POPULATION STATUS AND HUMAN-COMMON WARTHOG (*PHACOCHOERUS AETHIOPICUS*) CONFLICT AROUND ABIJATA-SHALLA LAKES NATIONAL PARK, CENTRAL RIFT VALLEY, ETHIOPIA

MSC THESIS

BY

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JIMA, ETHIOPIA

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A THESIS SUBMITTED TO POST GRADUATE RESEARCH, COLLEGE OF NATRAL SCIENCE, SCHOOL OF GRADUATE STUDENTS, JIMMA UNIVERSITY, JIMMA, ETHIOPIA

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Examiners' Approval Sheet

We, the undersigned, members of the board of examiners of the final open defence by TadesseZenebehave read and evaluated his/her thesis "Population Status and Human-Warthog (*Phacochoerus Aethiopicus*) Conflicts around Abijata-Shalla Lakes National Park, Central Rift valley, Ethiopia" and evaluated the candidate. This is, therefore, to certify that the thesis has been accepted in Partial fulfillment of the Requirement for the Degree of Master of Science in Biology.

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Final approval and acceptance of the thesis is contingent upon the submission of the final copy the thesis to the candidate's Department through the office of the Department Graduate Program Coordinator.

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Declaration

I, the undersigned, declare that this thesis entitled "Population Status and Human-common Warthog (*PhacochoerusAethiopicus*) Conflict around Abijata-Shalla Lakes National Park, Central Rift valley, Ethiopia" is my original work and has not been presented for any other award, and that all sources of materials used in this thesis are duly acknowledged. This thesis was carried out under the supervision of my principal advisor TsegayeGadisa (PhD), Department of Biology, College of Natural and Computational Sciences, Jima University in the academic year of 2022.

Name of student candidate: _____

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This thesis has been submitted for examination with my approval as university **advisor/co-advisor**.

Name of the advisor _____

Signature of the Advisor with date: _____

Name of the co-advisor: _____

Signature of the co-advisor with date: _____

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List of Acronyms

ANOVA Analysis of variance

ASLNP Abijata-Shalla Lakes National Park

GPS Global positioning System

HWC Human and wild life conflict

M.a.s.l Meter above sea level

NGO Non-Governmental Organization

SPSS Statistical Packages for Social Sciences

ABSTRACT

This study was conducted to assess population abundance and human-common warthog (phacochoerus aethiopicus) conflict around abijata shalla lakes national park, central rift valley, Ethiopia from December 2019 to November 2020. The main objective of the study was to evaluate population size and the level of conflict between the local community and the common warthog around the Abijata Shala Lakes National Park, Central Rift Valley, Ethiopia.Data were collected through questionnaire, interview, direct observation and focus group discussion and data were analyzed using SPSS computer software package and compared using t-test for independent sample of groups. The population sizes were studied during both wet and dry seasons.The maximum number of common warthog recorded was 216 during the wet season and the lowest 132 during the dry season. The highest population was recorded during august and the lowest in January. The male to female ratio of adults and sub-adults together was 1.00:1.63. Respondents reported habitat disturbance, proximity of natural forest, increased subsistence agriculture and increased of wild animals' population as causes of HWC. As Abijata Shalla Lakes National Park forest was surrounded by extensive farmlands, the area needs a close follow up and detailed studies to identify current human-wildlife conflict in the area.In general, there was conflict between common warthogs and the surrounding people. Therefore, the park authority should reduce human settlements and expansion of farmlands around the park.

Key words; Abijata Shalla, Common warthogs, National Park,Population Status, Seasons

1. INRTODUCTION

1.1. Background of the study

Human-wildlife conflict is a worldwide problem both in urban and rural areas (Distefano, 2005). It is intense in developing countries particularly in Africa including Ethiopia mainly in and around protected area when human and wildlife live in proximity (GetachewGebeyehu&AfeworkBekele, 2009). Human-Wildlife Conflict (HWC) has recently become one of the fundamental aspects of wildlife management as it represents the most widespread and complex challenge currently being faced by the conservationist around the world. Human wild life conflict arises mainly because of the loss, degradation and fragmentation of habitats through human activities such as logging, animal husbandry, agricultural expansion, and developmental projects (Fernando *et al.,* 2005). As habitat gets fragmented, the boundary for the interface between humans and wildlife increases, while the animal populations become compressed in insular refugees.

Human–herbivore conflicts are generally more intense in developing countries particularly in Africa including Ethiopia, mainly in and around protected areas, where agriculture is important aspects of rural people's livelihoods and income (Else, 1991, Treves *et al.,* 2006;Eniang*et al*., 2011). Increasing human population in Ethiopia has resulted in overexploitation of natural resources, which in turn led to a variety of human wildlife conflict. In addition to insects and small mammals, elephants, baboons, monkeys, warthogs, and different antelopes cause major crop damage when these animals venture out of the protected areas looking for food (Petersen, 2003). These animals can also cause significant damage to human lives. These losses can trigger conflict between rural people and wildlife (Begg*et al*., 2007; Bonham *et al*., 2007).

The common warthog is the most wide spread extant wild pig species. It occurs practically everywhere in Africa, except in arid regions and in tropical forests. Owing to fragmentation of habitats and expansion of agricultural land use, warthogs, like other large mammals, are now restricted to protected areas. Up to 10 different subspecies in the warthog were originally named on the basis of cranial characters (reviewed in Meester and Setzer, 1971). Kingdon (1989) however dismissed the recognition of subspecies. Recently, only four subspecies were provisionally recognized (Grubb, 1993): P.*hacochoerusafricanusmassaicus* (inhabiting eastern Africa), P. *africanussundevallii* (southern Africa) P. *africanusafricanus* (western Africa) and P. *Africansaeliani* (Eritrea and Ethiopia).

Based on genetic evidence two distinct species of warthogs were recognized in Africa specifically the common warthog (*Phacochoerusafricanus*) and desert warthog (*Phacochoerusaethiopicus*) (Kleiman*et al*., 2004). These two species are distinguished largely through the presence and absence of functional incisors and external appearance (d'Huart& Grubb, 2005). The common warthog is distributed widely over Africa. An important component of their diet is underground rhizomes, bulbs, and tubers, all of which are dug up with the tusks and snout (Nyafu, 2009). They have specialized multi-cusped hypsodont third molar and reduced premolars which makes them well-adapted to grazing (Mendoza &Palmqvist, 2007).

Common Warthogs are considered a pioneer species as they are one of the first species to inhabit and utilize previously disturbed habitats, potentially promoting nutrient turnover in soils and grasses and assisting in their restoration (Treydte*et al.,* 2006a, 2006b). They have economical potential as a profitable species in terms of recreational and trophy hunting, eco-tourism and meat production (Somers &Penzhorn 1992). Considered a popular bush meat species, they are hunted and utilized by local communities for subsistence and readily exterminated locally by

hunting with domestic dogs. Local markets also trade in warthog ivory, obtained from the large canines. Use and Trade Common Warthogs have an economic value as a game animal hunted for trophy value and meat provision (Vercammen & Mason 1993). Generally, Common Warthogs are used for local subsistence, commercial meat provision, trophy and recreational hunting, and live animal auctions (Somers &Fike 1993; Nyafu 2009).

1.2. Statement of the problems

Nowadays, wildlife in the world is being reduced by different reasons. Especially in developing countries like Ethiopia, the issue is very critical. These countries expand agriculture and industries, which have negative side effect on the wild life of these countries.To restore and conserve many wild lives, Ethiopian government develops and designs policy, strategies, proclamation and regulations at national and regional level. In addition to that the government tries to establish national parks, sanctuaries, protected areas, etc. However, these areas have been facing many problems due to their closeness to human settlement. This cause conflict between human and wildlife in different ways like human–herbivores conflict. These conflicts have negative effect on both in the abundance of some wild animals and on the economic value of farmers.

Population growth, land use around the protected areas and human wildlife conflicts are the major challenges observed around these protected areas (Ashenafi& Leader Williams, 2005). Competition between local communities and wildlife has been reported in various conservation area of Ethiopia (Kumsa&Bekele, 2014;Tessema*et al*., 2007). However, the nature and magnitude of the problem varies from area to area depending on human population growth rate and scarcity of critical natural resources especially grazing and farm land (Kumsa&Bekele, 2014).

The Abjitata-Shala Lakes national Park area is very much threatened by overgrazing and deforestation for fuel wood production and illegalsettlements (Temesgen*et al.,* 2013).The terrestrial habitats faced degradation and fragmentation due to major agricultural activities which compete with wildlife for food, cover and space. Subsequently, the biodiversity of both terrestrial and aquatic habitats are under great challenge (Tafesse, 2008). In ABSLNP, farmers reported significant crop and other damages resulting from HWC including warthogs. Warthogs are killed for raiding wheat, rice, beans, or groundnut fields. In some agricultural areas, people are also eliminating this species, as they can potentially carry African swine fever. Local farmers are affected by food shortages and undernourishment for several reasons, including shortage of land, unreliable weather, low crops yield as a result of low soil fertility, lack of improved varieties, and damage by different wild life including warthogs. Several researches are carried out to minimize human-wildlife conflict inside protected areas. But only few researches are done to shed light on Human-Warthog conflict inside protected areas. It was in this context that the present research was to be conducted and was expected to fill the gap of knowledge in this regard.

1.3 Research Objectives

1.3.1 General objective

The general objective of the study was to record population size and common warthog conflict between the local community around the Abijata-Shala Lakes National Park, Central Rift Valley, Ethiopia.

1.3.2 Specific objectives

- To determine population size of the warthogs in Abijata-shala Lakes National Park
- To look at the human – common warthogs conflict in the area
- To look at the type of crop damaged by common warthogs
- To identify the measures taken by farmers to avoid crop damage common warthogs

1.4. Limitation of the study

The study area was inside and in the boundary of the ASLNP focusing only on common warthog.

1.5. Significance of the study

This study is an original contribution to the existing literature in several ways. First, it generated information about the type of the major problematic HWC, perceived extent of their damages, perception of population change, and proportion of farmers suffering from the conflicts. Secondly, the study was expected to identify the direct and indirect economic, environmental, and social impacts as a result of the HWC in the area, as perceived by the farmers. Thirdly, it shared farmers' knowledge about the management and control options for reducing warthog's damage. Additionally, management options, best experiences and lessons practiced are expected to be documented so that the farmers in other areas may adopt better methods to manage the conflicts. Here we aim to fill the gap of scientific data on the approaches to human-warthog conflict management in and around ASLNP, Central Rift Valley Ethiopia.

2. LITERATURE REVIEW

2.1. Description of the common warthog

They are characterized by a broad snout, long curved tusks and warts on the sides of the face (Ewer 1958; d'Huart& Grubb 2005).The tip of their tails has a small clump of black hair (Smithers 1983).Their bodies are grey in color (Smithers 1983), and sparsely covered with coarse bristles about 40 cm long (Smithers 1983). There are long black, brown or yellowish erectile hairs along the mid-back from the ears to the base of the tail (Skinner &Chimimba, 2005).The size of adult male common warthogs is usually weighed up to about 100 kg, whilst females weigh around 70 kg (Treydte et al. 2006; Smithers 1983). Warthogs are short-sighted and short legged, as a result they are quick to respond to the warning calls of other mammals or birds (Smithers 1983). Males are bigger than females and their tusks are longer compared to females (Mason 1982; Smithers 1983). The upper tusks of old adult females tend to curl over the top of the snout more than those of males (Ewer 1958; Smithers 1983). Common warthogs are distinguished from desert warthogs by the presence of two upper and six lower functional incisors (Grubb 1993). They have cone-shaped warts under the eye, their ear tips are erect and the head is slightly diabolo-shaped when viewed from the front, whereas the desert warthog has hooked warts, bent ear tips and the head is more egg shaped (d'Huart& Grubb 2005).

2.2. Distribution of the warthog in Africa

In Africa, there are two species of warthogs (Suiformes, Phacochoerinae), the common warthog (*Phacochoerusafricanus*Gmelin, 1788) and the desert warthog (P. *aethiopicus* Pallas, 1766) (Grubb, 1993; Randi *et al*., 2002). The two species diverged genetically some 3 million years ago (Randi *et al*., 2002) and differ in morphology (d'Huart& Grubb, 2005). Common warthog is widely distributed in Africa, and numerous studies on its ecology and behaviour have been

published. The distribution of desert warthog is discontinuous with the extinct Cape warthog (*P. aethiopicusaethiopicus*) restricted to the south-western part of the Cape Province of South Africa and the extant desert warthog (P. *aethiopicusdelamerei*) confined to the horn of Africa (d'Huart& Grubb, 2001).

Little is known of the biology of desert warthog, and its distribution is poorly described although the species is regarded as of least concern (IUCN, 2010). The abundance of the species is equivocal (d'Huart& Oliver, 1993; Grubb, 1993). Some of the locations that d'Huart& Grubb (2001) confirmed the presence of desert warthog are in highly insecure regions of Kenya and Somalia. The continued civil war in Somalia is a factor that could influence distribution and persistence of wildlife. It has not been ascertained that the species still occurs in these ranges, and therefore, the objective of this study was to provide locations where the species was present, captured and positively identified.

2.3. Distribution of the common Warthog in Ethiopia

In Ethiopia warthogs are distributed throughout arid lands (including Airori on the Danakil Depression from where De Beaux (1931) reported P.africanus), Savanna and lightly wooded areas below approximately 200m and are completely excluded only from the dense forests of the south-west. They occasionally extend as high as 3000m in some parts of the plateau, and up to 3500 on the summit of Mt.Gaysay, in Bale Mountains National Park (Yaldenet al.1996). A recent ground survey in Ogaden reported that warthogs were abundant in all areas visited, even close to villages and towns (Wilhelmi, 1997).

They have been reported to be abundant in Ethiopia as a whole (Hillman 1993). It has been confirmed that specimens collected in the Rift Valley of Ethiopia attributed to P.aethiopicussensulatop.africanusYalden 1996. Probably all warthogs from the Ethiopian

highlands are P.africanus. A skull of this species from Metemma near the western border of Ethiopia has also been examined. The only confirmed records of phacochoerusaethipicusdelamerei from Ethiopia are a skull, from Dolo (De Beaux, 1992) and lower jaw (as well as direct field observations) from KebriDehar (F.Wilhemi, personal communication, 2000). The latter provide the first evidence that desert warthogs still survive in modern Ethiopia.

Figure 1 view of common Warthog in the study area

2.4. Diet of warthogs

Understanding the nutritional status of plants and animals is essential for wildlife population and habitat management (van der Waal et al. 2003). Common warthogs are grazers, foraging on a wide range of food resources with high nutrient levels, specifically grasses (Nyafu 2009). The diet of these animals consists of grasses, sedges, fallen fruits and forbs (Vercammen& Mason 1993; Nyafu 2009). Warthogs can also dig out roots using their tusks and rhinarium, depending on the abundance of food resources available (Ewer 1958). They prefer to feed in damp areas,

with fresh and green grass (Somers 1992; Vercammen& Mason 1993). Nyafu (2009) showed that in the Eastern Cape they may increase browse intake, particularly in winter.

2.5. Pest status and common warthogs

As explained byEyebe*et al.,* 2012)The transformation of wood lands, forests, savannah and other ecosystems into agrarian areas or urban agglomerates as a consequence of the increasing demand for land, food production, energy and raw materials, has led to a dramatic decrease in wildlife habitats. The gradual loss of habitat has led to increasing conflict between humans and wildlife (Frank, 2012).Largely, crop raiding is the main sources of conflict between wild animal and rural people in the world (Distefano*et al*., 2010) which includes wildlife moving from their natural habitat on to agricultural land to feed on the crops that humans grow for their own consumption (Ojo*et al*., 2010). Primate crop-raiding has been recorded in at least 73 species in nearly all range countries varying from raiding small garden crops to raiding commercial plantations (Warren, 2003). Competition for food between human and non-human primates can have significant impact on both agricultural yields and human nutritional status. Because of this communities perceive conservation of wildlife and their habitat often negatively. Moreover, Thorton et al., 2006.stated that they are not willing of participating in preservation for the reason that, rather than they get immediate benefit from conservation, they are repeatedly affected by their negative impact.

2.6. Reproductive Biologyof warthogs

Reproduction may be markedly seasonal. They inhabit areas with distinct dry and rainy seasons and tend to breed towards the end of the wet season (peaking around early April). Females of desert warthog are polyestrous, with estrous periods lasting for about 72 h (d'Huart and Grubb, 2001). Common warthogs are seasonal breeders with the mating season occurring in May and

June (Somers *et al*. 1995). The mating system of warthogs is promiscuous, with males mating with numerous females and the females mating with more than one male (Somers *et al*. 1995). Their gestation period is approximately 170 days, and the average litter size is 3 with a range of 1-8 (Somers &Penzhorn, 1992). Adult female warthogs (between three and five years) have a high reproductive capacity (Boshe 1981), as compared to older and young ones. Warthogs can live up to the age of about 17 years (Mason 1982).

2.7. Threats to warthog

The major threats to warthogs include overhunting, adverse climatic conditions, disease and predation. Humans are a threat through overhunting for meat and are probably the most important threats to *P. africanus* (Vercammen& Mason 1993). Human overhunting is allegedly the main factor that contributed to the early extinction of the Cape warthog *P. aethiopicus* (Vercammen& Mason, 1993) although the evidence for this is limited (Skead 2007). Vercammen& Mason (1993) noted that warthogs are highly susceptible to a range of diseases that could seriously affect local populations i.e. African Swine Virus (Dixon & Wilkinson, 1988). They are also susceptible to low temperatures such that high mortalities occur during extreme cold weather conditions (Vercammen& Mason 1993). This could probably be caused by their lack of insulation (Smithers 1983; Vercammen& Mason, 1993).

Warthogs are preyed upon by lions, leopard and spotted hyaena (Tambling et al. 2009). Lions are the top predators preying on warthogs, probably followed by leopards (Vercammen& Mason, 1993). Other possible predators of warthogs include caracal, brown hyaena and black-backed jackal (Somers &Penzhorn, 1992; Somers &Fike, 1993). Warthogs can sometimes defend themselves against predation by cheetahs and wild dogs (Mason 1982). Sometimes warthogs are taken out of their burrows by lions (Smithers 1983).

2.8. Human –Wild Animal Conflict

Human-Wild animal conflict is resulted when the needs and behavior of wild animal negatively impact human safety or when humans negatively affect the needs of wildlife. For instance the 5^{the} World Park Congress in Durban pointed out that Human-wild animal conflict occur when the needs and behavior of wild animal impacts negatively on the goals of humans or when the goal of humans negatively impacts on the needs of wild animal (Lewis, 1996).

Conflict between humans and wild animals is one of the most widespread and intractable issues facing conservation biologists today. Naturally, organisms live together in an ecosystem for a long period of time by showing high degree of intrinsic stability through time and resilience to climate and other environmental factors in the given ecosystem(Messmer, 2000).However, because their habitats are increasingly alter by humans, some wild animals persistently cause considerable problem to humans, other animals or the environment (Anonymous, 2001).Conflict humans and wild animals are one of the major threat of affecting the relationship protected areas and communities living adjacent to the protected areas (Naughton-Treves, 1998). Human-wild animal conflicts vary according to geography, land use patterns, human behavior, and the habitat and behavior of wildlife species (Leta, 2014). Most wild animal species come in to conflict with people when they damage property or threaten human safety by their activities (feeding, killing, browsing, grazing), digging and burrowing. A further reason for conflict is that wildlife are carriers of diseases that can be harmful to people and their domestic animals (Mesele, 2006). It is recognized that humans have profoundly impacted wildlife and the environment in many ways. These are through habitat loss, pollution, introduction and spread of exotic and invasive species, overexploitation, and climate change. One of the effects of human activities is introduction of exotic species.Most of the introduced species cannot build up an adaptive coexistence with

native species. In addition, in many cases, the introduced species are not capable of resisting predator, disease and other factors that happened in the habitat, as a result HWCoccur (Messmer, 2000).

HWC has been the cause of series damage to both humans and wild animals for years (Raini, 1996). It occurs as result of occurrence of both parties in close proximity. The conflict usually starts when wild animals consume resources meant for human consumption: crops by herbivores and livestock by carnivores (Kissui, 2008). In addition, wild animals that have massif body size like elephants, rhinos, hippo's causes considerable damage to fences, electric posts and water pipes as they raid within settlement areas. In addition, such large animals could cause significant damage to crops trumping (Dudley *et al.,* 2008). Generally, a wide range of species with the principle culprits being insects such as locusts and caterpillars; birds such as seed-eaters and fruit-eaters; primates such as baboons and vervet monkeys; rodents such as rats, mice, springhares and porcupines; such as antelopes, bush pigs, elephants, hippos, buffalos and zebras; large carnivores such as loin leopards, hyenas, wild dog and wolves; small carnivores like gents, servals and mongooses; the crocodiles are responsible for conflict (Hill, 2000). Wild animal and people can coexist together if and only if the animals experience safe from humans' threats and if animals are not causing property damage or public health concern (Einarsen, 2002).

HWC incidents are widespread but not evenly distributed because they are dependent on the proximity of wildlife. In addition, different species cause different types of at different time of the year. The damage caused has different effects on the livelihood of the communities depending on their level of livelihood security (Mulonga, 2003). Human- wild animal affects species particularly large animals. Due to such conflicts, most are either critically endangered or declining rapidly because of the attacks by humans.

2.9 Human impact on wildlife

According to Muruthi(2000), 15 elephants (equal to three-quarter of the local population's mortality) had been killed in conflict with local people in Kilimanjaro heartland between 1996 and 1997. At the sometime one third of elephants mortality, which occurred in Amboseli in 1974 and 1990 were caused by local people (Murrthi, 2005)a study in Bible Elephant Sanctuary, Ethiopia from2004 to 2008 showed that six elephants were killed in connection with crop raiding problems (Yirmed, 2010). This made human-wildlife conflicts to be the major threats to conservation in Africa (Weladji and Tchamba, 2003). It also cause dilemma for state and most wildlife management authorities faced with the demand of local communities to control wildlife (Gillingham and Lee, 2003). The different activities of humans have its own impact on wildlife by modifying the behavior of animals and species distribution. The distribution of behavior al patterns can affect their social structure because social structure is key components of in the evolution and dynamics of species. Thus it is distribution by human disturbance can have considerable effect on population performance even if the disturbance does not directly affect the survival and reproduction (Manor and Saltz, 2003). Factors like noise, disruption of the physical environment including migration, alteration of chemical environment and introduction of exotic species are responsible for disturbing the regularity of wildlife. Increasing human population and the associated impacts such as habitat loss and hunting are the underlying factors for decline of mammalian species. They are considered species threatening factors and vary in intensity across the surface of the earth. Species that populate more heavily impacted regions are increased their risk of extinction (Cardillo,2004).

3. MATERIALS AND METHODS

3.1. Description of the study area

Abijata-Shala Lakes National Park is located at the center of the Ethiopian Great Rift valley, 207 km South of Addis Ababa between latitudes of 7°30' to 7°40'N and 38°35' to 38°45'E. It covers an area of 887 km^2 at an elevation ranging between 1,540 and 2,075 m.s.l. The National Park encompasses three lakes: Abijata, Shallaand chittu.The Park is in the boundary of two weredas which are Negelearsi and Shashemene under which the study focuses on kebeles such as Labuusabbuuqaa and Sago mi'ooftu are in Shashemenewereda. The others are from Negellearsi such kebeles are Algedilbeto, Gubetaarjo, Mudhiarjo and Destaabijata. The dominant vegetation is open Acacia woodlandh is extensively overgrazed and deforested because of encroachment. The woodland vegetation covers 382 km2 (43%) of Acacia woodland. The two big lakes, Abijata and Shalla cover an area of about 506 km2 (57%) including Chitu Lake with an area of over 500 m2 with four nesting islands and spots of hot-springs (Tefera&Almaw, 2002).

The average rainfall within the Park is 500 mm per annum. The main rain season is between late January and early April but there are considerable variations from year to year. The temperature of the Park is normally in the ranges of 24 to 45°C. However, it can range more than 45°C during the warm months (May to June) (Tefera&Almaw, 2002). The Park is mainly established to protect aquatic birds such as Flamingo lesser, Great White Pelican, phytoplankton, zooplankton, and fish as well as several terrestrial species Grant's gazelles, Oribi, warthog, the Golden Jackal and spotted hyena (Abdi, 1993). The Park also harbors human settlement as well. As a result, an extensive area of the Park was disturbed for expansion of agricultural land and livestock grazing.

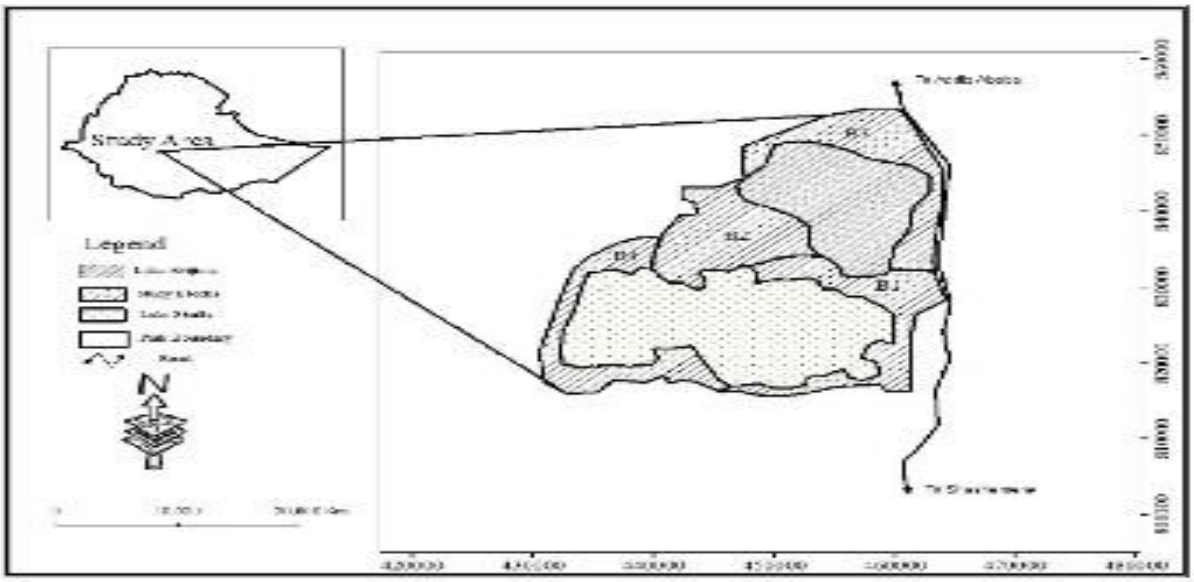

Figure1. Location map of Abijata Shalla National Park

3.2. Materials and methods

The materials used during this study were note book, pen, calculator, binoculars, digital camera, GPS, field guides, data sheets, Sleeping bag and rain coatwas used during the study period.

3.2.1 Preliminary Survey

The preliminary survey was conducted through informal interview with residents (elders), scouts, experts and forest area managers. Its purpose was not only to introduce the researcher with the study area and some responsible bodies, but also to acquire general background information about abijata shalla lakes national parks Area establishment.. Based on the feedback of the pilot survey, the questionnaire was revised and developed. The preliminary survey was conducted in January, 2019 before the actual data collection

3.3Data source and Method of data collection

3.3.1 Sampling method

This study wascarried in ASLNP from August 2019 to June 2020. Both primary and secondary sources of data were used for the study. For the primary data, before the actual study of the area, reconnaissance survey was done to have some information about the study area and adjust the questionnaire and the checklists for the group discussion. And the secondary data were collected from Woreda offices and from project plans and reporteddocuments. The household selected from nearbyworedasrandomly such kebeles are Algedilbeto, Gubetaarjo,Mudhiarjo, Labuusabuuqa, Sagomi'ooftu and Destaabijata.

3.3.1.1 Questioner survey

The household data were collected using well-structured survey design. The questionnaire were administered to farmers within their farm and/or residence, at a random manner based and

different age groups. Key informants were selected with the expert from the park considering deep knowledge about the area. Household survey data were collected using the structured and semi structured questionnaire to generate information.

3.3.1.2. Field Observation

Field observation was carried out to observe the distribution and to estimate the population abundance of common warthogs using direct observation on foot during the study period. This was carried out when common warthogs was most active with good visibilities in the morning (6:00-8:00AM) and in the afternoon (4:00-6:00 PM) time.

3.4. Line Transect Survey

A research design was established depending on this initial field observation. The actual data was collected by dividing the study period in to dry and wet seasons. Data collections were carried out in April and May 2019 to accommodate the dry season which are the highest dry months in the study area, and July and August 2019 to accommodate for the wet season that are the most wet months of the study area. Seasonal differences in the population size, age categories and abundance of common warthogs across dry and wet season was compared. Quantitative data was collected on the population size, age and sex categories.

3.4.1. Population Count

Survey was carried out to observe the distribution and to estimate the population abundance of common warthogs using direct observation on foot during the study period. Physical features were used for sex identification of common warthogs. Counting of the population of common warthogs was carried out starting from 06:00 - 8:00 AM in the morning and from 04:00 to 06:00 PM in the afternoon. This data collection was conducted in two seasons of different months of

the year. The first season was dry season in April and May (2019) and the second season was in July and August (2019) which is wet season. Division of the observation or count in to wet and dry season was very important to see whether a season affects the population size of common warthogs in the study area.For the sake of this investigation, the park area was divided into 3 parts based on vegetation cover.

Total counting of warthog population in the Park required intensive coverage of the whole forest area in both dry and wet seasons. Direct observation was made by unaided eye and/or using binoculars depending on the distance between the observer and focal animals as well as the topography of the habitat. There was minimal human error in counting warthogs, because they were seen singly or in very small group. Additionally the counting blocks were selected based on natural boundaries and/or artificial boundaries that were noticed easily if there was movement of animals from one block to the other.

During the census, detailed observation of the entire herd was collected. Warthogs were assigned to one of the three age classes. The classes were the adult male and female, sub-adult male and female, and unknown sex (young) since they hide in the long grass and bushes. The habitats in the park were classified as woody grassland, woodland and open grassland. The vegetation type in which the warthogs were observed was recorded in order to analyze the wet and dry season distribution of the animal. For the purpose of this investigation, the Park area wasdivided into three blocks. The whole population was counted, rather than a smaller sample of the whole to estimate population size. This was based on silent detection as accomplished by NortonGriffiths (1978), Sutherland (1996) and Kumssa and Bekele (2008). Total estimation of warthog population in the Park required intensive coverage of the whole study area in both dry and wet seasons.

3.4.2. Sampling procedure

For the household survey, 10% of the total households were sampled. The sampling strategy was tobe stratified random sampling based on the land size and wealth status. The base for the classification of the wealth and land size class was developed from key informants and/or PA Leaders in the local situation. The sample size was proportionally being distributed for the land size and wealth categories.

3.4.3Sample size determination

From several approaches to determine a sample size this study were applied in simplified formula provided by (Yilma, 2005 cited in Adugna,2008) to determine the required sample size at 95% confidence level, degree of variability=0.5 and level of precision= 9%(0.09)

$$n = \frac{N}{1+N(\ell)^2} \quad \text{----------} \quad (1)$$

Where n is the sample size, N is the population size (total household heads size), and e is the level of precision.

Table 1.Population and households characteristics of study kebeles

Woreda	Kebele	Total Population	No. of sample households
Arssinegele	Alga dilbeto	100	10
	Mudhiarjo	500	50
	GubataArijo	286	29
	Dastaabijata	359	36
Shashemene	Labuusabbuuqa	598	60
	Sago mi'ooftuu	237	24

Source: Woreda Agriculture and Rural Development Offices and field survey

3.5. Data Analyses

The collected data were analyzed by using Statistical package for Social Sciences (SPSS) version 20. Chi-square test was used to analyze association of warthogs counted during dry and wet seasons and association of habitat with sex of warthogs. The results of the study were expressed in tables.

Descriptive statics used, responses werecompared using chi-square test. Chi-square test was used to analyze the extent of crops damage. In the study site, counting of the population of warthogs were carried out by walking on foot throughout the whole study sites which were divided intwo blocks/transect lines to precede the counting of population.

4. RESULT

4.1 Population Estimation

The data collected was done by dividing seasons in to wet and dry season. In order to understand the impact of seasons on wild life distribution and the vegetation cover. Table 2 indicates the common warthog observed in different habitat during the present investigation. The maximum number of common warthog recorded was 216 during the wet season and the lowest 132 during the dry season. Table 2 revealed that the highest population was recorded during august and the lowest in January. Result of warthog counts in ASNP is given in Table 2. The maximum population in this area was on compartment 3 and the minimum on compartenent 2. The total for all transects was 216. The highest population was recorded during wet season and the lowest in dry season. There were differences in the populations on transecting 1, 2 and 3 during wet and dry seasons (Table 2).Data of the animal survey in acacia dominated wood land given in Table 2 revealed the presence of 216 and 132 warthogs during wet and dry season respectively in the area. But the number of individual animal during wet season was not statistically significant (x^2 = 4.3, DF =2, P>0.05). There were differences in the mean number of warthog observed during wet and dry season in the different study blocks. The highest record during the wet seasons was 96 from block 3. The lowest mean was 55 in block 1. During the dry season, the highest mean was 59 in block and the lowest was 31 in block 2. Data on population counts in the study block 3 showed a significant differences (x2=14.23, DF=1, p<0.05) with more warthog during the wet season in Block 3 and during the dry season in B3.

Table 2. Total count of common warthog

season	Compartment 1	Compartment 2	Compartment 3	Total
Wet	65	55	96	216
Dry	42	31	59	132

Table 3. Total Sex category of common warthog

Season	M	F	Undefined	Total
Wet	70	100	46	216
Dry	34	48	50	132
Mean	52	74	48	174

4.1.1 Sex and age distribution of warthogs counted during the wet and dry seasons.

Out of the 74 individuals sighted during the dry observation period, adult females comprised 23.5% and adult males 32.5 %. Sub-adult females and sub-adult males comprised 14.3 and 16.3%, respectively and young 12.8 %. Adult male to female, adult to young and sub adult male to female did not showed significant differences between the sex and age structure in both wet and dry seasons. Out of total 216 of common warthog adult males are 51 and 76 are adult female. Female sub-adults are 25 and 28 are male sub-adult. 36 of from the total wet count are young.

Table 4. Sex and age distribution of warthogs counted during the wet and dry seasons.

	Adult		Sub- Adult		Youngˆ	Total
Season	M	F	M	F		
Wet	51	76	28	25	36	216
Dry	31	43	22	19	17	132
Mean	41	54	25	22	27	174

4.1.2 Distribution of warthog based on vegetation cover

Regarding to the distribution of warthog based on vegetation cover based on seasons, in wet season out of the total warthog count (216) majority 103 (47.7%) common warthogs prefer woody grass land, 71(32.8%) preferred open grassland and 42(19.4%) preferred woodland respectively. In dry season, 65(49.2%) preferred woody grassland, 43 (32.5%) preferred open grassland and 24 (18.1%) preferred woodland respectively.

Table 5. Distribution of warthog based on vegetation cover

Season	wood land	woody grass land	open grass land
Wet	42	103	71
Dry	24	65	43
Mean	38	84	57

4.2 Household response human-warthog conflict

The study presented questionnaires for both male and female respondents to share their idea about common warthog and their relations with human around the area. Majority 68.8% (n=144) of the respondents were males and few 31.2% (n=65) of the respondents were females. Regarding to educational background of the respondents, 58(27.7%) were illiterate, 45 (21.3%) completed basic education (can read and write), 71 (84%) completed primary education, 35(19.9%) completed secondary education. Most (78%) of the respondents were within the age of 31-40 years (Table 2). There is no significant difference among the age groups and educational status of the respondents ($\chi2 = 2.167$, df= 3, $p = 0.539$; $\chi2 = 2.210$, df= 3, $p = 0.530$), respectively.

Table 6. Socio-demographic characteristics of respondents

Socio demographic characteristics		responder	Percentage (%)
Sex	Male	144	68.8
	Female	65	31.16
age range	20-30	63	32.21
	31-40	78	42
	41-50	35	14.2
	51-60	23	6.4
	>61	10	5.1
Education	Illiterate	58	27.66
Background	read and write	45	21.65
	Elementary	71	33.84
	high school	35	16.95

4.2.1 Tendency extent and season of crop damage with respect to forest location

On the degree of crop damage by common warthogs, 165 (93.77%) of the respondents agreed that crop damage is increasing in high manner, 20 (3%) respondents reported that crop damage is low and the remaining are no idea about crop damage by common warthogs.

All the respondents were also asked about the amount of crop loss by common warthogs with regard with forest location 139(76%) of them responded there is high crop damage near to forest location (Table 7).

Table 7. Response of respondents about tendency extent and crop damage with respect to forest location

	measurement	Number of respondents	%
Tendency of crop damage	Increasing	165	93.77
	Decreasing	20	3.15
	No idea	24	4.24
Damage of crop with respect to forest location	forest zone	139	76.43
	Center	30	7.78
	Both	40	15.88

4.2.2 Animals those raid crop

There are different animals that damage crops around the study area. Most of the respondents, 75 (36%) responded that damage of crops by warthogs, 49(23%) responded that damage of crops by wild pigs and warthogs, 28 (14%) responded that damage of crops by porcupine, 24 (12%) responded that damage of crops by monkey, 22 (10%) responded that damage of crops by baboons and the remaining respondent say other animal damage crops (Table 8).

Table 8.Response of respondent about animals those raid crop

Animal	Number of respondents	Percent %
Warthog	75	36
wild pig and warthog	49	23
crested porcupine	28	14
Grivet monkey	24	11.8
Baboons	22	10

4.3 Control measure by the local people to reduce human warthog conflict

Regarding control/protection measures used to prevent common warthogs from crop damage, most of the respondents used physical Barriers Exclusion of wild animals can protect their crops. Properly designed, constructed and maintained, fences can be completely effective in preventing conflict between people and wild animals. They also used Stone walls to exclude warthogs from invading cultivated areas. Trenches and moats have been used. Watch towers also provide good vantage points, built around fields of crops. Simple alarm systems, using string and cowbells or tins, can also be effective and avoid the farmer having to be alert all night long. Dogs can be effective in protecting homesteads and livestock from attack by predators.

4.4 Crop damage by common warthogs

The current study confirmed that different animal pest's mainly common warthogs, Grivet monkey and Anubis baboons adversely damage crop in the study area. As the respondents stated, many crops mainly cereal crops such as maize, sorghum, grasses and also fruits and rootstalks etc. are the most preferable crops to common warthogs.Common warthogs are among the species most cited by farmers as notorious crop raiders. They cause much crop damage by eating. People who live adjacent to protected areas and national parks complain that common warthogs and other animal pest damage their crop. Because most farmers at these areas depend on agriculture (crop production and livestock farming) as their livelihood, they always compete for food to themselves and to their domestic animals with animal pests like common warthogs. This causes human wildlife conflict at these areas.

5.DISCUSSION

Warthogs are the only pigs adapted to grasslands and savanna habitats. They are known to have differences in their activity patterns based on seasons; graze during the wet season and dig out

underground rhizomes of perennial grasses, sedges, bulbs and tubers during the dry season with the tough snout (Cumming 1975). In AS National Park, it was possible to approach warthogs within a distance of 20 to 40 m, without causing disturbance to their regular activities. This has helped us to follow them at a close range. Separation of the study period into wet and dry seasons was important in order to observe the influence of the seasons on the vegetation cover and thus on the distribution and activities of the animals. Warthogs were encountered during the wet season than during the dry season. Young were born at the end of the dry season and at the beginning of the wet season as reported earlier elsewhere (Child et al. 1968, Boshe1984). Hence a population build up could be expected during the wet season as confirmed by the present investigation. There might also be high rate of mortality during the dry season due to physiological stresses in connection with shortage of food and water. Counts of warthogs among the 3 compartment were significantly different. This might be due to a number of ecological factors including resources such as food, breeding site and protection from predators. Out of all habitat types, they frequented more in block 3, which is open grassland supporting Cumming(1975). Block 1 and 2 showed lowest number warthog counts. As this area is the most protected in thewhole of the park with fencing along the park headquarters, the above warthog density is reasonable. However, due to this high density, some disturbance in the vegetation is also observed. Eventhough, warthogs do not prefer forests, they were found on the clearings between the forests (Lavrenchenko 2000).

An increase in the human population and expansion of human settlements within and around the park since early 1990s has intensified the competition among the wildlife, livestock and people. However, this did not reveal any significant effect on the warthog population in the present study area. The knowledge of sex and age distribution of individual mammals is vital for evaluating the

viability of a species. Sex and age structure of a population at any given point of time is also an indication of the viability of the population (Woolf and Harder 1979) in addition to the structure and dynamics of the population (Wilson et al. 1996). As it was difficult in determining sex of the young warthogs in the field, only the sub-adult and adult ones were sexed during the present investigation. The presence of more females in the population was also expected (Cumming, 1975). The sexual disparity was observed only after one year of ageas in the case of Tanzanian populations of warthog, leading to female favored status (Boshe, 1981). This shows that the males are subjected to high levels of mortality probably due to their wandering habits and getting exposed to predators as they move away from the hide outs, in addition to isolation from the group by the time they mature. The male is preferred to be hunted by local people might also contribute further to this effect.

Data collected through the questionnaire survey pointed out that wild animals found around the study area often destroyed standing crops and caused economic loss to farmers in the study area. Similar studies in different parts of Africa revealed that wild animals posed major threats on crops (Hill, 1997; Kagoro-Rugunda, 2004; Okello, 2005). From the total respondents, 162 (77.14%) replied as the damage of the crop was sever in wet, 9 (4.43) replied that it was sever in dry and 38 (18, 43%) responded that occur in both seasons.According to the responses of the respondents, several of animals were involved in different degree of crop raiding. Most of the respondents reported some degree of crop losses as a result of damage by wildlife. According to the respondents, warthogs were the most commonly reported crop raider on the farmland causing much damage. They damage crops early in the morning and evening when people are absent near farmlands. Regarding control measure used to prevent wild animals from crops, 66 (47.14%) permanent guarding, 41 (29.29%) chasing by dogs, 19 (13.57% making scarecrow and 14

(10.00%) hunting (Table 8). Guarding was the most familiar methods. Most of the respondents reported that they guarded their crops especially during the harvest season. Chasing by stones are also the other methods used in addition to using fire during night.

The analysis of data collected through direct observation also has shown more or less the same result with that of questionnaire survey. Species observed damaging crops were the same as those species listed under questionnaire survey. In case of direct observation warthog (15.78%) and other wild animals (5.18%) destroy farmers' crops. The result of this study showed that there was a strong conflict between these animals and the local people. The conflict between these animals and the local people was high during the wet season where the animals get enough resources for the survival of the species. The competitions for resources cause conflict between wild animals and people. This result is in line with the study of Hill (2000) and Quirin (2005) who reported that the wild animals increasing year to year which is due to competitions for resources between wild animals and human populations. Because of the destruction of natural habitat of the animal by human activities the natural diet of the animals was lost in the area. As a result animals move to the farmland in search of food and caused damage.

The study showed that the population of wild animals in the study area varied from season to season. Relatively more pest population was recorded during the wet season than the dry season because the maize farmland across the forest will become attractive and will provide a plenty of Food sources for these primates. During the dry season food will become scarce in the farmland, thus the warthogs might temporally migrate from forest to forest in different areas. In addition the warthogs exploit different varieties of food that enables them to Survive and have large number of population in the area. The variation in the sex ratio provided suitable conditions for male individuals to find mates for reproduction. As a result, warthog population is in a good

status in the area. This was confirmed by observation and population estimation both during the wet and dry seasons. The finding of the current study showed that the sex ratios (M/F) in the two pest primates were 1:1.4 for warthog. The number of females counted in the study site is high. This variation in sex ratio provided suitable condition for the male individuals to find mates during the time of reproduction and possess their genes to the next generation. Resource competition was one of the causes for the conflict. The farmers in the study area use the forest for different purposes by destructing the habitat of wild animals. This practice forces wild animals to engage in crop damage and distraction of other valuable material. Similar studies was done by (MeleesYahner, 2006) in Bale and around the Semen Mountains National Park the people destroying forest for the purpose of fire wood, cattle grazing and other benefit engages primate to raid crop.

In relation with conflict between human and warthog's community found in the study area,use of Physical Barriers Exclusion of wild animals can protect their crops.In many situations, is an effective method of settling human-warthogconflicts? If they are properly designed, constructed and maintained, fences can be completely effective in preventing conflict between people and wild animals. The major factor limiting the wider use of wildlife fences is their cost. This will vary depending on many factors among them topography, type of fence and the species it is designed to contain; the 3.3 metre-tall, electrified fence currently being constructed around Aberdare National Park in Kenya costs on average US$20 per metre. Fences to exclude elephants and other wildlife from human settlements, cultivated areas and livestock areas are in use in all Heartlands. The local community also used Stone walls to exclude warthogs from invading cultivated areas in surrounding kebeles. Trenches and moats have been used to keep common warthogs from cultivated areas with considerable success. The fencing-in of the

cultivated areas around ASLNP has significantly reduced levels of crop damage. In Samburu Heartland, (Ogada et al. 2003) reported that fences and modifications of traditional stockades significantly reduced livestock predation. However, predator-proof barriers require more maintenance than normal livestock-proof ones. Whatever their nature, exclusionary devices are most appropriate when effectiveness is more important than cost, and when the human-wildlife conflict is expected to persist for the foreseeable future

In addition to fence Watchtowers also provide good vantage points, built around fields of crops, increase the farmers' chances of their being alerted to the presence of potentially harmful wildlife before damage has occurred. Simple alarm systems, using string and cowbells or tins, can also be effective and avoid the farmer having to be alert all night long. Dogs can be effective in protecting homesteads and livestock from attack by predators.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The present study tried to investigate the cause and effect of human-wildlife conflict with special emphasis to warthog inAbijata shalla national park, Ethiopia based on crop damage. Human-wildlife conflicts exist in different forms all over the world and experienced more in developing countries. The cause of human-wildlife conflict is disturbance of natural habitats because of increased subsistence agriculture around forest edge, shortage of food in the forest, unfavorable situation in the forest. Farming system in the study area was traditional seasonal type. Crop raiders cause significant loss on farmers' crop production. Maize is the main crop which was cultivated by most of the farmers in the study area and it was the most vulnerable crop raided by wild animals. Farmers in the study area depend on the forest for different resources such as fire wood, fodder and wood for house construction and consequently competition between human and wildlife animals occurred.

6.2. Recommendations

Based on the present study, the following points are recommended to mitigate the human Warthog conflict in the study area.

- To reduce the dependency of the local people on the forest, it is better to encourage thelocal people to plant trees for their various types of utilization.
- Crop damage depends on the taste of the cereal crop plants. For example in the study area, totally feeds common crops. Therefore, the food habit of wildlife should be systematically studied and encouraged societies to grow less preferable and unpalatableCrop to wildlife.

- Giving awareness among the local people to develop the knowledge about the issue ofEnvironmental degradation and its overall impact, as well as sense of ownership ofNatural resources.
- Most of landless youngster of the study area uses the forest as better sources of farmland.To solve these problems, the government should encourage and organize youngsters indifferent organizations for creating job opportunities instead of damaging the forest forAgricultural purposes.
- Stakeholders should reduce human settlements around the forest, expansion of farmlandand cattle grazing in the forest.
- Encouraging farmers to protect their crop farms cooperatively from crop raiders.
- The local community should protect and conserve the natural habitat of animals.
- Encouraging the development of ecotourism which benefits local resident and wildAnimals without harming one another.

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Appendex

Appendix

Appendix.1 Data collection sheet for desert warthog census

Collectors Name---------- Time---------- Season----------

Site locality---------- Date----------

Time of observation Habitat type	Habitat sex type		Age		
	M	F	Adult	Sub-adult	Juvenile

Appendix 2: Data collection sheet for direct observation on crop damage caused by common warhog.

Woreda ---------- kebele ---------- village_____

Distance from the Park (km) ----------date of damage----------

Mender (block) ----------

Site (block)	Type of crop damage	Field size of the crops(m^2) in hectares	Proportion of damaged crop field size(m^2)	Time of damaged

Appendix 3: **Focus group discussion questions**

1. Do you think that the presence of the Park close to your locality benefited the community?
2. In what way and what benefits have been realized up until now?
3. Have you ever seen warthogs in the Park?
4. When are warthogs commonly seen in large number? A. At night time B. at day time
5. In which seasons of the year do warthogs appear commonly?

   A. In wet B. dry C. spring D. autumn
6. Do you think that local people affect warthogs?
7. What are the main cause of conflict between humans and warthogs in and around Abijata-Shalla National Park?
8. Do warthogs affect the community in terms of crop damage and livestock degradation?
9. How do you or your community protect crop and livestock from warthogs attack?
10. How do local community and wildlife in the Park coexist in peace and harmoniously?
11. To increase the local community benefits and at the same time securing the Park, what should be done by their
    a. local community
    b. conservationist
12. In order to bring sustainable development for both the Park and the local community, what do you suggest?

The main purpose of this questionnaire is to gather data concerning human warthog conflict in Abijata-Shalla National Park of Central Rift Valley and suggest possible solutions in mitigating

the problem. Thus, the information you provide has paramount importance information for the study.

Thanks in advance for being cooperative

1 Socio-Economic Status of the Community

Make (x) where appropriate

1. Name of village (kebele) _____

2. Personal information

1. Household type: (Male headed, ☐ female headed) ☐

2. Age: A/18-30 years B/ 31 -35 years C/36-40years D/ 41 and above

3. Sex: Male Female

4. Marital status Married: ☐ Widowed, ☐ Divorced, ☐

Unmarried ☐

5. Educational status: literate ☐ , illiterate ☐

Read and write only ☐ First cycle ☐

Second cycle ☐ High school ☐

Certificate ☐ Diploma ☐

Degree or above ☐

6. Religion: Orthodox Christian, ☐ Protestant, ☐ Muslim, ☐ other, ☐

7. Occupational status: Governmental employ Business men Farmer Others

3. Basic information

1. For how long have you been living in the area?

1-5 years ☐, 6-10 years ☐ 11-20 years ☐ >20 years ☐

2. What is the main occupation of the household?

Farmer ☐ pastoralist ☐ trader ☐ others ☐

3. What is the main source of your income?

Crop production ☐, Animal husbandry ☐, and mixed farming ☐

Petty trade ☐, other (specify) ☐

4. Do your household currently own agricultural land Yes ☐, No? ☐

5. If your answer to Q No 4 is yes, indicate the amount of land (in hectares) that you own

No.	Category of land	Total owned	Main production	Remark
1	Crop land			
2	Grazing land			
3	Woodlots			
4	Fallow			
5	Homestead			
6	Others, specify			

6. How far is your house from the park?

Very far (>10km) far (5-10km) near (1-5km) very near (<1km)

7. Is there a clear boundary for the Park? Yes ☐, No ☐

8. If your answer to question number 7 is 'YES', do you respect the boundary?

Yes ☐ No ☐

9. Are all your grazing and farm fields close to your home? Yes ☐, No ☐

10. If your answer to question no. 9 is NO, please specify.

Very far (>10km) Far (5-10km) near(1-5km) Very near (<1km)

11. The types of crops grown size of the field and the yield obtain in the past three years.

No.	2016			2017			2018		
	Types Of crops grown	Size of the field(ha)	Yield obtain d (Kg)	Types Of crops grown	Size of the field(ha)	Yield obtain d (Kg	Types of crops grown	Size of the fields (ha)	Yield obtained (kg)
1									
2									
3									
4									
5									
6									

12. Do warthog cause damage to your crops and livestock? Yes ☐, No ☐.

13. If your answer to question No.12 is "YES", list crops that are damaged by warthogs and your estimate of the level of damage?

No.	2016			2017			2018		
	Type of Crop damaged	Degree of damage	Loss of crops (kg)	Type of Crop damage	Degree of damage	Loss of crops (kg)	Types of crop damaged	Degree of damage	Loss of crops (kg)

1									
2									
3									
4									
5									
6									

14. Rank types of crop plants that are severely damaged in the area you live in, the most sever first.

1st---------- 2nd ---------- 3rd ----------

4th ---------- 5th ---------- 6th ----------

15. At what stage do warthog attack your crops most, if at all?

Stage	Crops type					
Seedling						
Intermediate						
Mature						
Other						

16. What different techniques do you know of which are used to control (minimize) the human warthog conflict.

A. Barriers (fences, trenches, walls, buffer zones, etc.)

B. Guards (human or animal)

C. Changing the type, timing or location of human activities

D. Repellents (chemical, auditory or visual aversive stimuli)

E. Removal of warthogs (capture, killing, sterilization)

17. Which of the above techniques are most effective?

a. “A”, b. “B”, c. “C”, d. “D”, e. “E”

18. Which of these techniques are least effective?

a. “A”, b. “B”, c. “C”, d. “D”, e. “E”

19. What measures do you think should be taken by the following in order to prevent the crops damage and livestock predation?

By government: A. Capture, B. Killing, C. Sterilization, D. Chemical, E. others

By farmers: A. fences, B. trenches, C. walls, D. Buffer zones, E. others

20. At which time do you think the problem of crop damage is most severe in your field?

A. summer, B. winter, C. autumn, D. spring

21. Is that your attitude towards warthog positive? Yes ☐ No ☐

22. Do you have awareness about the park and its conservation?

Yes ☐, No ☐

23. If your answer to question No.22 is “YES”, who provided the education? A. government, B.non governmental organization

24. Do you think that warthog has to be conserved? Yes ☐, No ☐

25. If you say your answer to question No.24 is “YES” for what reason?

A. economical, B. tourism, C. social, D. biodiversity conservation, E others, specify

26. Do you get any benefit from the Park? Yes ☐, No ☐

27. If your answer to question No. 26 is "yes" what are the most important benefits?

No.	Item	Rank	Quantity
1	Fire wood (load)		
2	Construction posts/poles		
3	Timber (pcs)		
4	Honey (kg/year)		
5	Bush meat		
6	Grass		
7	Others, specify		

Appendix 5: Interview questions for key informants

1. Are there any awareness programs about the Park for the local community?
2. What benefits do you or your community gets from the Park?
3. Are you or your community happy by the existence of the Park around?
4. What do you think is the importance of conserving Park?

5. Are you or your community willing to play a role for the conservation of the Park?
6. How do you understand the size of the Park, increasing or decreasing? What may the reason behind?
7. How do you look the status of wild animals in the Park, Increasing or Decreasing? What could be the reason for this?
8. Which wild animals cause problem to human/property and what compensations are given from the Park?
9. What are the main cause for the conflict between wild animals and the local community?
10. What are the impacts of people and livestock on the Park?
11. Are you or your community willing to play a role for the conservation of the Park?

Figure 2 Partial view of ASLNP (Photo: TadesseZenebe, 2019).

Figure 3 Partial view of ASLNP woodlot and grass land (Photo: TadesseZenebe, 2019).