



SURVEY ON DAMAGE BY WILD BOAR ON FARMLAND AND GRASSLANDS IN THE PRESPA BASIN (GR)



Agios Germanos

April 2020

*prespa*NET

A NETWORK OF ENVIRONMENTAL NGOS FOR PRESPA

CONTENTS

Preface	2
1. Background information.....	3
1.1 Ecology of the wild boar.....	3
1.2 Population trends and socio-economic and environmental impact of wild boar	4
1.3 The wild boar in the Greek Prespa basin.....	5
2. Study area and methods.....	8
2.1 Study area.....	8
2.2 Structure of the questionnaire and implementation of the interviews.....	8
3. Results.....	10
3.1 Socio-demographic data.....	10
3.2 Presence of wild boar.....	11
3.3 Damage by wild boar.....	14
3.4 Proposed measures.....	17
4. Discussion.....	19
5. Conclusions.....	23
Bibliography.....	24
Appendix.....	26

PREFACE

This survey was carried out in the framework of the project “Strengthening NGO-led Conservation in the Transboundary Prespa Basin”, which is being implemented by the PrespaNet network and funded by the Aage V. Jensen Charity Foundation and the Prespa Ohrid Nature Trust (PONT), with support from EuroNatur. The project aims to strengthen the network’s collaboration through concrete conservation activities in the region, by building the partners’ respective capacities through sharing knowledge and expertise and thus demonstrate an exemplary case for integrated cross-border co-operation on biodiversity protection. One of the project’s main pillars of action refers to the conservation of large mammals and it includes, amongst others, a survey on depredation by large carnivores in Albania and North Macedonia, and the present survey on damage by wild boar in Greece.

The survey was implemented by the Society of the Protection of Prespa (SPP) during summer and autumn 2019. The survey team consisted of:

Vaso Nitsopoulou – implementation of interviews

Kostas Papadopoulos - implementation of interviews

Giorgos Catsadorakis – scientific support

Thanos Kastritis – co-ordination of the survey

The SPP would like to thank all the members of the local community who kindly participated in the survey, as well as Dr. Michalis Petrakos for his contribution to the development of the questionnaires, and MES and PPNEA for their helpful review of the final report.

Recommended citation:

Kastritis, T., Nitsopoulou, V., Papadopoulos, K. & Catsadorakis, G. 2020. Survey on damage by wild boar on farmland and grasslands in the Prespa basin (GR) – Final Report. Society for the Protection of Prespa, Agios Germanos.

The information presented herein is not allowed to be replicated without the written consent of the authors

BACKGROUND INFORMATION

1.1. Ecology of the wild boar

The wild boar (*Sus scrofa*) is an ungulate with a large global distribution extending from western Europe and North Africa eastwards through the Middle East and central and south-east Asia, to its south-eastern limit at the Greater Sunda Islands, Indonesia. In Europe, it is widespread in most continental areas, with the exception of northern Fennoscandia and European Russia. It disappeared from the British Isles and Scandinavia in the 17th century, although it has now been reintroduced to Sweden, and escaped animals have established themselves in the wild in Britain (Spitz, 1999, as cited in Herrero et al., 2007). The species is listed as “Least Concern” in the Red List of the IUCN at global, European and Mediterranean level, due to its wide range, abundance, tolerance to habitat disturbance and presence in many protected areas (Herrero et al., 2007; Jdeidi et al., 2010; Keuling & Leus, 2019).

The wild boar occupies a wide variety of temperate and tropical habitats and, in Europe, it prefers broadleaved forests and evergreen oak forests, but may also be found in more open habitats such as steppe, Mediterranean shrubland, and farmland, so long as there is water and cover nearby (Jdeidi et al., 2010). In order to survive in a given area, wild boars require a habitat fulfilling three conditions: i) areas of heavy bush, providing shelter from predators, ii) water for drinking and bathing purposes, iii) absence of regular snowfall. Wild boars rest in shelters made from branches and dry hay. These resting places are occupied by whole families, though males lie separately (Tack, 2018).

Wild boars are social animals typically living in female dominated herds, or “sounders”, of varying size depending on locality and season, but usually of between 6-20 individuals, though aggregations of over 100 have been reported (Jdeidi et al., 2010, Tack, 2018). The sounder is led by an older female, or matriarch, and consists of interrelated females and their young, of both sexes. Male boars leave their sounder at the age of 8–15 months. Females remain with their mothers or establish new territories nearby. Adult males tend to be solitary outside the breeding season, with sub-adult males sometimes living in small groups (Jdeidi et al., 2010, Tack, 2018).

The species is omnivorous, though stomach and faecal contents analyses indicate that vegetable matter, principally fruits, seeds, roots and tubers, constitute the great majority of the diet (Baubet et al., 2004, Jdeidi et al., 2010). Although the diet of the wild boar consists mainly of plant material, the inclusion of a proportion of animal food in the diet may be important for growth and survival. According to 11 studies on wild boar diet (undertaken in Europe), which were reviewed by Schley & Roper (2003), there were four major vegetable food categories: mast, roots, green plant matter and agricultural crops. Although wild boars consume a wide variety of plant species, their diet always includes at least one energy-rich plant food such as acorns, beechnuts, chestnuts, pine seeds, olives, cereal grains or other agricultural crops. Within these energy-rich food types, however, preferences are exhibited. For example, mast, if available, is preferred to agricultural crops such as maize and to supplementary food (oats or maize) provided artificially. Indeed, it has been suggested that the availability of oak and beech mast is the single most important factor determining the consumption of other plant foods. The diet of the wild boar diet is highly variable in its detailed

composition, depending on time of year, year and geographical region. It is an opportunistic omnivore, whose diet in any particular instance is strongly influenced by availability (Schley & Roper, 2003)

Wild boars are normally most active in the early morning and late afternoon, though they become nocturnal in disturbed areas, where activity usually commences shortly before sunset and continues throughout the night. A total of 4 to 8 hours are spent foraging or travelling to feeding areas. Feeding is generally a social activity (even solitary males may join feeding groups), which also provides an opportunity for display and other antagonistic behaviours. Radio telemetry studies in southern France indicate that they generally travel between 2 and 15 km per night, though this is often within an area of only 20 to 150 ha. However, the home range estimates for adult females and adult males over a 2- to 3-month period varied from 500-1,000 ha and from 1,000-2,000 ha, respectively (Jdeidi et al., 2010).

Wild boars show the highest reproductive rates among all ungulate species in relation to body-mass. Reproductive activity tends to be seasonal and positively correlated with the relative availability of principal foodstuffs or related climatic factors. Sexual activity and testosterone production are triggered by decreasing day length and reach a peak in October and November when the rut occurs. In the breeding season, male wild boars, who normally live solitarily or in loosely knit groups with other males, move into female groups. The availability of food is important for the breeding success. Giving birth occurs mostly between March and May, peaking in April. A couple of days before giving birth the sow will leave the group and build a specially constructed nest where the piglets are born. The average litter consists typically of 4–6 piglets, with the maximum being 10-12. The lactation period lasts 2.5–3.5 months, but rooting behaviour develops almost immediately and piglets are fully weaned after 4 months (Tack 2018).

1.2 Population trends and socio-economic and environmental impact of wild boar

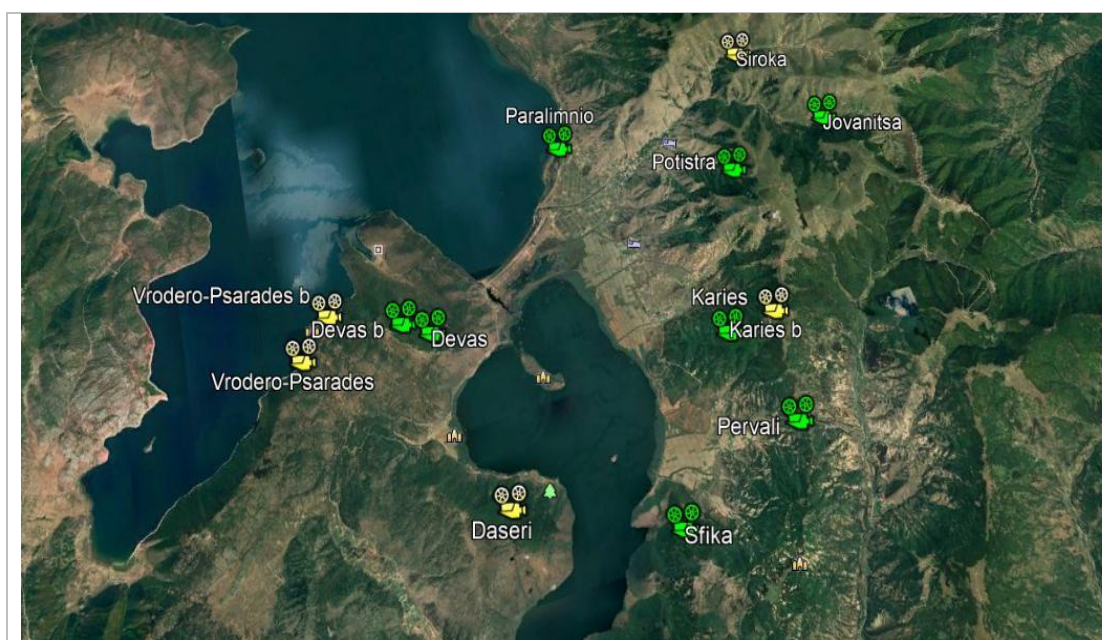
Although no recent EU-wide study on wild boar populations has been carried out, most research has shown localised increases in population. A study on European wild boar population trends in 1986 showed a simultaneous increase in wild boar numbers during the period 1965-1975, followed by a period of stabilisation (Saez-Royuela & Telleria, 1986).

Due to the increased populations, the damage to crops by wild boars has also increased dramatically in the last decades, leading to an increase in social conflicts, expenditure on compensation and a risk to natural ecosystems. The consumption by wild boar of crops, such as maize, wheat, barley, rye, oats, rice, sorghum, potatoes, grasses and sugar beets, is very common throughout Europe and leads to crop damage, and consequently to economic losses and farmer irritation. Dependence on energy-rich plant material as a major component of the diet, coupled with large body size and a propensity to trample crops as well as consume them, means that wild boars cause significant agricultural damage (Amici et al., 2012, Schley & Roper, 2003). It should also be mentioned that, when rooting and digging for invertebrate prey and underground plant parts, wild boars make holes of up to 60 cm in depth and, in the process, cause substantial damage to grassland. The damage to grassland could be up to 50% of the total damage reported (Baubet et al., 2004, Schley et al., 2008). The increasing numbers and negative impact on agricultural land is part of the reason why the wild boar is considered a pest species in many parts of the world and many European countries now compensate farmers for damage caused by wild boars (Tack, 2018).

Apart from the damage to agricultural land, the conflict between humans and wild boars include causes such as the risk of disease transmission to humans, livestock or other domestic animals, road collisions with vehicles and damage to forests and their regeneration. In addition, wild boars' extensive rooting for the underground parts of plants and their predation on birds may pose a threat to ecosystems, especially in parks, old growth forests, and in the Natura 2000 network of protected areas (Giménez-Anaya et al., 2008, Schley & Roper, 2003, Tack, 2018). It is worth mentioning that, due to a recent incident of African swine fever in Bulgaria near the Greek borders, special measures have been established by the Greek state regarding the hunting of wild boar. These include precautionary measures during hunting, as well as the establishment of special teams consisting of hunters and employees of the veterinary and forestry services for the culling of wild boars (Common Ministerial Decree No3067/297195¹).

1.3 The wild boar in the Greek Prespa basin

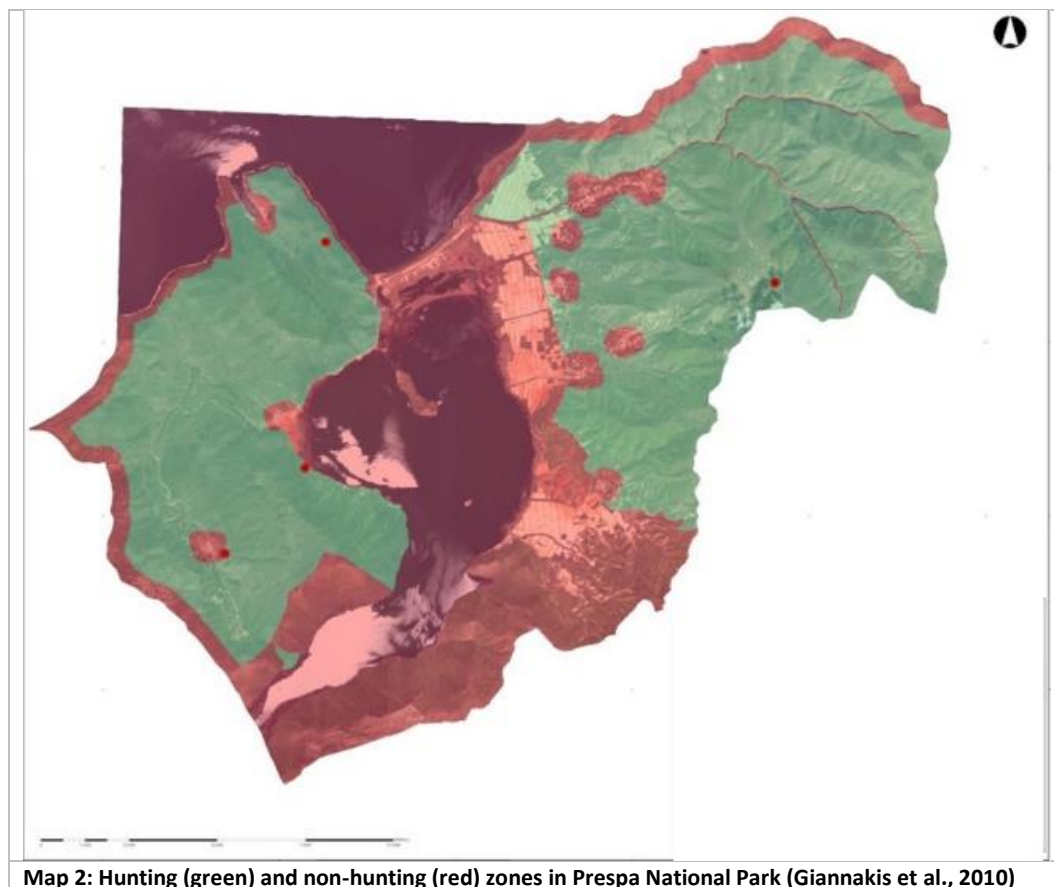
The wild boar is a species commonly found in the Prespa basin and has a widespread distribution, which covers a large area from the forested slopes of the basin's mountains to the reedbeds around the Lesser and Great Prespa lakes. In the framework of the project "Strengthening NGO-led Conservation in the Transboundary Prespa Basin", a preliminary survey for large mammals' presence is currently being implemented at transboundary level using trap cameras. 176 photos of wild boar were captured in 2018 on the Greek side of the Prespa basin, most of them in the riparian forest by Great Prespa Lake. Map 1 shows the locations of the trap cameras: in green are cameras with photos of wild boars, while in yellow are cameras that didn't capture any wild boars. It is emphasised that the lack of photos of wild boars in the yellow camera sites doesn't imply the absence of the species in these areas; on the contrary, according to people's testimonies its distribution covers almost the entire Prespa basin, something also mentioned by Catsadorakis & Kollaros (1985).



Map 1: Locations of trap cameras, in green those with photos of wild boars.

¹ https://dasarxeio.com/wp-content/uploads/2019/11/3067_297195_2019.pdf

There are no specific studies focused on the species in Prespa, however Catsadorakis & Kollaros (1985) mention that its numbers have increased due to the ban on hunting in specific parts of the basin. Today, hunting of wild boar is permitted in the eastern and western mountain areas of the basin (Mount Varnous and Mount Devas respectively). The non-hunting areas of Prespa include the southern part of the basin (Mount Sfika), the agricultural zone and the villages, the littoral zone of Lesser and Great Prespa lakes, as well as a buffer zone of 500 m along the borders with North Macedonia and Albania (Map 2). Wild boar is hunted by locals, but also hunters from the wider region of Western Macedonia or other areas of Greece often visit Prespa to hunt wild boars. The main hunting method is the driven hunt or “battue”: a group of hunters, using dogs, drives the animals towards another group of armed hunters, who are located in strategic points. It is alleged that releases of wild boars for hunting purposes by regional hunting associations have taken place in the recent past.



As wild boar was not an uncommon species in the area in the previous decades, damage to cultivations caused by the species were not infrequent. The critical difference between the past years and today is related to the type, as well as to the intensity, of the damage. Damage in the past was mostly related to cereal cultivation, which was much more common until 30 years ago. The wild boars moved from the forested areas to the cultivated areas, causing damage by either trampling the plants and/or eating the crop. Today, wild boars cause damage mostly to the areas cultivated with beans, which are the dominant crop of the area and the main source of income for the local community. Furthermore, it is a widespread belief amongst the local farmers and stockbreeders that damage by wild boar has increased significantly during the last years. It should be noted that according to the regulations of the Greek compensation system, damage to cultivated areas from wild boar can only be compensated if the damage area is within a Ramsar site. In Prespa, the great majority of the

damaged cultivated areas or grasslands, due to inadequate delineation, are outside the limits of the Ramsar site of Lesser Prespa Lake, therefore damage is not eligible for compensation. During the last years the problem has been identified and highlighted in the annual meetings of the Wetland Management Committee; in its meeting on 17/3/2016, the Wetland Management Committee decided that damage caused by wild boars in the agricultural land and the meadows would be recorded by the Management Body of Prespa National Park (MBPNP), in order to prepare a specific report, addressing the problem, for the relevant authorities (See also Appendix C). In addition, the MBPNP has officially reported the problem to the Greek Agricultural Insurance Organisation on many occasions. At the same time, the MBPNP has also taken the initiative to increase efforts, together with the Society for the Protection of Prespa and other stakeholders, to advocate for the revision of the borders of the Ramsar site of Lesser Prespa.

Aim of the present study

The aim of this study was to assess the perceptions of the local community on wild boar presence in the Greek part of the Prespa basin and the damage caused by the species to farmland and grasslands. The main results and conclusions of the survey will be used, together with the outcomes of the aforementioned surveys on depredation by large carnivores, in the development of a set of guidelines on the mitigation of human-large mammal conflict in the basin, and the implementation of relevant pilot activities in the Greek Prespa. In addition, the conclusions and recommendations of the “Preliminary study on the conflict with large carnivores, emphasizing on the grey wolf, within the Prespa National Park”, which was carried out in 2017 (Iliopoulos & Petridou, 2017), will be taken into consideration.

2. STUDY AREA AND METHODS

2.1 Study area

The study area of the survey is the Greek part of the Prespa basin. Prespa is a transboundary basin shared by Albania, Greece and North Macedonia; the Prespa catchment (1,386 km²) includes the two lakes: Lesser Prespa and Great Prespa. Both Prespa lakes are situated approximately 850m asl, amidst mountains rising to over 2,600m asl. Prespa is a region of high biodiversity and endemism. The importance of the area is internationally recognised, and for this reason, the three countries have designated four national parks, one nature park and three Ramsar sites, wholly or partly within the Prespa basin. The Prespa Park, a transboundary protected area which covers the two lakes and their surrounding catchment basin, was the first transboundary protected area in the Balkans. The Greek part of the catchment also contains two Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), in accordance with European Union legislation (Society for the Protection of Prespa, 2017).

The Greek part of the Prespa basin (33,814 ha) is located within the Municipality of Prespa (51,528 ha), the jurisdiction of which extends beyond the borders of the actual watershed. The total resident population of the Municipality of Prespa is 1,560 inhabitants, distributed in 21 villages. Within the Prespa basin there are 13 villages with 1,060 inhabitants (Center for Sustainable Entrepreneurship Excelixi S.A., 2015). The majority of the economically active population works in the primary sector and mainly on intensive bean cultivation, which covers more than half of the cultivated land in the basin. Other crops include clover and cereals, such as rye, barley, corn and wheat. The percentage of organic farming is 3% of the total. Goat and sheep rearing, which used to be one of the main occupations of Prespa's residents, is declining in inverse proportion to the rise of farming. Nevertheless, the total number of cattle raised for beef production has increased. According to the 2008 census, in the Municipality of Prespa there were 42,061 sheep and goats and 2,863 cows (Center for Sustainable Entrepreneurship Excelixi S.A., 2015). Regarding fishing, there are 53 boats in total on the two lakes, with one or two fishermen in each, who fish on a regular basis and can be considered to be occupied in the commercial fisheries sector, irrespective of whether fishing is their principal or supplementary occupation (Catsadorakis et al., 2018). Less than 8% of the economically active population works in the secondary sector, while 22% works on the tertiary sector, mainly on tourism and recreational activities (Center for Sustainable Entrepreneurship Excelixi S.A., 2015).

2.2. Structure of the questionnaire and implementation of the interviews

The face-to-face, semi-structured interviews were carried out from July to October 2019 by two interviewers from the Society of the Protection of Prespa. The selection of the interviewees was made according to their occupation (farmers and stockbreeders were preferred), their frequent presence in the countryside and their willingness and availability to participate in the interviews. The interviews took place at cafes/tavernas, houses or other places of work in 12 villages of the area. Each interview lasted approximately 30 minutes. In total, 68 questionnaires from 12 villages were completed in the framework of the survey.

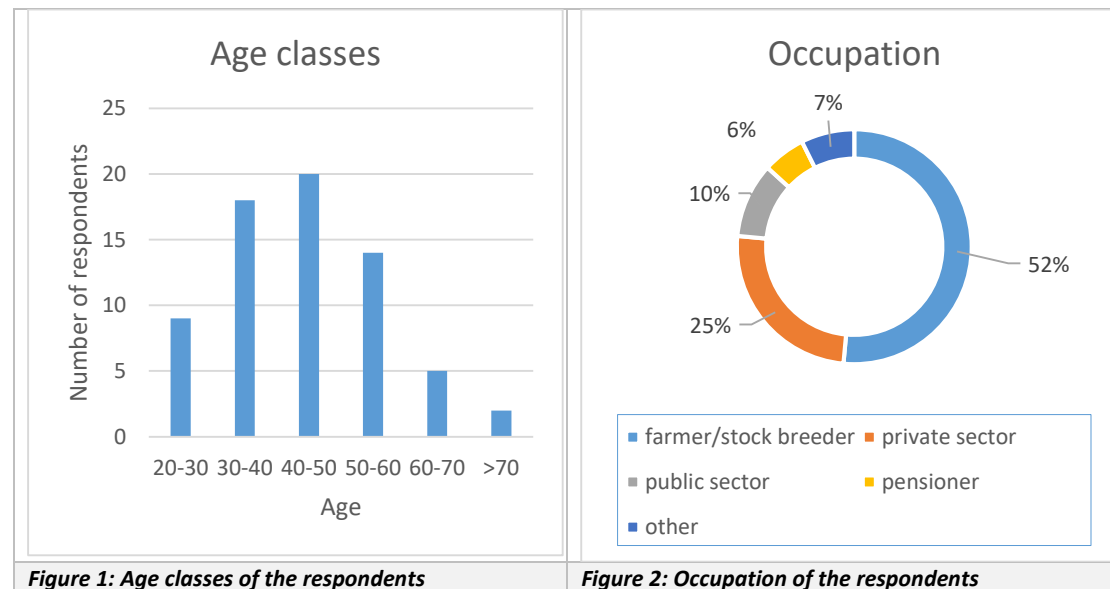
The questionnaire consisted of four main sets of questions: i) personal details of the interviewees, ii) a dataset on the presence (both observation of individuals and observation of signs, such as tracks, scats, etc.) of wild boar in the area, iii) a dataset on the damage caused by wild boar, and iv) a dataset on the assessment of the problem of damage and the proposals

for possible solutions. A multiple-choice-type questionnaire was used for most of the questions, while for each set of questions a section of open-type comments was available to the respondents. For the cases where the answer had to be linked with a geographical area, e.g. the location of a damage incident or of an observation of a wild boar, the respondents were asked to indicate the relevant location on a map with a grid of 2 x 2 km plots. The questionnaire, as well as a sample of the map, can be found in the Appendix.

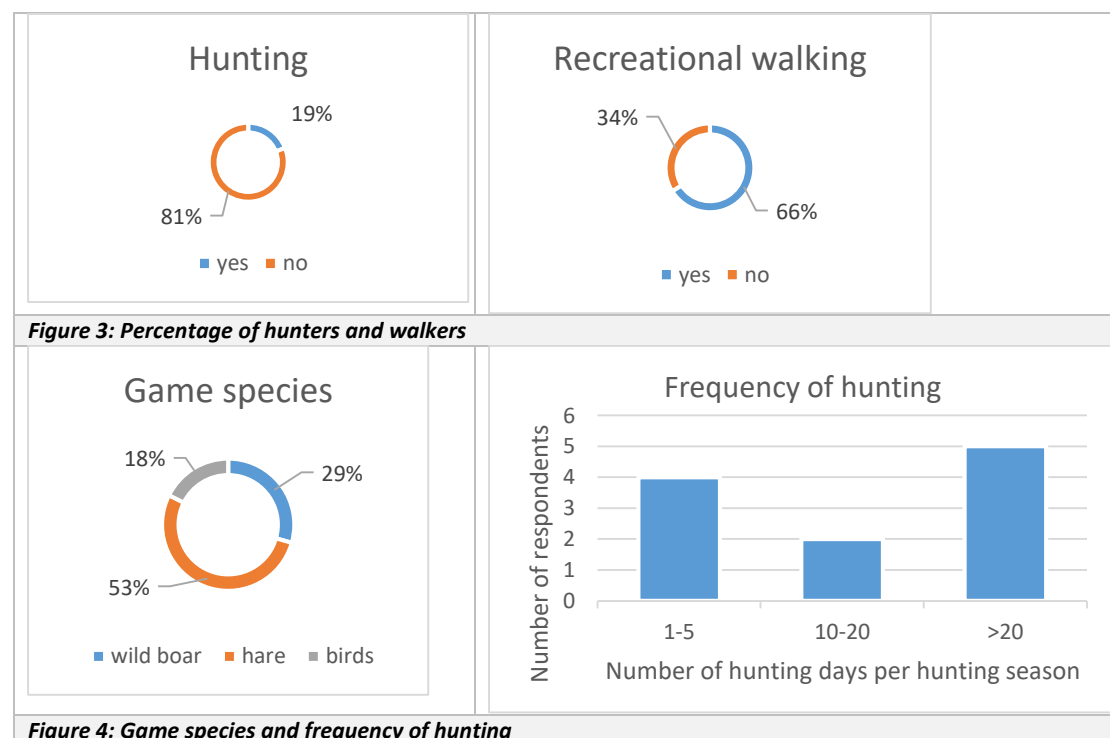
3. RESULTS

3.1 Socio-demographic data of interviewees

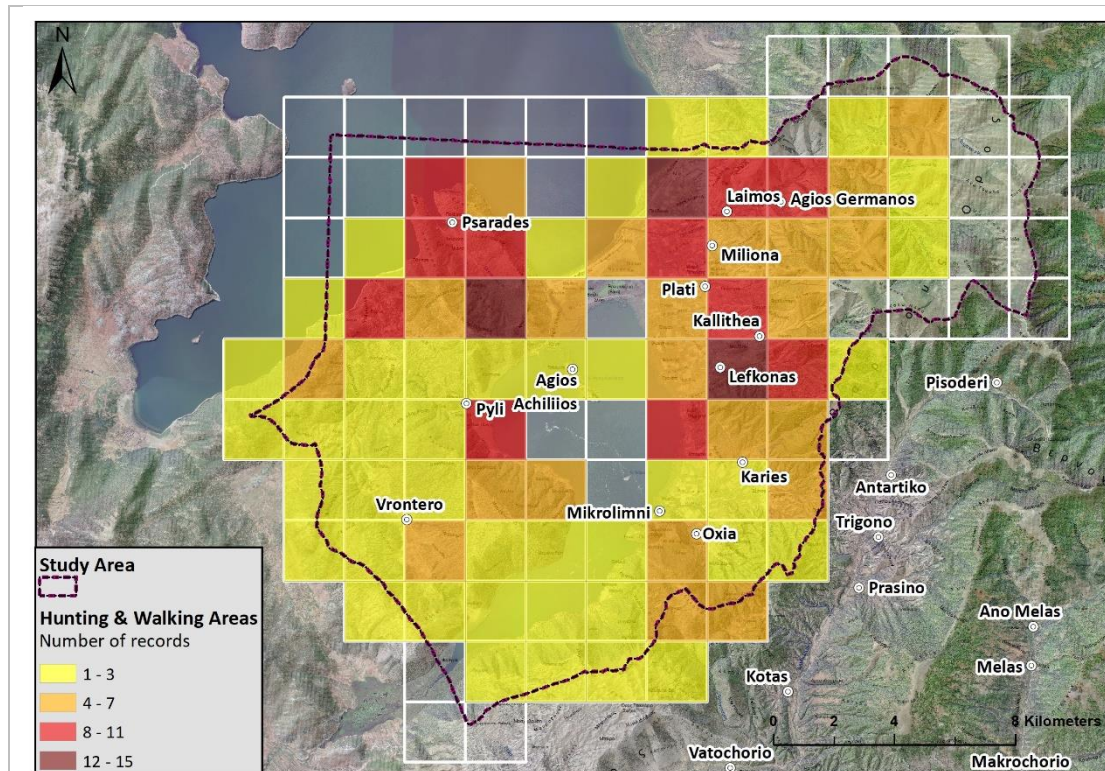
In total, 68 questionnaires were filled in in the framework of the survey. The great majority of the respondents were men (62 out of 68) and their age class was mostly between 30 and 60 years old (Fig. 1). Most of the respondents were farmers and/or stockbreeders, followed by people working in the private sector (Fig. 2).



One fifth of the respondents were hunters, while 2/3 of them used the study area for recreational walking (Fig. 3). The majority of hunters hunt for European hare, followed by those who hunt wild boar. Most of the hunters go hunting more than once per week during the hunting season (Fig. 4).



The respondents were asked to identify on the map the areas they use for hunting and/or walking. The combination of the hunting and walking areas indicates the area “used” by the respondents and consequently the geographic area which most of the data provided by the respondents regarding wild boar sightings, tracks, damages etc. refers to (Map 3). As can be seen in the map, the areas that are used the most by the respondents are mainly located in the vicinity of the villages.

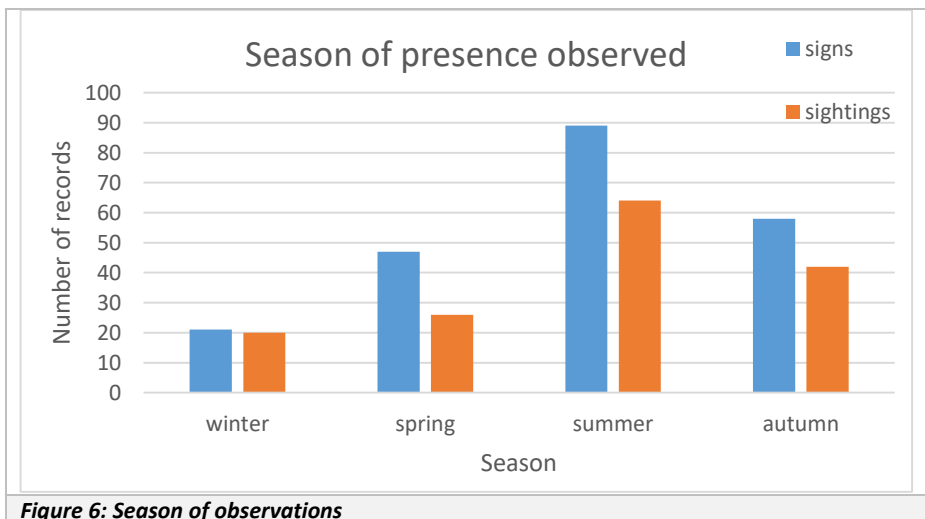
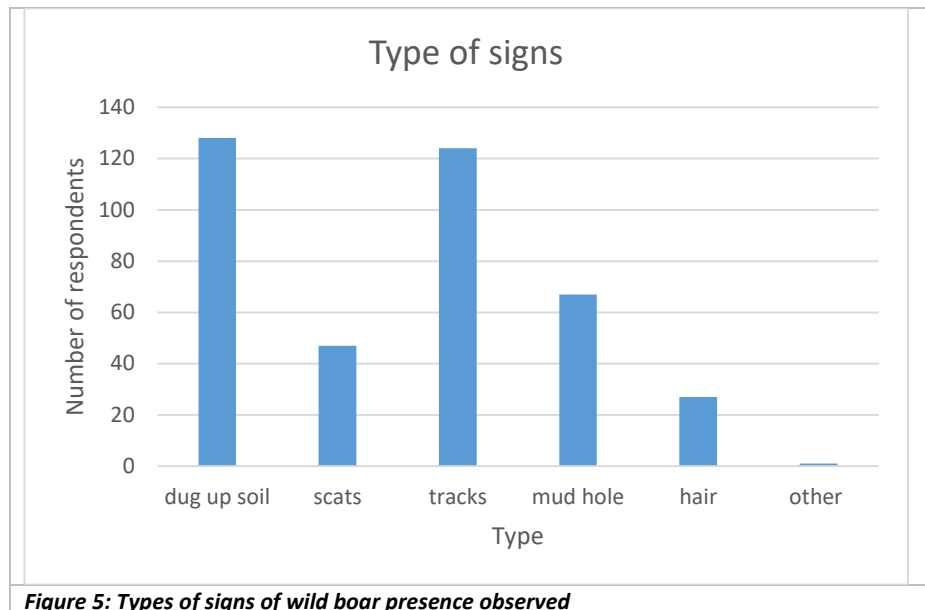


Map 3: Area used by the respondents: the ‘number of records’ refers to the number of times a particular quadrat was mentioned by interviewees as being one they used for their activities (hunting, walking, etc).

3.2 Presence of wild boar

90% of the respondents stated that they had observed wild boars within the study area in the last year. In total, 151 sightings were recorded, that is around 2.5 sightings per respondent in a one-year period. Similarly, the great majority of the respondents had observed tracks, scats or other signs of wild boar presence, with the most common type of signs being tracks and dug up soil (Figure 5). Hunters and walkers seemed to observe signs more frequently than the non-hunters and non-walkers (2.31, 2.47 and 1.67 records of signs/respondent respectively).

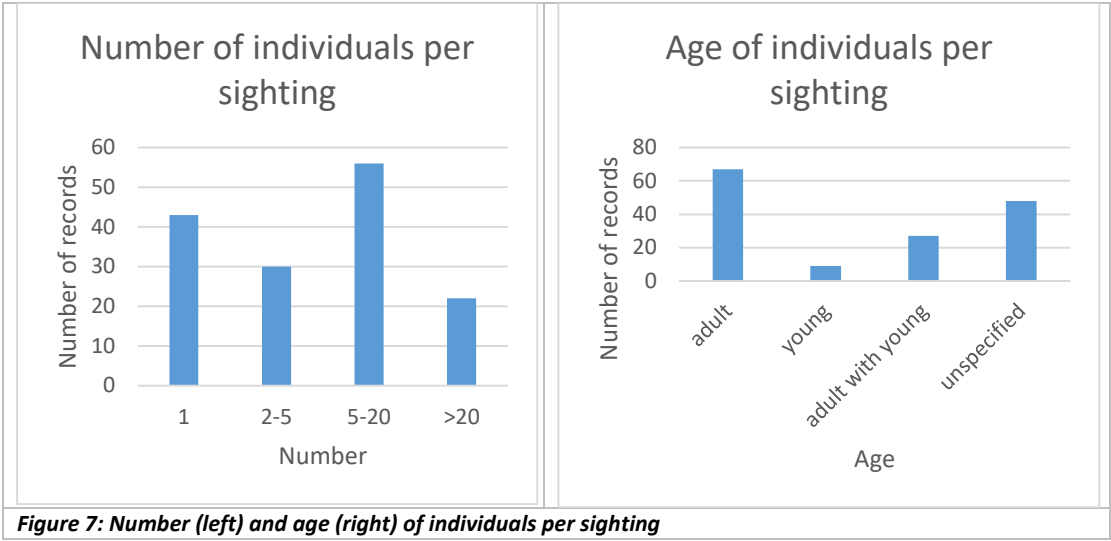
Regarding the season when sightings and signs of presence had been observed, most records took place in summer and autumn (Figure 6). Regarding the time of the day, most sightings were recorded during night and morning hours, but there were a significant number of sightings during afternoon and dusk/evening.



Most of the time, 5 to 20 individuals were observed per sighting, followed by the sightings of a single animal (Figure 7). The majority of the sightings refer to adult animals (Figure 7). According to the responses, when adults and young were observed together, the adult/young ratio was 0.33 ± 0.18 . In a few cases, sightings of dead wild boars were made (11 records). Most of these cases refer to piglets drowned in irrigation ditches. A few sites were indicated as sites with no presence of wild boars. These areas are usually around the villages (therefore wild boars don't use them due to the human presence), or areas with difficult access (e.g. the island of Agios Achillios) or lack of vegetation for cover.

Regarding the habitat, most of the sightings occurred on the roads (Figure 8), usually while driving. The next most common habitats with sightings are farmland and forests. The frequency of encounters with wild boars on roads is also highlighted by the cases of collisions with cars recorded in the survey. In particular, three incidents of collisions have been recorded, while another five cases were reported where the collision was just avoided. On the other hand, in the case of signs of wild boar presence, the most common habitats are farmland

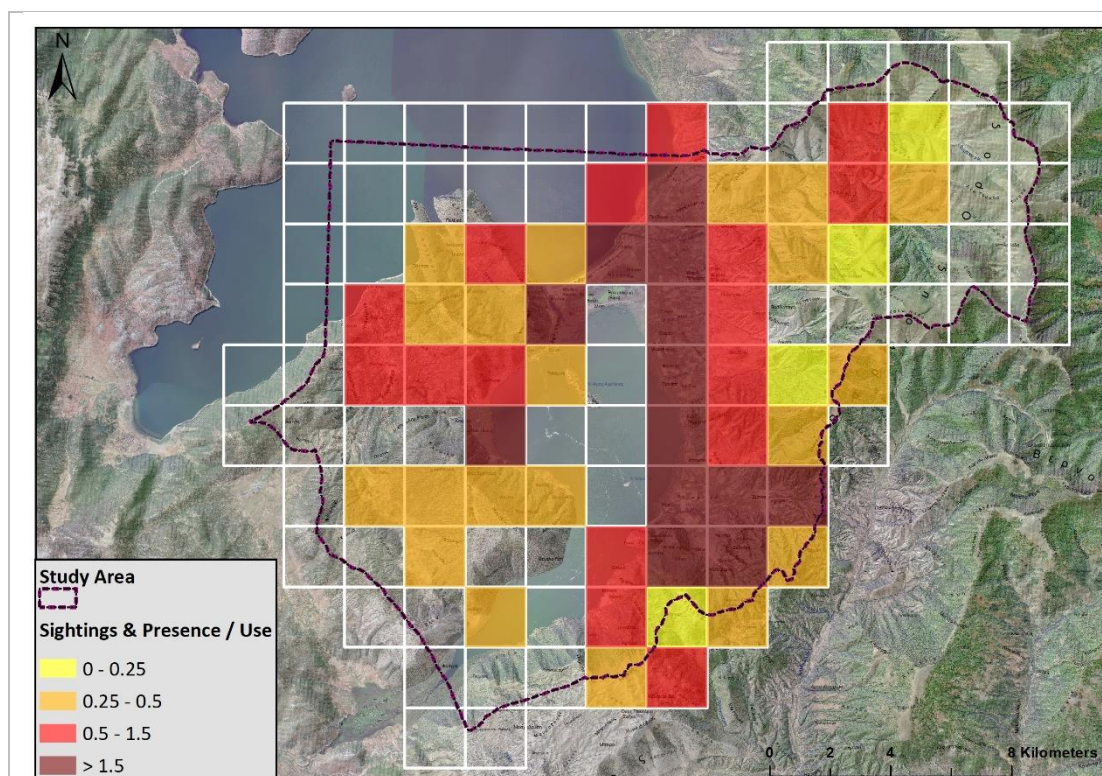
and forests (Figure 8), with the bean fields being the most common type of crop where animals or signs were observed.



Almost 80% of the respondents believe that the wild boar has a permanent presence in the area, while almost 90% of them estimate that the wild boar population in Prespa has increased during the last 10 years. The respondents also highlighted the frequency of encounters with either large individuals (males) or large groups of animals, as well as the bold behaviour of the wild boars towards humans.

Finally, the general perception regarding the movement pattern of the wild boars was that the animals usually move from the forested slopes towards the lakes. The spatial distribution of wild boar occurrence, estimated by overlaying the records of sightings and the ones of signs observed in the study area is shown on Map 4. In order to normalise the data, the values for each 2x2 km plot were calculated as follows: the number of records of wild boar occurrence

(sightings and/or signs) in any given plot was divided by the number of respondents using that same plot (i.e. walking or hunting). For example, within plot X1 there were 5 sightings and 3 signs of presence of wild boar, while the same plot was used by 2 respondents as a walking area and by another 2 as a hunting area. Therefore, the value for plot X1 is $(5+3)/(2+2)=2$. According to the calculated plots' values on the map, the littoral and farmland zone in the eastern part of Lesser Prespa, as well as the isthmus in the northern part, seem to be the areas with the most frequent presence of wild boar.



Map 4: Presence of wild boar in the study area. Each colour represents a range of plot values, according to the calculation described in the above paragraph.

3.3 Damage by wild boar

60% of respondents reported damage by wild boar and, in total, 67 cases were recorded. The type of damage varied and multiple types were often recorded in the same instance.

The most frequent types of damage-causing activity by the wild boars were associated with the digging up of soil and the uprooting and trampling of bean plants (Figure 9). Another type of recorded damage, which directly affects the bean cultivation, is when wild boars knock over the canes that support the bean plants.

There are two main categories of damage caused by the activities of wild boar in the study area: i) damage to crops – mostly destruction of plants, particularly bean plants, and ii) damage to the pastures in the littoral zone – mostly digging up of soil – which makes the pastures unsuitable for grazing.

Damage to crops usually occurs when the wild boars cross through the bean fields in order to reach the littoral zone of Prespa or return from there to their daytime haunts. During these movements they may: a. destroy bean plants by trampling or uprooting them, or just by hauling the bean plants along and knocking down the supporting canes in their effort to cross

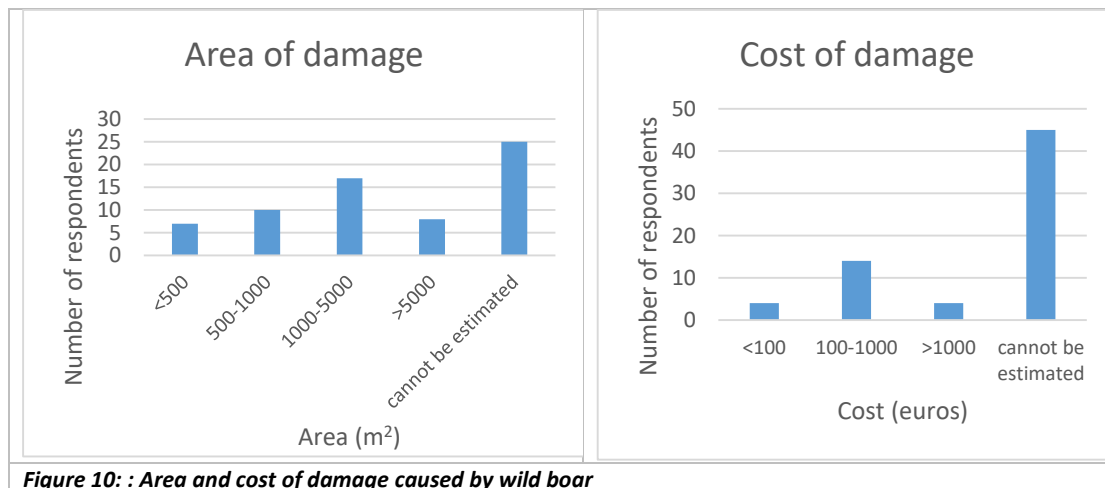
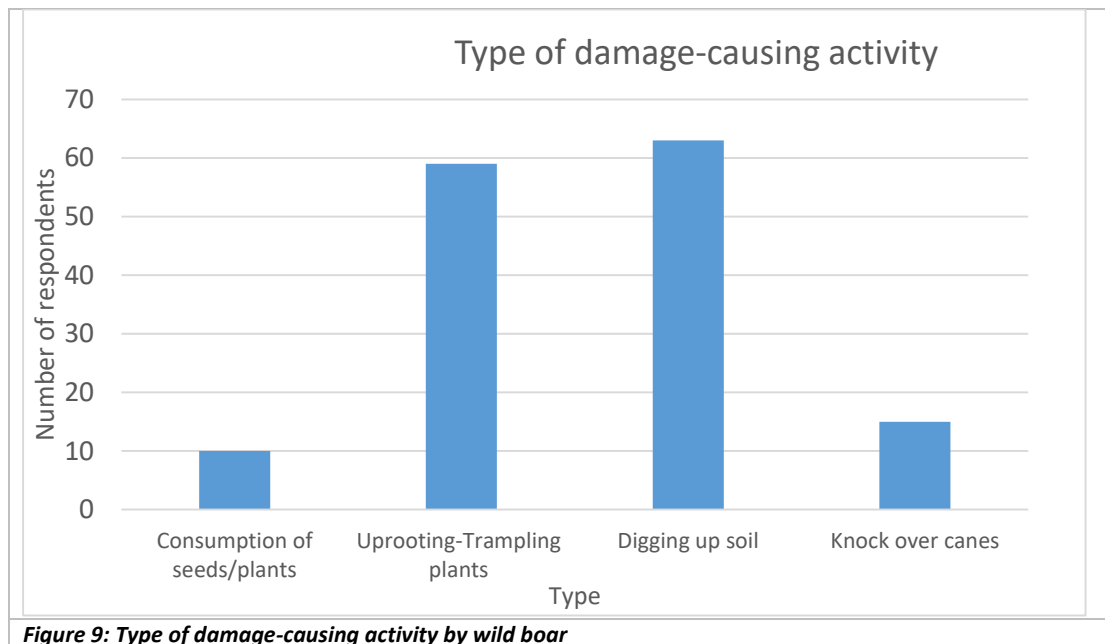
the dense rows of plants; b. in their search for food they dig up the furrows, thus creating problems for the proper irrigation of the fields which is practiced by flooding the furrows between the plants. So the passing of wild boars through a crop field may either result in a real damage in the case of plant uprooting or destruction or, in the case of furrow-messing or cane-knocking, in a problem that has to be discovered and fixed. This type of damage takes place mainly in summer and autumn, as during this period crops are in full growth and any plant destruction, uprooting etc. cannot be recovered, thus having a financial impact. In contrast, damage to pastures can be observed throughout the year, especially in areas with short rough grass, such as the eastern part of the littoral zone of Lesser Prespa. In areas where the grass grows higher, damage occurs mainly in autumn after the completion of the mowing carried out by the local stockbreeders (e.g. in the northern part of the Lesser Prespa) (Photos 1 & 2).



Photos 1 & 2: Damage caused by wild boar to pastures in Prespa

The actual extent of damage to the fields is difficult to estimate; during summer and autumn the bean plants are fully grown, densely covering the surface of the field, thus access of

farmers to every part of the field is difficult, therefore, “close inspection” and estimation of the damage is not feasible. In addition, the estimation of the cost of the damage can only be made after the harvest, when the actual loss of the production can be calculated. As during the implementation of the survey, the harvest had not been completed, a more accurate estimation of that year’s damage was not feasible. These issues are reflected in the answers to the questionnaires: most of the respondents were unable to estimate with precision the extent (area) or the cost of the damage (Figure 10).



In any case, the great majority of the respondents believe that the damage caused by wild boars has increased during the last 5 years due to the increased number of wild boars in the area (Figure 11). Map 5 depicts the spatial distribution of the recorded damage. The cases of damage are concentrated in the farmland zone around Lesser Prespa Lake and especially in its eastern part. Again, in order to normalise the data, the values for each 2x2 km plot were calculated with the same method, as the one described in Section 3.2: in any given plot, the

number of records of damage by wild boar was divided by the number of respondents using that same plot (i.e. walking or hunting).

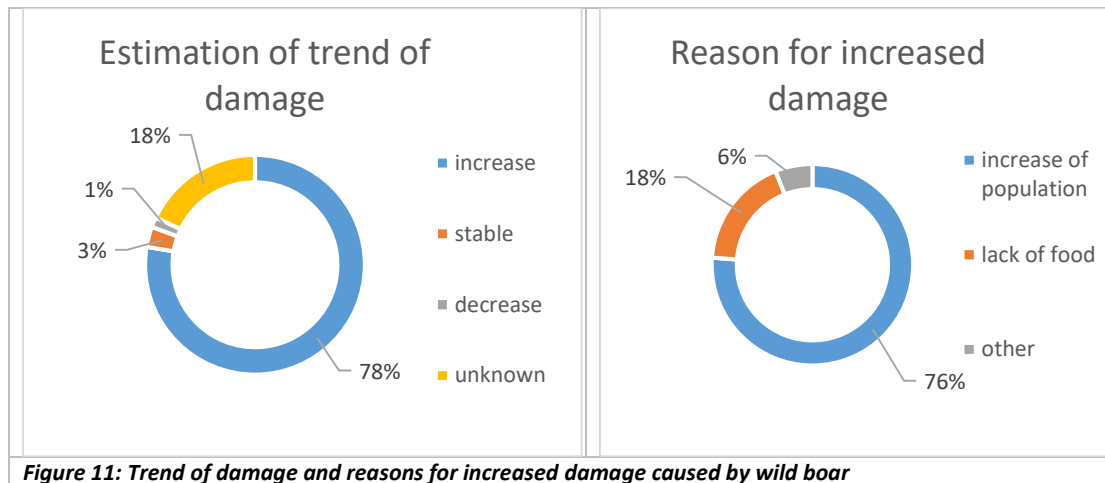
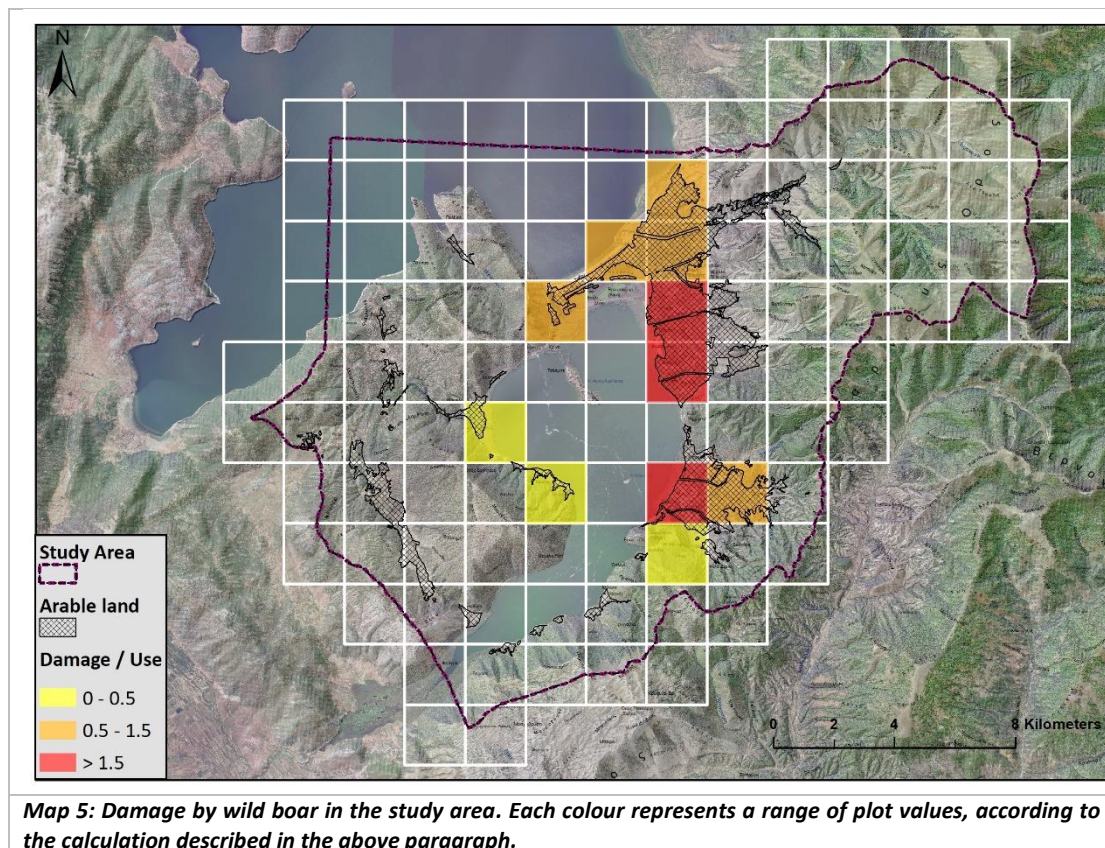


Figure 11: Trend of damage and reasons for increased damage caused by wild boar

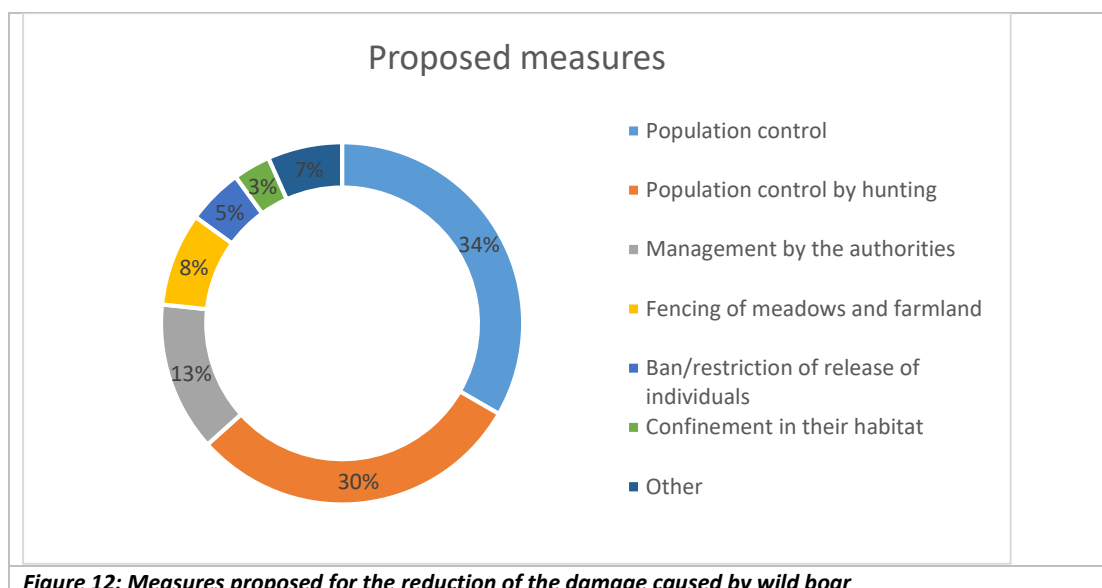


Map 5: Damage by wild boar in the study area. Each colour represents a range of plot values, according to the calculation described in the above paragraph.

3.4 Proposed measures

The reply to the question “what should be done to decrease the damage caused by wild boar” was open type, therefore the responses varied greatly. In an effort to categorise the given answers, we list below the measures which were proposed by the respondents (see also Figure 12):

- Population control of the wild boar (without specifying method),
- Population control of the wild boar through culling. Under this response, some more specific measures were proposed, such as: increase of the bag limit, increase of the permitted hunting days per week and permission of wild boar hunting in non-hunting areas,
- Management of the problem by the relevant authorities (without specifying any concrete measures),
- Fencing of areas sensitive to damage to limit the access and/or fencing of suitable wild boar habitats to keep the animals away from the cultivations,
- Ban or restriction of the release of wild boars for hunting purposes,
- “Confinement” of wild boar in its habitat without specifying any concrete measures,
- Wetland vegetation management in order to prevent providing wild boars refuge within the reedbeds,
- Use of repellent constructions, such as scarecrows,
- Provision of supplementary food,
- Improvement of the compensation system for damages caused by wild boar.



4. DISCUSSION

The questionnaire was not randomly addressed to local people, but specifically to those who, because of their profession (farmers, stockbreeders), hobbies (e.g. hunting) and habits (hiking, jogging, etc.), would have had greater opportunities to meet with live wild boars, or had a greater likelihood of recognising their tracks and signs in the field. Half of the interviewees were farmers by profession and for this reason they spent a large part of their time in their fields, while almost all of them used private vehicles to get around, also increasing the possibility of encountering wild boars. The questionnaire included questions aimed at helping to tackle this triple attribute of the interviewees in a way that would allow unbiased results to be obtained, but also proportionate to the time the interviewees spent in each place/habitat/activity and the frequency of wild boar sightings (live and/or tracks and signs). We had little success with this aspect, however we consider that this fact does not introduce a bias that alters the value of the quantitative results of the study.

A very large percentage of interviewees reported wild boar tracks and signs and/or visual contact with live wild boars over a large portion of the study area and this confirms the wild boar's "widespread occurrence" in Prespa (Catsadorakis & Kollaros, 1985). All available data (information from interviewees, camera trap results, personal communications and personal observations) showed that it is encountered from the forested slopes of the mountains to the lowland agricultural zone and the littoral zone around the Lesser and Great Prespa lakes.

According to the interviews, records were made throughout the year but were more frequent in summer and autumn. Furthermore, most tracks and signs were observed in the bean fields and secondarily in woodland. With a relatively low number of interviewees spread over an area of some hundred square kilometres, it is rather difficult to reach conclusions about the variability of wild boar densities in a variety of habitats. Most likely the increased frequency of records in summer and autumn is owing to the fact that most respondents were farmers, who spend many hours in a rather restricted space (their fields) during these two seasons and thus they are more likely to see wild boar tracks and signs of presence. Nonetheless, what we can take from these data is that wild boars certainly visit the bean fields, or pass through them, often, at least during summer and autumn, something which took place to a much lesser extent, or not at all, up until 5-10 years ago. This result could be directly associated either with the actual seasonal activity patterns of the wild boar, or to the higher presence of people in the field in those seasons, or both. Certainly, it could also have been affected by the fact that the interviewees responded according to their memory, therefore recent sightings in autumn and summer were more likely to be reported (the interviews took place between July and October).

That most sightings of live animals (and many signs in the cultivated fields as well) were made from dawn to dusk confirms the fact that the wild boar in such a landscape is mainly active at night, something in agreement with Jdeidi et al. (2010). However, the not inconsiderable number of records in the early morning or early evening hours indicates that there are also movements of wild boars in the area during daylight, something which can also be associated with the remarks by many respondents that these animals have shown a rather bold behaviour toward humans in recent years.

The majority of sightings of live animals referred either to groups of 5-20 animals or solitary individuals, and this is again in full agreement with what is known for the social organisation of the species in Europe (Jdeidi et al., 2010). It is interesting to note that quite a few

interviewees underlined the unusually high size of broods (piglets of the same age grouping together), which is believed to be connected to cases of hybridisation with feral pigs, or with animals released by hunters' associations, allegedly belonging to different, more prolific "strains" of wild boar.

Most sightings of live wild boars were made by motorists while the animals were crossing roads. This is something that takes place in many parts of the world with many wildlife species and is of course commensurate with the size of several parameters, such as: the densities of the species, the amount and speed of traffic, the dimensions and features of roads and road sides, attributes of habitats crossed by the road, etc. Connected with the above is the increasing number of instances of wild boar- vehicle collisions taking place the last 10 years in Prespa, some of which were also reported as a recent threat by a few respondents who were aware of such cases. This is a real threat to both the wild boars and humans, which is understood to increase as a wild boar population grows, as the local traffic volume and average speed of vehicles increases, and of course when the mobility of animal movement patterns changes, as well as according to landscape and road features (Gunson et al., 2011; Neumann et al., 2012). We are not sure which of these factors operates with wild boar in Prespa but, based on the answers and comments obtained in the study, we strongly suspect that they could be easily attributed to all of the above reasons.

The vast majority of respondents believe that the wild boar population is resident in Prespa and has markedly increased in the last 10 years. A similar consensus is shared by the hunting and conservation communities in many European countries (Tack, 2018); overall wild boar numbers have been growing steadily across Europe in the past 30 years.

Most respondents have developed the understanding that the animals move from the forestlands to the lake and vice versa. From their answers we have not been able to obtain further insights into the possible causes underlying the spatial and temporal patterns of these movements. According to the literature the seasonal presence and movements of the species are related to the availability of food and access to feeding grounds, as well as the selection of resting places, which provide safety from disturbance and predators (Schley & Roper, 2003; D' Andrea et al., 1995). Moreover, protected areas (where human disturbance is limited and hunting is forbidden) act as a source of secure places for resting periods throughout the year, but also provide food resources (Rossel et al., 2004). According to the results of the study, in Prespa the presence of wild boars in the lowlands around the lakes is more frequent during late spring, summer and early autumn. This is likely related to the actual presence of the animals, but also with the increased presence of people (observing the animals or their signs) in the agricultural zone during this period. In fact, there are repeated and confirmed observations of wild boars in the marshes and reedbeds of the isthmus between the two lakes during winter too (SPP unpublished data, H. Nikolaou and M. Malakou pers. comm.). Moreover, during the winter the MBPNP has recorded damage in the meadows caused by wild boars, while in Prespa's littoral zone several snares for wild boars have also been found (for an example please refer to the letter with Ref. No. 319 sent by the MBPNP to the Forestry Service of Florina on 11/2/2020). Thus, there are sufficient arguments to support the claim that wild boars are present in the littoral zone of Lesser Prespa Lake all year round.

According to the interviewees' responses, the areas with highest frequency of wild boar presence are the littoral and farmland zones on the eastern side of the lake and the isthmus between the two lakes. A number of plausible explanations exist, which rather tend to persuade us that this is the actual situation and not a reflection of the intensity of observation:

on the western side of Lesser Prespa Lake, oak woodland and juniper-oak shrubland reach the lakeshore along a long frontline, so if wild boar need to reach the lakeshore they may do so easily without having to cross any barrier. In contrast, on the eastern side of the lake there are only a few spots where the outer borders of oak woodland reach the water's edge, whilst everywhere else the distance between the forest edge and the lakeshore is wide (ca 2-5 km), and, in addition, the animals have to cross the barrier of the intensively cultivated bean field zone (average width ca 1500m) in order to reach the water or the reedbeds and the marsh along the shore. Furthermore, the isthmus between the two lakes hosts the largest and most inaccessible marsh and reedbed areas, providing food, shelter, safety and water for the animals.

The most frequently reported damage concerned the destruction of bean plants by moving and feeding animals, the destruction of pastures by digging and the wrecking of irrigation furrows, again by digging. According to the respondents, the damage caused by wild boar in Prespa is frequent. Damage to the bean crops isn't caused by the wild boars foraging on the crops themselves. On the contrary, the animals trample, drag and uproot the densely growing plants and their supporting canes as they move between them, as well as uprooting plants in their effort to find food by digging. In fact, in other areas in Europe trampling of crops may constitute the most important source of crop loss (Amici et al., 2012; Schley & Roper, 2003). The other main type of damage in Prespa is the digging of soil in pastures or wet meadows in the littoral zone of Lesser Prespa Lake, probably in search of specific types of food, such as worms found in grassland soil (Baubet et al., 2004, Schley et al., 2008), or perhaps plant rhizomes and tubers. Therefore, wild boar negatively affects the two main human activities in the primary sector, farming and stockbreeding, causing income loss.

Although in general respondents failed to assess the extent and the economic value of damage by wild boar, most believe that damage frequency and magnitude have increased the last 5 years, mainly due to a population increase in wild boars. In most cases attempted evaluations of income loss referred to 0.1-0.5 ha and less than €1,000 per case.

The most frequently proposed measures for the mitigation of the wild boar problem centred on population control (in general, methods unspecified) and population control through culling and fencing. In order to limit the extent of damage by wild boar to the agricultural land, a number of preventative methods has been explored in Europe. Three methods dominate amongst the attempts to reduce wild boar damage: i) reduction of population density by hunting (culling), ii) fencing of crops or use of other deterrent systems to prevent wild boars from entering the fields, and iii) provision of supplemental food in the forest to keep the wild boars off the farmland. A number of studies have shown that hunting (culling) can significantly reduce population density and damage frequency (Mazzoni della Stella et al., 1995; Geisser & Reyer, 2004; Sweitzer et al., 2000). The mere presence of high numbers of hunters (and battues) may force wild boars to move to other areas with less disturbance. Within a particular territory, however, damage only seems to be reduced when the animals are reduced. Most often, the effect of culling seems to be relatively small, taking into account the high reproductive potential of wild boar. In addition, the results of management actions are not always tested and wild boar density/damage relationships have rarely been quantified. It might also be expected that, when populations are reduced to well below the local environmental carrying capacity, increased fecundity can occur, leading to high rates of population increase and compensatory growth (Bengsen et al., 2013).

Some authors recommend fencing as the most successful method of damage prevention, while others did not see a significant impact (Geisser & Reyer, 2004; Tack, 2018). More specifically, fences only seem to cause wild boars to shift their damaging activity to less protected regions in the area or to other habitats (e.g. grassland) (Geisser & Reyer, 2004).

Several studies provide evidence for a successful reduction of damage using supplementary food, however others find no significant reduction (Geisser & Reyer, 2004; Tack, 2018). Careful planning, co-ordination and timing of supplementary feeding is vital to ensure success and lead to less agricultural damage. However, when there is a food shortage wild boars tend to increase their range in order to find new food sources to survive. This has implications for both the spread of transmissible diseases and the potential for damage to agricultural crops and property. In such cases, additional feeding can limit the dispersal of wild boar populations. High energy food such as maize is especially efficient in these cases (Tack, 2018).

In any case, the conflict between humans and wild boar needs to be tackled and measures for its mitigation should be explored, but always bearing in mind that Prespa is a protected area with very important biodiversity at global level. Therefore, the problem of the damage caused by wild boar, as well as the appropriate measures for its mitigation, should be examined taking into account the needs of the many rare and important species which breed or winter in the area, and thus any measures applied must have no more than the minimum impact upon them. For example, attempts to cull the wild boar population outside the hunting season or in non-hunting zones could cause very serious disturbance problems to a number of protected species. Even the fencing of areas to create “non-wild boar zones”, should, at the same time, ensure the free, unrestricted movement of other wild species. Therefore, in an area protected for its rich biodiversity such as Prespa, any planning and implementation of measures for the mitigation of the damage caused by wild boar, should take into account the ecological needs of the rest of the wildlife and the impact of the proposed measures upon them.

5. CONCLUSIONS

Wild boars are widespread in Prespa, being present all year round; they seem to be active mainly at night, but also around dusk and dawn, and have the typical social organisation which is reported in the literature for Europe. The vast majority of respondents believe that the wild boar population has markedly increased in the last 10 years.

Most sightings of live animals were reported by motorists while the animals were crossing roads. The high number of road-crossings might be related to an increased wild boar population, an increased mobility of motorists and/or a change in the mobility patterns of the animals or a combination of those factors. Most respondents consider that the animals move from the forestlands to the lake and vice versa, and this is a movement that was not observed so frequently in the past. Most tracks and signs were observed primarily in the bean fields and secondarily in woodland, which may be attributed to the length of time most of the respondents spend in their fields. The areas with the highest frequency of wild boar presence (live animals + tracks and signs) are the littoral and farmland zones at the eastern side of the lake and the isthmus between the two lakes. This can most likely be attributed to the geomorphology of the basin and the landscape differences between the eastern and the western part of Lesser Prespa Lake, as well as the extent and the inaccessibility of the reedbeds and marshes on the isthmus between the two lakes. The causal factors behind the wild boar population increase, as well as those behind the spatial and temporal activity patterns and movements of the animals within the basin, are not clear.

The most frequently reported damage was the destruction of bean plants by moving and feeding animals, the reduction of the grazing value of pastures by disturbing the soils of large areas through digging and the wrecking of irrigation furrows in the bean fields, again by digging. The extent and economic value of the damage are difficult to estimate accurately enough, but in most cases referred to areas of 0.1-0.5 ha and less than €1,000 per case. Most people believe that damage frequency and magnitude have increased the last 5 years, due to the population increase of wild boar. The most often proposed measures to cope with the problem were population control (unspecified methods) and population control through culling and fencing. Decisions on effective methods to tackle the problems and damage caused by the wild boar population in Prespa should certainly take very thoroughly into account the implications any management measures may have for the rich wildlife and biodiversity of this valuable area.

BIBLIOGRAPHY

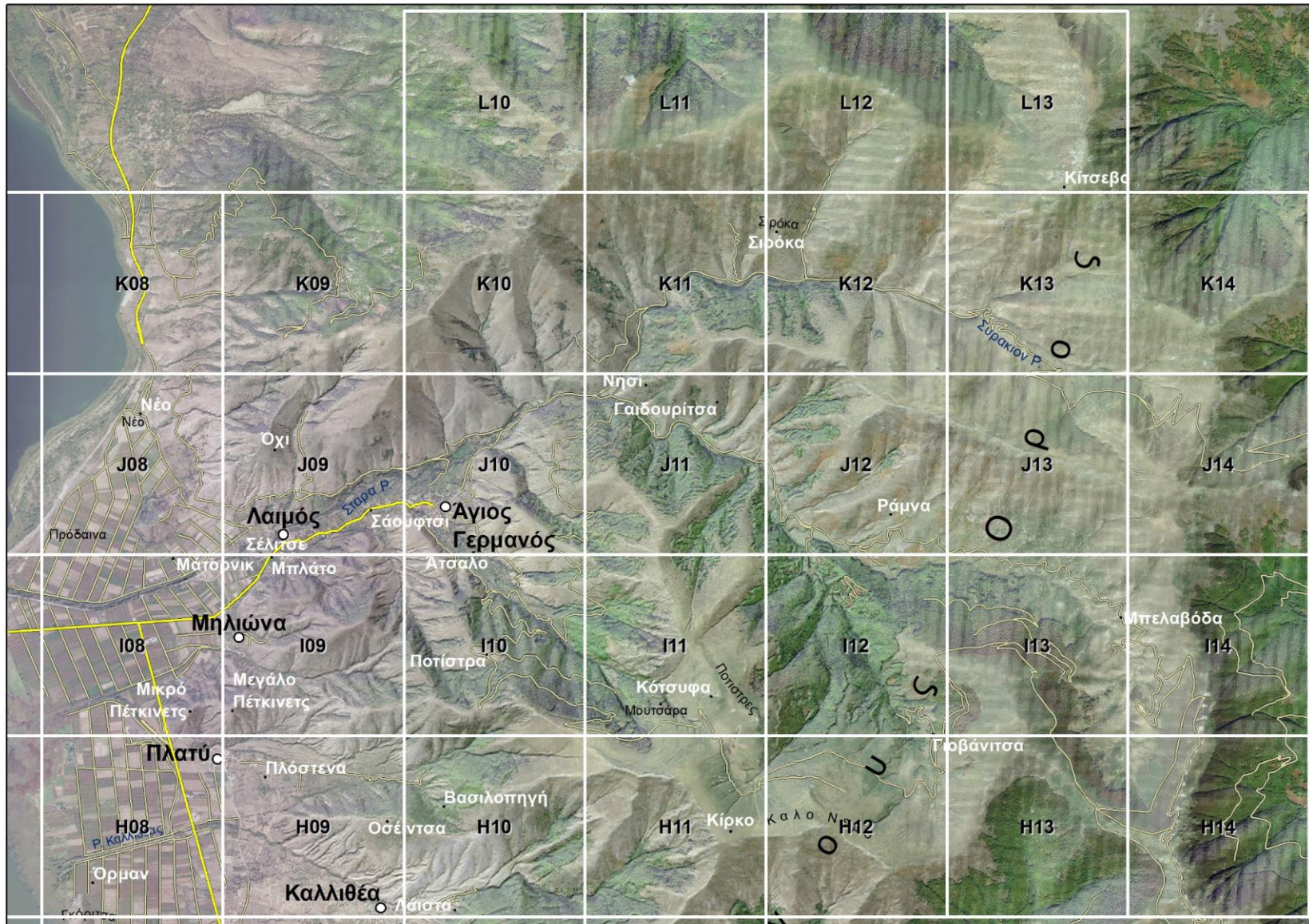
- Amici, A., Serrani, F., Rossi, C. M., & Primi, R. (2012). Increase in crop damage caused by wild boar (*Sus scrofa* L.): the “refuge effect”. *Agronomy for Sustainable Development* 32: 683-692.
- Baubet, E., Bonenfant, C. & Brandt, S. (2004). Diet of the wild boar in the French Alps. *Galemys* (16): 99-111.
- Bengsen, A., Gentle, M., Mitchell, J., Pearson, H. & Saunders, G. (2013). Impacts and management of wild pigs *Sus scrofa* in Australia. *Mammal Review*, doi:10.1111/mam.12011.
- Calenge, C., Maillard, D., & Fouque, C. (2004). Efficiency of spreading maize in the garrigues to reduce wild boar (*Sus scrofa*) damage to Mediterranean vineyards. *European Journal of Wildlife Research* 50: 112-120.
- Catsadorakis, G. & Kollaros, D. (1985). Preliminary notes on the mammalian fauna of the Lake Prespa National Park (W. Macedonia, Greece). *Biologia Gallo-hellenica* vol. 12, pp. 507-517.
- Catsadorakis, G., Papadopoulou, E., Petrakos, M. & Koutseri, I. (2018). Status of fisheries at Megali Prespa Lake and Mikri Prespa Lake, Greece, based on a census of fishermen's opinions. *Environment and Ecology Research* 6(6): 583-592.
- Center for Sustainable Entrepreneurship Excelixi S.A., (2015). Strategic study for the funding tools under the new CAP in Prespa area.
- D’ Andrea, L., Durio, P., Perrone, A. & Pirone, S. (1995). Preliminary data of the Wild boar (*Sus scrofa*) space use in mountain environment. *IBEX Journal of Mountain Ecology* vol.3, 117-121.
- Geisser, H. & Reyer, HU. (2004). Efficiency of hunting, feeding and fencing to reduce crop damage by wild boars. *Journal of Wildlife Management* 68: 939-946.
- Giannakis, N., Bousbouras, D., Argyropoulos D. & Kazoglou, Y. (compilers) (2010). Management Plan of Prespa National Park. Prefecture of Florina, Management Body of Prespa National Park, Florina.
- Giménez-Anaya, A., Herrero, J., Rosell, C., Couto, S. & García-Serrano, A. (2008). Food habit of wild boars (*Sus scrofa*) in a Mediterranean Coastal Wetland. *Wetlands*, 28 (1): 197-203.
- Gunson, K.E., Mountrakis, G., & Quackenbush, L.J.. 2011. Spatial wildlife-vehicle collision models: A review of current work and its application to transportation mitigation projects. *Journal of Environmental Management* 92: 1074-1082.
- Herrero, J., Giannatos, G., Kranz, A. & Conroy, J. (2007). *Sus scrofa*. The IUCN Red List of Threatened Species 2007: e.T41775A10562008. Downloaded on 31 January 2020.
- Iliopoulos, G. & Petridou, M. (2017). Preliminary Investigation about the human –large carnivore conflict in the Prespa National Park, Greece. Prespa National Park Management Body (in Greek).
- Jdeidi, T., Masseti, M., Nader, I., de Smet, K., & Cuzin, F. (2010). *Sus scrofa*. The IUCN Red List of Threatened Species 2010: e.T41775A10561189. Downloaded on 30 January 2020.
- Keuling, O. & Leus, K. (2019). *Sus scrofa*. The IUCN Red List of Threatened Species (2019): e.T41775A44141833. Downloaded on 31 January 2020.

- Keuling, O., Stier, N. & Roth, M. (2009). Commuting, shifting or remaining?: Different spatial utilisation patterns of wild boar *Sus scrofa* L. in forest and field crops during summer. *Mammal Biology* 74:145–152.
- Mazzoni della Stella, R., Calovi, F. & Burrini, L. (1995). The wild boar management in a province of central Italy. *IBEX Journal of Mountain Ecology* 3:213–216.
- Neumann, W., Ericsson, G., Dettki, H., Bunnefeld, N, Keuler, N.S., Helmers, D.P., Radeloff, V.C. 2012. Difference in spatiotemporal patterns of wildlife road-crossings and wildlife-vehicle collisions. *Biological Conservation* 145: 70–78.
- Rossel, C., Navas, F., Romero, S. & De Dalmases, I. (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.
- Saez-Royuela, C. & Telleria, J.L. (1986). The increased population of the wild boar (*Sus scrofa*) in Europe. *Mammal Review* 16:97–101.
- Schlageter, A., & Haag-Wackernagel, D. (2012). Evaluation of an odor repellent for protection crops from wild boar damage. *Journal of Pest Science* 85: 209-215.
- Schley, L. & Roper, T.J. (2003). Diet of wild boar *Sus scrofa* in Western Europe, with particular reference to consumption of agricultural crops. *Mamm Rev* 33:43 – 56.
- Schley, L., Dufrêne, M., Krier, A. & Frantz, A.C. (2008). Patterns of crop damage by wild boar (*Sus scrofa*) in Luxembourg over a 10-year period. *Eur J Wildl Res* (2008) 54:589–599.
- Society for the Protection of Prespa (2017). Five-year Strategic Framework 2018 – 2022.
- Sweitzer, R. A., Van Vuren, D., Gardner, I.A., Boyce, W.M & Waithman, J.D. (2000). Estimating sizes of wild pig populations in the north and central coast regions of California. *Journal of Wildlife Management* 64:531-543.
- Tack, J. (2018). Wild Boar (*Sus scrofa*) populations in Europe: a scientific review of population trends and implications for management. European Landowners' Organization, Brussels, 56 pp.
- Wetland Management Committee (2016). Minutes of the 9th Meeting of the Wetland, Management Committee. Agios Germanos, 17/3/2019

APPENDIXES

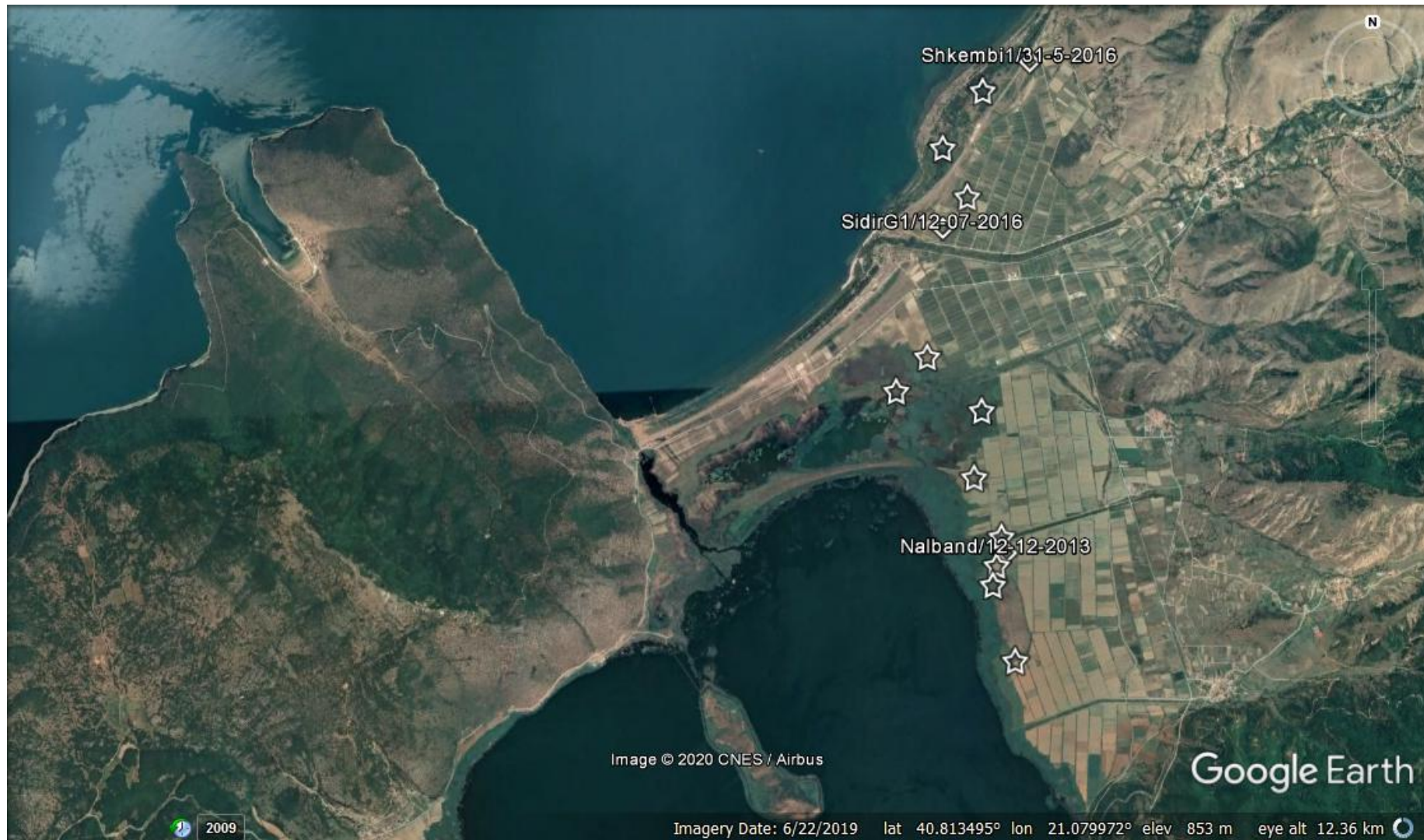
- A) Questionnaire (in Greek only, as accompanying separate PDF)**
- B) Sample of map (in Greek only, below)**
- C) Maps indicating locations of wild boar damage made in reports to the Management Body for the Prespa National Park, Greece (below)**

Appendix B

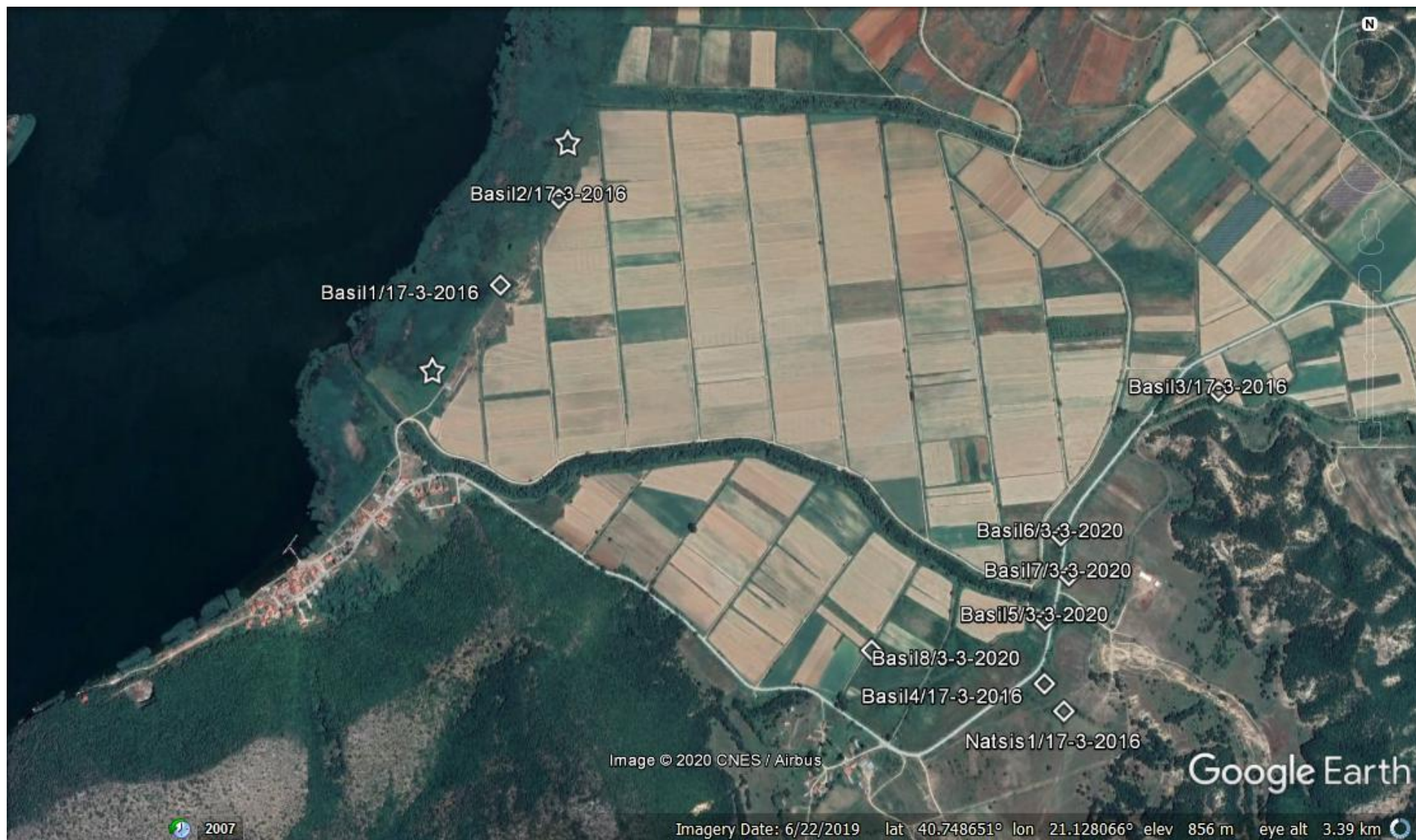


Map of grid used to identify locations of incidences of wild boar damage in the Prespa National Park, Greece

Appendix C



Map 1 of incidences of wild boar damage which have been reported to the management Body for the Prespa National Park, Greece. Locations marked with a diamond and a date are incident reported to the management body, locations marked with a star are those where farmers not included in the study have reported damage or where SPP staff have observed extensive digging by wild boar.



Map 2 of incidences of wild boar damage which have been reported to the management Body for the Prespa National Park, Greece. Locations marked with a diamond and a date are incident reported to the management body, locations marked with a star are those where farmers not included in the study have reported damage or where SPP staff have observed extensive digging by wild boar.