Hunting and Wildlife

Head of the department: Professor Alen Slavica, PhD

Mentors: Associate professor Magda Sindičić, PhD, Professor Tomislav Gomerčić, PhD

Members of the Committee for Defence of the Master´s Thesis:

1. Prof. Alen Slavica
2. PhD Miljenko Bujanić
3. Ass. Prof. Magda Sindičić
4. PhD Ira Topličanec

Thesis contains 29 pages, 10 figures, 34 literature citations.

Acknowledgements

I hear by want to thank my mentors, associate professor Ph.D. Magda Sindičić and prof. Ph.D. Tomislav Gomerčić for the professional guidance, motivation and exceptional help in the preparation of this paper.

A big thank you to my family, which gave me the opportunity to full fill my dream of becoming a veterinarian and supported me throughout my studies unconditionally.

I am very grateful to Ingo, which was there for me and helped me in every situation during the studies, we shared the good and the bad moments.

As well as to Matko, which helped me especially in the beginning of my studies to settle in, I would have never thought we would become such good friends, it had to be destiny.

I unfortunately cannot mention everyone here but the people which are the closest to me know that I am talking about them when I say, I appreciate every single one of you. You made the time here to a better time and all these memories which we have made are due to you guys!

Table of Content

1. INTRODUCTION

Wild boar is one of the most abundant wild mammals in Europe and one the most important game species. At the same time this species can cause significant damages in agriculture and can be the reservoir for zoonosis, so it certainly has an important role in economy, agriculture and public health. Thus, knowing the ecology of this species is important to be able to manage it properly. As there is no available scientific data about the activity of wild boars in Croatia the goal of this diploma thesis was to gain insight into daily and season activity of wild boars in Gorski kotar and Lika region, using camera traps.

2. REVIEW OF THE RESULT OF PREVIOUS RESEARCH

2.1. Wild boar biology

Sus scrofa of the family Suidae, commonly called wild boar, Eurasian wild pig or wild pig is native to Eurasia and North Africa. Their natural habitat extends from western Europe to Russia (CHANNON et al., 2022), inhabiting grassy savannah, swamplands, wooded forests, agricultural areas and shrublands. The range of *S. scrofa* is primary limited by its inability to withstand long and cold winters in polar climates as well as desert regions with limited amounts of water (WEHR, 2021).

Wild boar body length ranges from 153 to 240 cm and they can reach up to 90 cm in height. They weigh between 66 to 272 kg as adults. Female wild boars are smaller than males, the size difference becomes more clear as animal age. Wild boars grow until the age of 5 to 6 years. The appearance of the coat ranges from black over red-brownish to white. Piglets up to the age of about 4 months have yellowish-brown stripes, which run down their back. *S. scrofa* has a life span of up to 9 to 10 years, but due to the high hunting pressure they often only reach age of 1 to 2 years.

Overall, the ability of wild boars to adapt and their flexible diet helps them to survive in a wide variety of climates and habitats. As an opportunistic omnivore, wild boars will feed on most forms of vegetation such as leaves, roots, berries, shoots and nuts as well as on carrion, macroinvertebrates and small vertebrates as a source of protein (WEHR, 2021). In areas, which are inhabited by humans, they can also feed on garbage and crops that are planted on the field. (BALLARI and BARRIOS-GARCIA, 2013)

S. scrofa are very social animals, they live in large groups, so called “sounders” which are led by a female wild boar. These groups usually consist of 6 to 20 related females and young males. Adult males are usually solitary, they stay with their mothers until they are 1 to 2 years of age. They only return to the so sounders during mating season, groups of females in estrous are attracting the solitary living males.

Reproduction of *S. scrofa* can take place all year long and is usually depending on the climate as this can affect the availability of feed. If the nutritional requirements are not met, breeding can be supressed. Sexual maturity of sows occurs around 10 months of age, in males sexual maturity takes place between 5 to 7 months. Female wild boars are polyestrous, their cycle lasts between 21 to 23 days. Gestation period is between 108 to 120 day (WICKLINE, 2024). They can produce up to two litters per year with 1 to 12 piglets per litter, on average of

6.28 piglets (BYWATER et al., 2010). Factors that correlate with a higher number of piglets are the weight of the sow and years in which oak trees produce a lot of seeds as they are a preferred source of food for wild boars. Temperature and precipitation in summer effects litter size. If these two factors interact it showed a positive effect on litter size, high temperature in combination with high precipitation in summer resulted in higher litter sizes. This is thought to affect the availability of food and not directly *S. scrofa*, as oak trees and agricultural land usually carry more crops in warm and rainy summer. If summer was hot and low precipitation or high precipitation and low temperatures, this had a negative impact on the litter size (FRAUENDOR et al., 2016).

New born piglets weigh about 400 to 800 grams and are weaned between 8 to 12 weeks of age. The sow leaves the sounder during the time when they prepare to give birth and return afterwards with their young. One to three days before parturition, they will build a nest (WICKLINE, 2024). These are usually located within dense vegetation, where they feel safe and sheltered from bad weather (ALLWIN et al., 2016). Parturition lasts for approximately 2 to 3 hours. For the next 4 to 6 days the piglets will stay in or near the nest before they return to the sounder (WICKLINE, 2024).

Figure 1. Wild boar with piglets, picture taken with LIFE Lynx project camera trap.

Sounder become larger as different females group together with their young to protect them against predators. The main predators in Europe is the human. If we talk about natural predators the most significant one is the wolf (*Canis lupus*). They predate usually on young wild boar. With an increased activity of wolfs or in the season of drive hunting increased social affinity of wild boars is observed (IACOLINA et al., 2009).

In general wild boars are not defending their territory against other groups of wild boars. They have non-exclusive, overlapping home ranges (WEHR, 2021). Depending on the availability of food the home range can be as small as 0,5 km^2 in areas with high food availability and can increase up to 58,7 km^2 in areas with lower availability of food (WEHR, 2021). The population density ranges from 0 to 2 pigs/km2 to a density of as high as 12-47 pigs/km2 in areas with optimal conditions (IACOLINA et al., 2009). Wild boars are the most abundant in dense forests with high landscape and food diversity. If agricultural fields are present, wild boars prefer to stay in the areas between the field and forest, as they have easy access to food and hiding places (ALLWIN et al., 2016). Human activity has also been shown to induces changes in home range size and departure from resting sites. These effects are more evident when drive hunts are performed (IACOLINA et al., 2009).

Male boars occupy a larger area. During non-breeding season the tolerate overlapping of ranges with other boars. During mating season they are competing over the right to breed with females, in this period they are defending their home range against other males (WICKLINE, 2024).

Depending on the habitat and climate *S. scrofa* can be active during day and night. In warmer weather conditions they usually rest during the day in the shade and wallow in water sources to keep cool, at the same time it will protect them from ectoparasites. Increased activity takes place during the night as this is their peak feeding time. In colder weather conditions they will actively feed during the day or rest on slopes which are exposed to the sun (ALLWIN et al., 2016). They will avoid open areas which would make them an easy target for hunters and natural predators such as wolfs. These areas will then be visited during dusk, night or dawn to have cover by the night of these predators (WICKLINE, 2024).

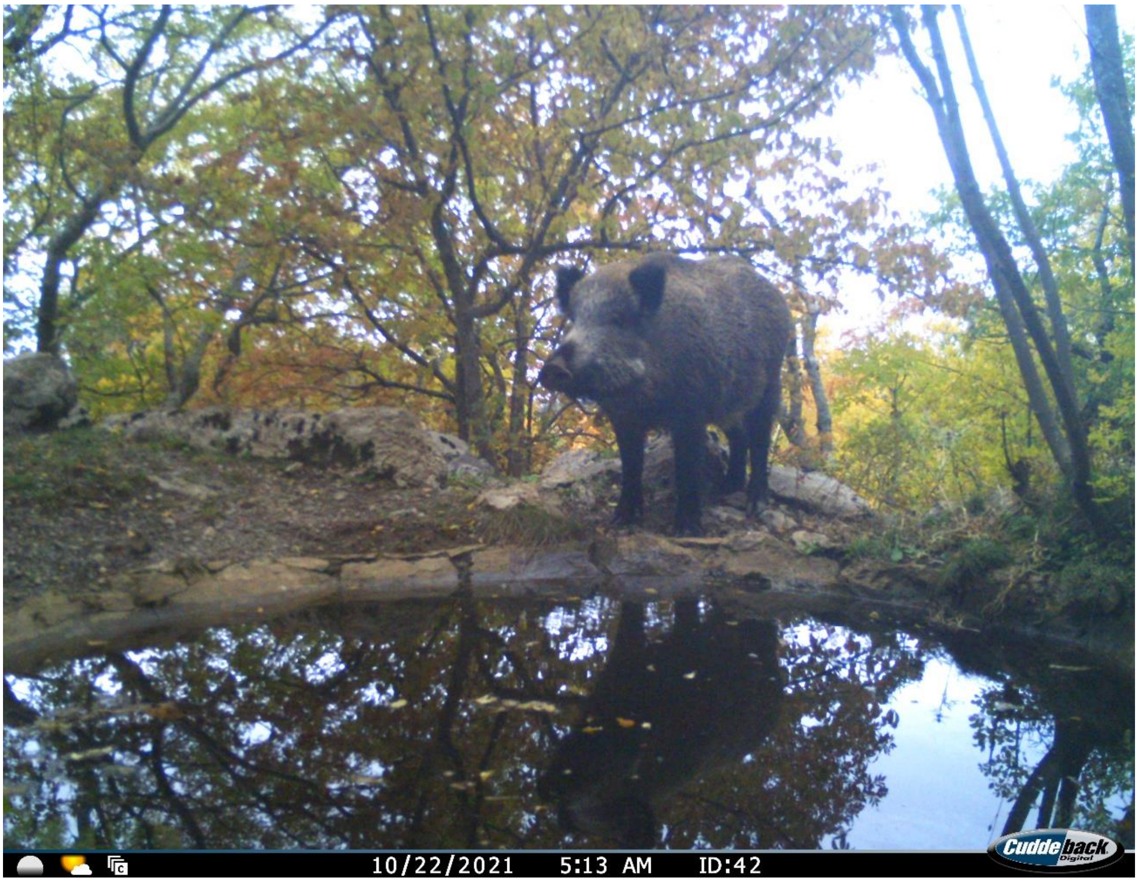

Figure 2. Wild boar, picture taken with LIFE Lynx project camera trap.

It was observed in areas which are relatively undisturbed by humans, that *S. scrofa* tend to be diurnal. Due to intense hunting pressure wild boar have become mainly nocturnal in areas where humans are present (ALLWIN et al., 2016). In general wild pigs tend to have seasonally driven activity patterns. Diurnal activities are recorded during winter and spring months, with peaks of activity in the morning and late afternoon. During the summer months diurnal activity decreases and nocturnal activity pattern are dominant, especially during full moon. Due to the absence of sweat glands wild boars have to focus on controlling their body temperature during this time (ALLWIN et al., 2016).

2.2. Animal activity patterns

Daily activity patterns of animals are considered to be affected by environmental and evolutionary factors. The group of environmental factors can be divided into abiotic and biotic factors.

The dominant abiotic factors are light conditions, ambient temperature, relative humidity, precipitation, and wind speed. In the group of biotic factors, we have different trophic levels. On the same trophic level, we find members of the same social group, mates and members of different species which are competitors. Biotic components from a different trophic level are prey, predators and parasites. All these factors have an impact on how the animal is going to behave in the given conditions (HALLE, 2000).

As all these factors are environmental, they can change any moment and are not constant, but usually follow a pattern, which is related to the season of the year. So long lived species have adapted physiologically as well as behaviour wise.

Animals adapted to the environmental changes over time as there are good and bad times for activities. By following the rule, if a specific time was suitable for doing a specific thing on one day, choose the same time to do the same thing next day (HALLE, 2000). Animals have learned due to the selective pressure which activities are best performed during which time of the day. Environmental factors play an important role in this adaptation as they are not always constant and can change on a daily basis. Based on these changes animal still need to keep their flexibility to be able to adapt.

Two major aspects must be looked at when we look at activity patterns. The first one is the timing of a certain behaviour and the second aspect is the physiological parameters in correlation with the environmental factors.

There are six relevant physiological rhythms: ultradian, tidal, daily, semi-lunar, lunar and annual rhythms. Which of these apply to a certain species depends on their ecological niche and the conditions they live in. In circadian rhythms, regular sleep/wake cycle gives order to the active and resting periods of the animal. Periods of sleeping reduce the energy expanse and mortality risk during times when activity would have had a negative net effect for the animal. Well timed inner clock which does not depend on the environment regulates animal activity and is of great importance especially in cases when there is no information about the status of the environment e.g. bats resting in caves. However timing, daily and seasonal changes have a bigger impact on mammals.

Figure 3. Two wild boar, picture taken with LIFE Lynx project camera trap.

Most predictable of the environmental factors are the change of day and night. Also there is usually a change in temperature and humidity between these two phases. Furthermore the activity of other species such as predators or prey is dependent on the time of the day, due to this many animals are only active during one period. Based on the physical appearance of eyes and ears it is often possible to tell if an animal species is nocturnal or diurnal. Also the way of communication changes based on day and night. During the night the animals use more commonly smell and noises to communicate.

As the day light periods change with the season animals are able to re-adjust their circadian clock. It is verified that that the photoperiod is at least one important factor, since in autumn and in spring photoperiod is the same so there have to be other factors involved which tell the animal which season it is (HALLE, 2000).

An individual is synchronized with its environment, species-specific interactions and adaptation to the given ecological conditions. Conspecifics, which share the same home range, must be seen as competitors for resources and space. Agonistic interaction will be implemented.

If different species are present in the same area and the feeding ground is shared, they will adapt and have different times of activity to avoid competitors (HALLE, 2000). It is also possible that over time one species will disappear from the home range. If the two competing species are sharing the same home range and same source of food, the population of the dominate species will grow which will lead to a higher density of this species in the area. The weaker species is not able to keep their home range in this area and will disappear over time from the area.

Predator prey interaction is also of great importance when looking at activity patterns of animals. For pray animals the mortality risk in the shelter or resting area is usually lower compared to outside of this area. From time to time animals have to leave these sheltered areas. Searching for food, controlling their home range, scent-marking at the boarders, exploration, searching for a mate etc. When activity takes place in the open the situation for prey animals changes dramatically as they are now exposed to the predators. Moving around will further increase the chances of attracting predators. As a general rule, in times when prey animals are active and leave their shelter they are exposed to predators and the mortality risk is significantly increased (HALLE, 2000). By choosing a specific time of activity only the spectrum of predators which is active during this time are a source of danger. If prey animals are active during the night they are only exposed to predators which are nocturnal. If animals are active in dusk and dawn they can be exposed to early/late nocturnal and late/early diurnal predator species. The abundancy of predators plays also a role and influences the times of activity of pray species. (HALLE, 2000)

Predator animals will have to search for their prey so their periods of activity are much longer compared to prey animals. Some are able to learn the activity patterns of their prey and are only active during these periods to preserve their energy. Usually predators do not just feed on one species so they can not adapt to the activity pattern of one of the species they predate on, as their hunting success on this one species might not be sufficient to fulfil their requirements. Due to spacing behaviour of animals, pray is often active at different times of the day so predators will find prey during the times they are actively hunting (HALLE, 2000).

Figure 4. Seven wild boar in a wallow, picture taken with LIFE Lynx project camera trap.

Activity patterns of animals are also influenced by human activity. In areas where humans are present you can observe a change in activity patterns compared to areas where humans are not present (GEORGE and CROOKS, 2006). Some species are especially sensitive to human activity. For example, bobcats (*Lynx rufus*) shifted from primary diurnal activity pattern to mainly nocturnal behaviour or left the area completely to avoid humans (LEWIS et al., 2021). As pray animals are also affected by human activities, which can also interact with the time they are active, predator animals have to adapt their activity according to their primary pray.

Animals also respond differently depending on how humans are active in their home range. Studies have shown that animals activity patterns have not changed significantly if human disturbance was by motorized vehicles or horseback riding (GEORGE and CROOKS, 2006). When humans are moving by foot, bike or have their dog with them, they have a greater impact on the activity of the animals present in that area (GEORGE and CROOKS, 2006).

It is also of great importance where the animals are disturbed. If human disturbance takes place close to the breeding ground or the area where animals are resting it can influence the reproductive capacity or the animals will avoid this area (STEVEN et al., 2011). Changes in animal activity patterns depend on when the disturbance takes place. If animals are moving between their feeding ground and resting area while they are disturbed their travel time increases, at the same time resting and feeding time is reduced. If animals are resting while being disturbed by human activity the travel and feeding time on this day is reduced. Then animals spend more time hiding, at the same time this preserve energy.

If human disturbance ceases animal will go back to their regular activity patter (NAYLOR et al., 2009).

2.3 Camera traps

Wildlife camera traps are a good tool for monitoring animals and their activity in the wild without disturbing them (LEWIS et al., 2021).

Camera traps as we know them today came onto the market at the end of 1980s. The first camera traps were used to monitor which predators visit bird nests (TROLLIET et al., 2014). In the 1990 camera traps were used for the first time to monitor large mammals (TROLLIET et al., 2014). They have been used since then to research many parameters of wildlife biology and ecology. The major advantage of camera traps is the possibility to observe animals in their natural habitat and to record their behaviour without the presence of humans. At the same time it is possible to monitor areas which are difficult to access or species which are really difficult to find if humans are present in the area.

There are different technical aspects which have to be considered when using camera traps. Trigger speed is delay from an animal interrupting the infrared beam of the detection zone and taking the picture. Delay can vary from 0,197 to 4,206 seconds. If you want to observe fast moving animals you should take care that the trigger speed is rather fast.

The detection zone is the area which is covered by the infrared beam. Depending on the with and depth of the zone camera will take more or less pictures in a given event. The field of view is usually 42°. Using a camera trap with a wide detection zone is indicated when monitoring fast moving animals.

The time a camera needs to prepare to take a second picture after motion within the detection zone is detected is called “recovery time”. There is a wide variety of camera trap models on the market and this has also to be considered when thinking about how many pictures of an individual animal is needed when it appears in front of the camera trap.

The capability to take pictures during the night is often crucial as many species which are monitored are active during that time. There are two different methods how to take pictures during the night. Incandescent flash and infrared light.

Pictures which are taken with camera traps which use an incandescent flash are better in terms of overall quality and detail. With this method it is also possible to take pictures in colour during the night. These advantages can help to identify animals more easily based on their natural marks or tags. The disadvantage is that the flash of the camera can scare animals, which might lead to actively avoiding the trail where the camera trap is located which would affect the results of the collected data.

Infrared cameras are generally more often used when monitoring wild animals. Pictures taken during the night are black and white and of less quality compared to pictures which are taken with a flash. At the same time the animals are not disturbed so there is no reason for them to avoid the location of the camera trap (TROLLIET et al., 2014).

Figure 5. Camera trap Cuddeback 1224 (https://www.amazon.com.au/Cuddeback-Range-Model-Scouting-Camera/dp/B00HYY2RH4)

3. MATERIALS AND METHODS

This study was conducted in the Gorski kotar, Lika and northern Dalmatia region (Croatia, Europe), with a total surface area of the study region of around 6,350 km^2. This area is a part of the Dinaric mountain range, where the altitudinal range is pronounced, ranging from sea level up to the highest point, 1,757 m, at the summit of Mount Velebit. Predominant habitats are rugged karst terrains with mixed forests of European beech (*Fagus sylvatica*) and mixed oak forests that dominate at medium and low. The dominant canopy tree species of the mountain conifer forests are spruce (*Picea abies*), silver fir (*Abies alba*), and black pine (*Pinus nigra*). The area has two climate types: moderately warm and humid with warm summers and wet boreal in the altitudinal zone above 1,200 m. Average annual rainfall of 1,500-2,000 mm and an annual temperature averaging 5-8 °C, ranging from a maximum of 32 °C in July to a minimum of −20 °C in January, characterise this ecoregion (ŠEGOTA and FILIPČIĆ, 2003).

A network of camera traps was used to collect data. The study area was gridded into 10 × 10 km cells, and at least one camera trap was installed in each cell along wildlife trails, forest roads and lynx marking sites. Sampling was passive as attractants were not used (i.e. sight, sound, scent) to lure animals to the camera location. Forest roads were built primarily for forestry purposes and are usually covered in gravel, while wildlife trails are pathways worn by the movement of humans and animals. Forest roads are wider and usually flat, while trails are narrow and covered by rocks and roots. We also distinguish them based on the possibility of vehicle movement – only non-motorised human activity was possible on wildlife trails, whereas on forest roads, both motorised and non-motorised human activity could be observed.

Cuddeback model 1224 and Acorn LTL 6511 were used with the following technical settings: activation speed 0.25 s, camera resolution 5 and 12 MP, flash with infrared light (wavelength IR, 850 nm), wide range. Camera traps were set to record one photo and 30 seconds of video or three photos without the video. Our intention was for camera traps to remain at each location all year round. However, due to malfunctions, theft, snow or intensive logging, some were not active during the entire research period at the selected locations or were moved to another location in the same grid cell. The minimum distance between two camera trap locations was at least 1 km, and only one camera trap was active at each 10 × 10 km cell at the same time. For that reason, only active days were considered in the analyses. The cameras were programmed to record the time and date for each photograph. Camera traps were visited at least every two months to replace memory cards and batteries. Photographs were processed using the camera trap software Camelot (HENDRY and MANN, 2018), while empty photographs were selected and erased before uploading into Camelot. On each photograph, we identified the species, the number of animals, age category (juvenile or adult) and sex (if possible). To avoid inflated counts caused by repeated detections of the same animal, we defined the same species captured within 10 minutes as one event (ROVERO and ZIMMERMANN, 2016).

According to ROWCLIFFE et al. (2014), we defined activity records as the time within the 24 h period when camera traps recorded a given species. Activity patterns were calculated using the software R (R Core Team 2021), Activity package (ROWCLIFFE, 2022).

4. RESULTS

In the period from March 2018 until December 2022 (58 months) camera traps were active on 208 locations, resulting in total activity of 52 395 camera trap days. During this period 36 798 wild boars were recorded upon 2420 events. On average 500,7 events were recorded yearly and 41,7 events per month.

Figure 6 displays a map showcasing the precise locations of the 208 camera traps used throughout this study. Notably, 141 camera traps captured images of wild boar at various locations. The yellow circle encompassing the location of camera traps denotes the frequency of wild boar sightings per month. The highest monthly frequency was 0,471, while the lowest was 0,0079. It is visible that in the area of Gorski kotar wild boar were not detected, which is the result of the location where traps were positioned – in Gorski kotar camera traps were positioned at lynx marking sites.

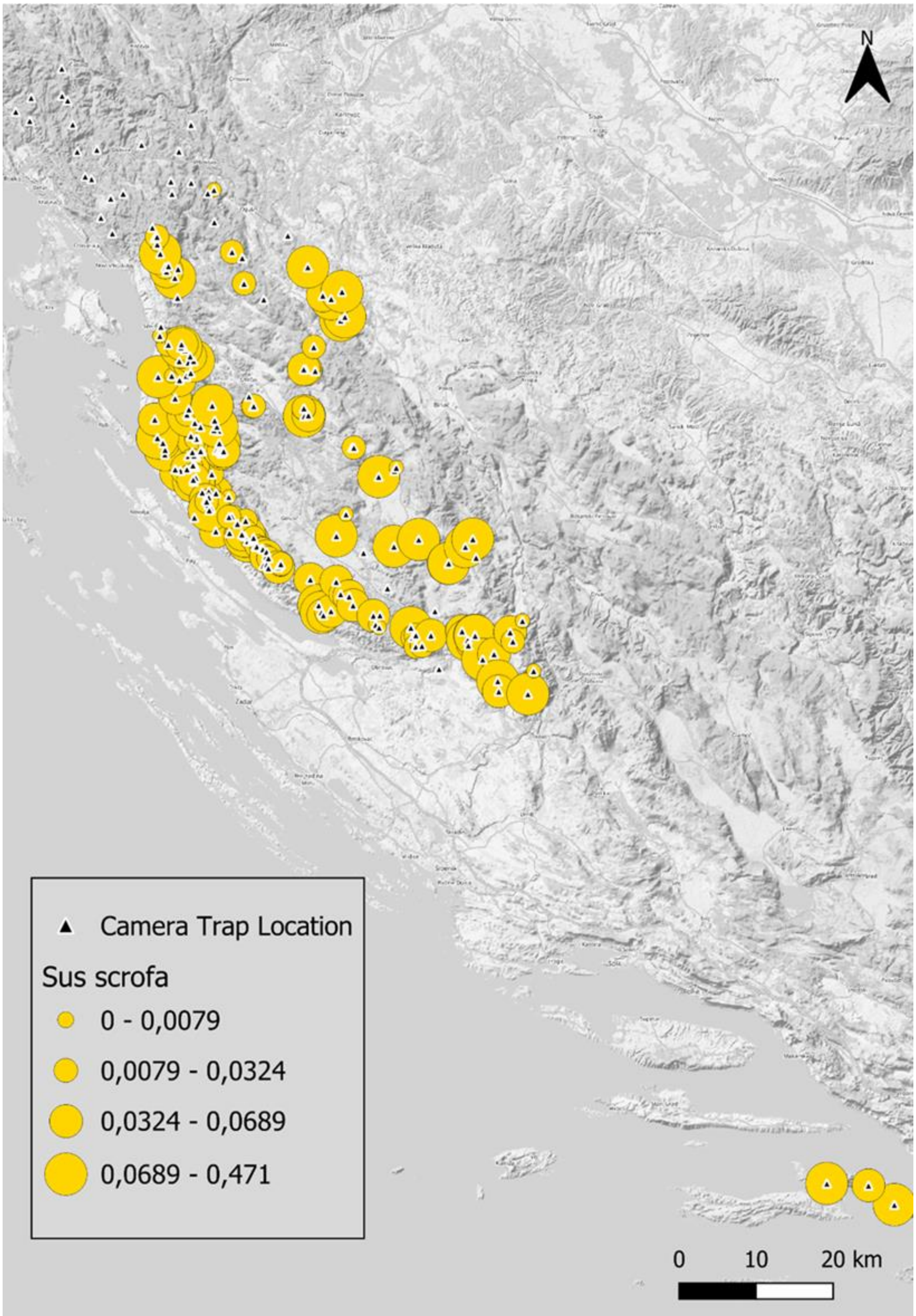

Figure 6. Locations of camera traps used in this study (black triangles). Locations where wild boars were recorded are marked with yellow circles, size of the circle reflects the frequency of wild boar photographed per month (active camera days divided by pictures of wild boar)

Wild boar activity was observed to be at its lowest between the hours of 7am and 2pm, with a gradual increase in activity recorded thereafter until it reached its peak between 6pm and 7pm. Following this peak, a slight decrease was observed from 7pm to 8pm, but activity levels remained relatively consistent until midnight. Subsequently, activity began to decline steadily, reaching its lowest point at 9am (Figure 7).

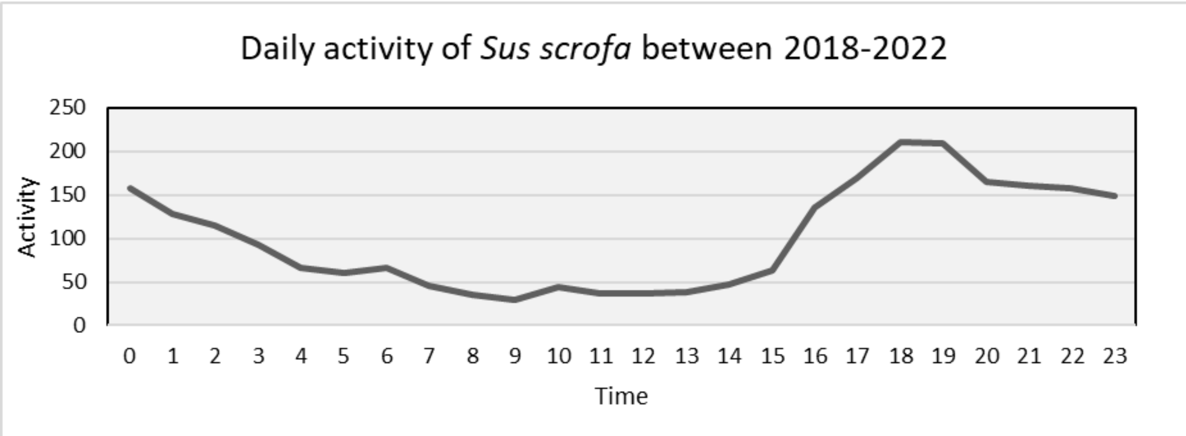

Figure 7. Daily activity patterns of wild boar across years, based on their hourly recordings by the camera traps.

Throughout the analysed period, wild boar activity was the lowest in February, with a gradual increase in activity observed up until April, whereupon it stagnated until June with the second increase during the summer months. The highest levels of activity were recorded in August, which subsequently decreased before reaching a second peak in October. Thereafter, activity gradually decreased until reaching the lowest point in January and February, concluding the seasonal activity cycle of the species (Figure 8).

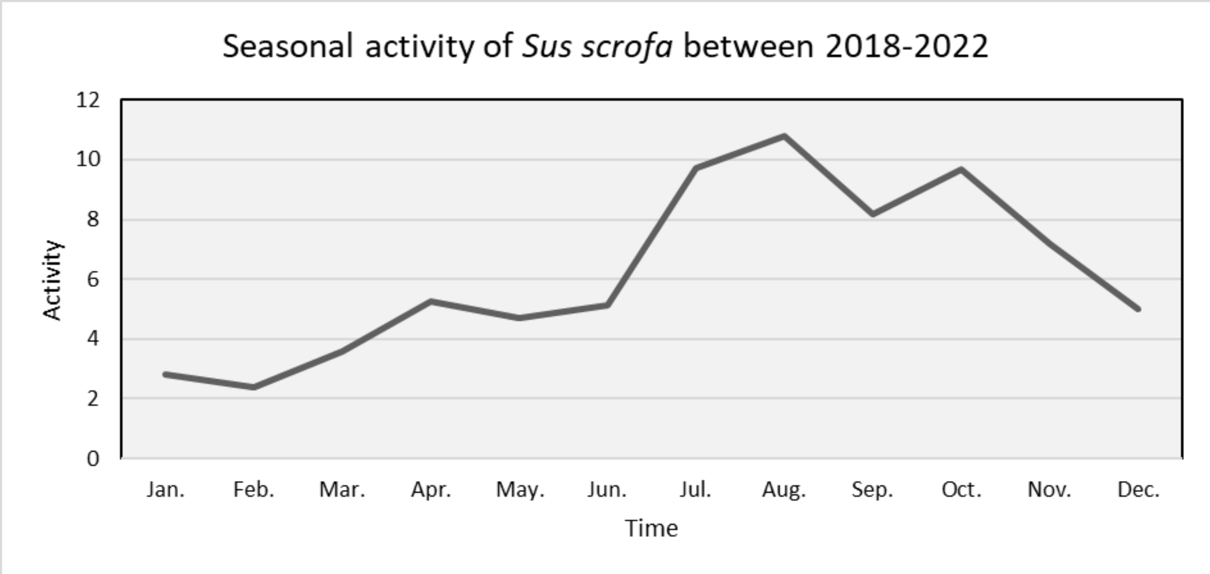

Figure 8. Activity of wild boar per month.

During the winter (December – February) the lowest activity was recorded between 3 am and 12 pm. From the lowest point at 12 pm, there was a gradual increase in activity until 3 pm, beyond which a sharp rise was observed, peaking at 6 pm. After reaching the peak, activity levels declined gradually until 3 am, marking the start of the period of lowest activity (Figure 9).

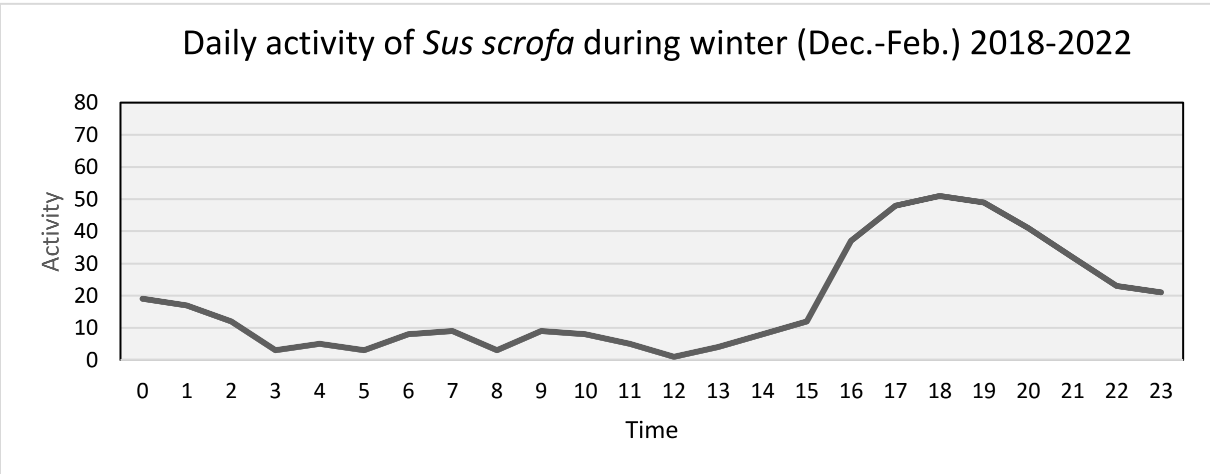

Figure 9. Daily activity of wild boar between December and February.

During summer wild boars were observed to be least active between 7 am and 3 pm, with the lowest activity recorded at 9 am. Activity levels increased gradually from 3 pm onwards, reaching its peak at 7 pm. After the peak, there was a slight decrease in activity, although levels remained relatively high until 3am. Following this, a drop in activity was observed from 3 am until 7 am, marking the period of lowest activity for wild boar (Figure 10).

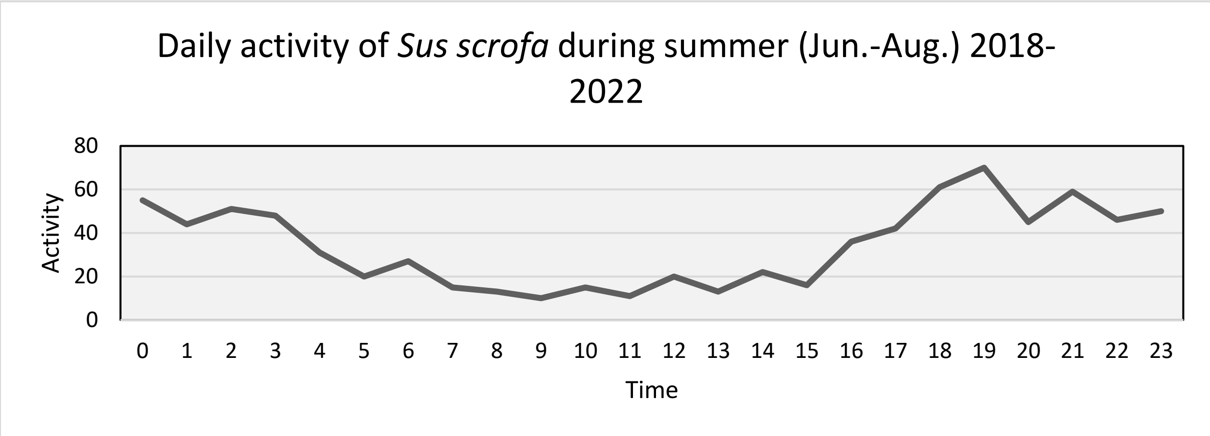

Figure 10. Daily activity of wild boar from June until August.

5. DISCUSSION

The wild boar is characterised by a great phenotypic and behavioural plasticity, which explains its particularly high adaptability. At the same time, this characteristic makes the study of this species more complex and underscores the need to conduct new research on a variety of ecological and behavioural topics in different geographical ranges (BRIVIO et al., 2017). Thus, the goal of this research was to study the seasonal and daily activity of wild boar (*Sus scrofa)* in Croatia, as according to my knowledge there is no published data on this topic. Wild boar as the most prevalent game species in the country, exerts a significant economic influence on both, game management and agriculture. Understanding the activity patterns of this species holds importance, considering it ranks as the most frequently hunted big game in Croatia. The findings from this study offer opportunities to refine hunting and management strategies, providing insights that can shape more effective approaches. This becomes particularly crucial in light of emerging infectious disease such as African swine fever, where the need for effective hunting and management practices becomes essential for controlling and containing potential outbreaks (CHENAIS et al., 2019).

The results from our research conclude that wild boars in Croatian region Lika are nocturnally active throughout the year with only small deviation throughout the seasons. This was achieved by positioning camera traps on 208 locations in the period from March 2018 until December 2022 (58 months), resulting in total activity of 52 395 camera trap days. During this period 36 798 wild boars were recorded upon 2420 events, and the data was analysed using the activity package in R software (ROWCLIFFE, 2022).

The results from our study confirm the predominantly nocturnal nature of wild boars, aligning with observations from many studies from different parts of the world where wild boars are hunted (OHASHI et al., 2013, PODGÓRSKI et al., 2013, CARUSO et al., 2018, GORDIGIANI et al., 2022). Besides becoming more active during the night, wild boars tend to hide, moving around less, staying inside forests instead of using open areas to reduce the chances of been detected and hunted (BROWN et al., 1999, ROSELL et al., 2004, SCILLITANI et al., 2010, BARRIOS-GARCIA and BALLARI, 2012, PODGÓRSKI et al., 2013, THURFJELL et al., 2013). On the contrary, the predominantly diurnal activity pattern or the lack of a pattern is common in areas where no hunting or control is carried out (KEULING et al., 2008, BARRIOS-GARCIA and BALLARI, 2012, PODGÓRSKI et al., 2013). It is noteworthy that even in areas with no hunting activities, the nocturnal activity of wild boars remains predominant, with only a low increase in daytime activity (JOHANN et al., 2020). This nocturnal predominance emphasizes the resilient nature of wild boar behaviour, irrespective of hunting pressures. The aforementioned study, conducted in Germany, a densely populated country, underscore the pervasive influence of human activities on wild boar behaviour. Even in areas without hunting, there exists a consistent disruption to wild boar due to human activities. Conversely, in Eastern European countries characterized by lower population density and reduced human disturbances, a surge in diurnal activity is evident in remote areas when compared to central European countries. Wild boar populations residing in rural locales in eastern European countries revealed a sustained increase in activity levels throughout the year in these less disturbed environments. Remarkably, the study further revealed a parallel activity pattern in wild boar populations situated in proximity to urban centers this aliens to the observed activity in our study (PODGORSKI et al., 2013). This leads to the hypothesis that wild boars may exclusively manifest diurnal behaviour in the absence of human disturbance. Consequently, we posit that the wild boar populations in the Lika area experience disturbances due to human activities, hindering the development of a pronounced diurnal behaviour pattern.

GORDIGIANI et al. (2022) analysed the correlation between wild boar activity and nocturnal light intensity in central Italy. Their research compared to our study demonstrates similar activity patterns, emphasizing a pronounced peak during dusk that gradually diminishes until dawn, accompanied by relatively low activity levels throughout the daylight hours. The data showcases a decrease in activity during the winter months in comparison to the heightened levels observed in summer. This aligns with our results, which was expected as we share the same hour and temperature zone, similar fauna (humans and grey wolf as the main wild boar predator) and similar habitat.

By drawing parallels with previous studies on vehicle collisions involving wild boars in Croatia, our findings reveal a striking congruence. These collisions predominantly occur during the transition from dusk to night, mirroring the outcomes of our own research. Aligning with seasonal patterns, the zenith of these incidents was observed between July and November, providing robust reinforcement for our research findings (VRKLIJAN et al., 2020).

As karst region of Lika is very rich in biodiversity, and wild boras share their habitat with several ungulate species and large predators, the next recommended step is to research the temporal overlap with these species and how they impact the wild boar activity.

6. CONCLUSION

1. Analysis of camera trap data confirmed wild boars in Croatia are nocturnally active.
2. The peak of wild boar activity was during dusk.
3. Seasonal activity is the highest in the summer months.
4. Daily activity pattern of wild boar has only small deviation throughout the seasons.

7. REFERENCES

1. ALLWIN, B., N.S.GOAKRAN, S. VEDAMANICKAM, S. GOPAL (2016): The wild pig (*Sus scrofa*) behavior- a retrospective study. J. Dairy Vet. Anim. Res. 3, 115-125.
2. BALLARI, S.B., M.N. BARRIOS-GARCIA (2013): A review of wild boar *Sus scrofa* diet and factors affecting food selection in native and introduced ranges. Mamm. Rev. 44(2), DOI:10.1111/mam.12015.
3. BARRIOS-GARCIA M., S. BALLARI (2012): Impact of wild boar (*Sus scrofa*) in its introduced and native range: a review. Biol. Invasions 14, 2283 2300.
4. BRIVIO, F., S. GRIGNOLIO, R. BROGI, M. BENAZZI, C. BERTOLUCCI, M. APOLLONIO (2017): An analysis of intrinsic and extrinsic factors affecting the activity of a nocturnal species: The wild boar. Mamm. Biol. 84, 73–81.
5. BROWN J., J, LAUNDRÉ, M. GURUNG (1999): The ecology of fear: optimal foraging, game theory, and trophic interactions. J. Mamm. 80, 385–399.
6. BYWATER, K.A., M. APOLLONIO, N. CAPPAI, P.A. STEPHENS (2010): Litter size and latitude in a large mammal: The wild boar *Sus scrofa*. Mamm. Rev. 40(3), 212-220.
7. CARUSO, N., A. E. J. VALENZUELA, C. L. BURDETT, E. M. LUENGOS VIDAL, D. BIROCHIO, E. B. CASANAVE (2018): Summer habitat use and activity patterns of wild boar *Sus scrofa* in rangelands of central Argentina. PLoS One 13:e0206513.
8. CHANNON, H.A., N.A. DYBING, D. MARSHALL, M.N. GENTLE (2022): Feral pigs. Reference Module in Food Science, Elsevier.
9. CHENAIS, E., K. DEPNER, V. GUBERTI, K. DIETZE, A. VILOTROP, K. STÅHL (2019): Epidemiological considerations on African swine fever in Europe 2014–2018. Porc. Health Manag. 5, 6.
10. FRAUENDOR, M., F. GETHÖFFER, U. SIEBERT, O. KEULING (2016): The influence of enviornmental and physiological factors on the litter size of wild boar (*Sus scrofa*) in agriculture dominated areas in Germany. Sci. Total Environ. 541, 877-882.
11. GEORGE, S.L., K. R. CROOKS (2006): Recreation and large mammal activity in an urban nature reserve. Biol. Conserv. 133, 107-117.
12. GORDIGIANI, L., A. VIVIANO, F. BRIVIO, S. GRIGNOLIO, L. LAZZERI, A. MARCON, E. MORI (2022): Carried away by a moonlight shadow: activity of wild boar in relation to nocturnal light intensity. Mamm. Res. 67, 39–49.

13. HALLE, S. (2000): Ecological Relevance of Daily Activity Patterns. Ecological Studies, 67-90.
14. HENDRY, H., C. MANN. (2017): Camelot - Intuitive Software for Camera Trap Data Management. Oryx 52 (1): 15.
15. IACOLINA, L., M. SCANDURA, P. BONGI, M. APOLLONIO (2009): Nonkin Associations in Wild Boar Social Units. J. Mammal. 90(3), DOI:10.1644/08-MAMM-A-074R1.1.
16. JOHANN, F., M. HANDSCHUH, P. LINDEROTH, C. F. LINDEROTH, J, ARNOLD (2020): Adaptation of wild boar (*Sus scrofa*) activity in a human-dominated landscape. BMC Ecol. 20, 4.
17. KEULING, O., N. STIER, M. ROTH (2008): How does hunting influence activity and spatial usage in wild boar *Sus scrofa* L.? Eur. J. Wildl. Res. 54(4), 729–737.
18. LEWIS, J.S., S. SPAULDING, H. SWANSON, W. KEELEY, A.R. GRAMZA, S. VANDEWOUD, K.R. CROOKS (2021): Human activity influences wildlife populations and activity patterns: implications for spatial and temporal refuges. Ecosphere 12(5), DOI:10.1002/ecs2.3487.
19. NAYLOR, L.M., M.J. WISDOM, R.G. ANTHONY (2009): Behavioural Responses of North Elk to Recreational Activity. J. Wildl. Manage. 73, 328-338.
20. OHASHI, H., M. SAITO, R. HORIE, H. TSUNODA, H. NOBA, H. ISHII, T. KUWABARA, Y. HIROSHIGE, S. KOIKE, Y. HOSHINO, H. TODA, K. KAJI (2013): Differences in the activity pattern of the wild boar *Sus scrofa* related to human disturbance. Eur. J. Wildl. Res. 59, 167–17
21. PODGÓRSKI, T., B. GRZEGORZ, B. JEDRZEJEWSKA, L. SÖNNICHSEN, S. ŚNIEŻKO, W. JEDRZEJEWSKI, H. OKARMA (2013): Spatiotemporal behavioral plasticity of wild boar (*Sus scrofa*) under contrasting conditions of human pressure: primeval forest and metropolitan area. J. Mammal. 94. 109-119.
22. R CORE TEAM (2021): R: a language and environment for statistical computing. R Foundation for Statistical Computing.
23. ROSELL C., F. NAVAS, S. ROMERO, I. DE DALMASES (2004): Activity patterns and social organization of wild boar (*Sus scrofa*, L.) in a wetland environment: preliminary data on the effects of shooting individuals. Galemys 16:157–166.
24. ROVERO, F., F. ZIMMERMANN (2016): Camera trapping for wildlife research. Pelagic Publishing, Exeter.

25. ROWCLIFFE, J.M., R. KAYS, B. KRANSTAUBER (2014): Quantifying levels of animal activity using camera trap data. Methods Ecol. Evol. 5: 1170–1179.
26. ROWCLIFFE (2022): Package activity. R Core Development Team. https://cran.r-project.org/web/packages/activity/activity.pdf
27. SCILLITANI L., A. MONACO, S. TOSO (2010): Do intensive drive hunts affect wild boar (*Sus scrofa*) spatial behaviour in Italy? Some evidences and management implications. Eur. J. Wildl. Res. 56:307–318.
28. ŠEGOTA, T., A. FILIPČIĆ (2003): Köppen's classification of climates and the problem of Croatian terminology. Geoadria 8: 17.
29. STEVEN, R., C. PICKERING, J. GUY CASTLEY (2011): A review of the impacts of nature based recreation on birds. J. Environ. Manage. 92, 2287-2294.
30. THURFJELL H., G. SPONG, G. ERICSSON (2013): Effects of hunting on wild boar *Sus scrofa* behaviour. Wildl. Biol. 19:87–93.
31. TROLLIET, F. M.C. HUYNEN, C. VERMEULEN, A. HAMBUCKERS (2014): Use of camera traps for wildlife studies. A review. Biotechnology, Biotechnol. Agron. Soc. 18(3), 446-454.
32. VRKLIJAN, J., H. DUBRAVKA, D. BARIĆ, D.UGARKOVIĆ, K. KRAPINEC (2020): Temporal Patterns of Vehicle Collisions with Roe Deer and Wild Boar in the Dinaric Area. Croat. J. For Eng. 41(2):347-358.
33. WEHR, N.H. (2021): Historical range expansion and biological changes of *Sus scrofa* corresponding to domestication and feralization. Mammal Res. 66, 1–12.
34. WICKLINE, K. (2024): *Sus scrofa*. Animal diversity web.

8. SAŽETAK

Philipp Hoffart

Dnevna i sezonska aktivnost divlje svinje (*Sus scrofa*) u Hrvatskoj

Aktivnost divlje svinje (*Sus scrofa*) uvjetovana je vanjskim i unutarnjim čimbenicima, među kojima su svjetlost, temperatura i aktivnost čovjeka najvažniji. Budući nisu dostupni znanstveni podatci o aktivnosti divljih svinja u Hrvatskoj, cilj ovog diplomskog rada je bio istražiti dnevnu i sezonsku aktivnost ove, najvažnije lovne vrste u zemlji. Istraživanje je provedeno na području Like, pomoću automatskih kamera postavljenih na 208 lokacija u razdoblju od ožujka 2018. do prosinca 2022. Tijekom ukupno 52 395 dana aktivnosti kamera prikupljeno je 2420 događaja na kojima je zabilježeno 36 798 divljih svinja. Većina događaja je zabilježena tijekom noći, dok su divlje svinje najveću aktivnost očitovale u vrijeme zalaska sunca. Zabilježene su blage promjene aktivnosti tijekom sezona, s najvišom aktivnosti tijekom ljetnih mjeseci, od srpnja do listopada.

Ključne riječi: divlja svinja, (*Sus scrofa*), aktivnost, automatske kamere, Hrvatska

9. SUMMARY

Philipp Hoffart

Daily and seasonal activity patterns of wild boar
(*Sus scrofa*) from Croatia

The activity of wild boar (*Sus scrofa*) depends on different external and internal factors, light, temperature and human activity are among the most important factors. There is no published reserch about activity patterns of wild boars in Croatia, so this thesis aimed to investigate the daily and seasonal activity of this, the most important game species in the country. Research has been conducted in the Lika region in Croatia, where 208 camera traps have been placed on different locations between March 2018 until December 2022. During the total of 52 395 camera trap active days, 36 798 wild boars were recorded upon 2420 events. The majority of events occurred during the night with the highest wild boar activity during dusk. There is only a slight change of daily activity throughout the seasons with the highest overall activity during the summer months from July till October.

Key words: wild boar, *Sus scrofa*, activity, camera traps, Croatia

10. CURRICULUM VITAE

I was born on 21 April 1997 in Mainz, Germany. From 2003 till 2007 I attended primary school Martinus Schule Mainz-Weisenau. Following this from 2007 on I attended IGS Mainz-Bretzenheim where I graduated in 2016 and acquired my A levels.

In May 2011 I completed a two-week externship at the Frankfurt Zoo. During August 2013 and July 2014, I gained insight in the work of small animal Veterinarians and a mixed practice.

Throughout my childhood and teenage life I played tennis for 10 years, did horseback riding for 4 years and played handball for 6 years. To improve my English skills and to travel I went to New Zealand in May 2016 and worked there as an Au Pair until May 2017.

From October 2017 on I am studying at the Faculty of Veterinary Medicine University of Zagreb, Croatia. During this time I completed multiple internships. In July 2020 I completed a two week at the Tierklinik Hofheim, the following year I stayed at their facility for another 4 weeks. In 2022 I stayed for 4 weeks at the Tierärztliche Gemeinschaftspraxis Dr. Meyer-Götz before I attended my longest externship over 10 weeks at the Tierklinik Dr. Schneichel in 2023.