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Handtekening.....

ANTON DE KOM UNIVERSITEIT VAN SURINAME

Faculteit der Technologische Wetenschappen

Estimation of the Giant Anteater (*Myrmecophaga tridactyla*) population density in the Central Suriname Nature Reserve and in forest patches located in Paramaribo (Weg naar Zee)

Een afstudeerverslag ingediend ter afronding van de studie van
Bachelor of Science (BSc)
in Milieuwetenschappen

Door:
Dipowirono Vijona

2020
Paramaribo, Suriname

PREFACE

This study was performed in order to finalize my Environmental Management study at the Anton de Kom University of Suriname, Department of Environmental Science. The purpose of this research was to estimate the population density of the giant anteater in Central Suriname Nature Reserve and in the Weg naar Zee area. The data from CSNR that was used is from the Tropical Ecology Assessment and Monitoring (TEAM) network. Weg naar Zee contains mainly swamp forest and Central Suriname Nature Reserve mainly has tropical rainforest, but also contains lowland forest, marsh forest, liane forest, savanna forest, mountain savanna forest, mesophotic forest and swamp forest.

I hope this thesis will be used for further research and for the baseline data of the giant anteaters in the Central Suriname Nature Reserve and in the forest islands of Weg naar Zee.

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ABSTRACT

Giant anteaters are peculiar and have an enormous impact on local insect communities. In order to protect them we must first know more about their life circumstances and what the size of their population is. Although they are not yet threatened with extinction, it is still necessary to know more about them as there is very little research done on this species. Green Heritage Foundation Suriname mission in regard to anteaters, is to preserve and to protect these animals and their habitat in Suriname. Since 2008, CIS had done Terrestrial Vertebrates monitoring as part of the Tropical Ecology Assessment and Monitoring project north of the Ralleighvallen area in the Central Suriname Nature Reserve (CSNR). This field area is divided in two arrays, with each 30 camera trap points. For this study the focus was mainly on the giant anteater in the TEAM field area in the CSNR and in the Weg naar Zee area in Paramaribo. The population density was estimated by using camera traps in both the CSNR and in Weg naar Zee. From the data analysis the population size for each year was estimated using the program CAPTURE and the population density for each year was estimated by Microsoft Excel. According to the results it may be concluded that the giant anteater population in the CSNR was the highest in 2009 (0.050 ind./km^2) and the lowest in 2011 (0.005 ind./km^2) and is slightly decreasing. The anteater population in 2017 in the Weg naar Zee is 0.105 ind./km^2, this however is not comparable with giant anteater population density in the CSNR because data of that same year is lacking. Also, forest islands with high human activities are inhabited by fewer giant anteaters, mainly as a result of deforestation and use of land for agricultural or housing purposes.

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LIST OF ABBREVIATIONS

CIS	Conservation International Suriname
CSNR	Central Suriname Nature Reserve
WZ	Weg naar Zee
GPS	Global Positioning System
CT	Camera Trap
GHFS	Green Heritage Foundation Suriname
IUCN	International Union for Conservation of Nature
TEAM	Tropical Ecology Assessment and Monitoring
WWF	World Wildlife Fund
UNEP	United Nations Environment Programme
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
FAO	Food and Agriculture Organization of the United Nations
CBD	Convention on Biological Diversity
EPN	Embrapa Pantanal Nhumirim Ranch

1 INTRODUCTION

The giant anteater (*M. tridactyla*) is the largest existing species in their superorder Xenarthra (Wetzel, 1982). Together with the collared anteater (*Tamandua tetradactyla*) and the silky- or pygmy anteater (*Cyclopes didactylus*) it shares the suborder Vermilingua (Eisenberg, J.F. 1989). In comparison with the collared- and silky anteater, the giant anteater differ in size. The *Tamandua* is less than half the size of the Giant Anteater and the *Cyclopes* is approximately the size of a squirrel (Gardner, A. L. 2008). They range from Mexico to Central and South America and roam in places such as savannahs, moist forests, swamps and all the places where ants and termites are abundant (IUCN,2014). These animals epitomize the concept of sustainable harvest (Eisenberg, J.F.1989). After brief courtships they produce only one offspring due to a long gestation period of 6 months (Smith, P.2007). Giant anteaters are threatened by habitat loss, habitat fragmentation, roadkills, forest fires, hunting and feral dogs (IUCN,2014).

Conservation International Suriname (CIS), an environmental organization has since 2008 been working together with the Tropical Ecology and Monitoring (TEAM) Network and the Smithsonian Institute of Tropical Research in North Carolina. They are doing a terrestrial wildlife survey of the research site in the Central Suriname Nature Reserve (CSNR). This survey was done by using camera traps. The TEAM research site (CSNR), lies in the district Sipaliwini, which is in the interior of Suriname. The site covers an area of approximately 200 km^2 (TEAM,2005). The CSNR contains primary tropical rainforest, predominantly montane and moist lowland forests, small fragments of marsh forest along the rivers and creeks, and isolated savanna areas (UICN, UNEP-WCMC.2011). The giant anteater (*Myrmecophaga tridactyla*) occurs along with other type of mammal species in this area. According to many records of population extirpation, the giant anteater is considered the most threatened mammal in Central America. Currently it is listed on Appendix II of CITES and is categoried as vulnerable in all regional and national Red Data Lists (IUCN,2014). It is also protected in some provinces in Argentina as a national heritage (Miranda et al. 2014).

The Green Heritage Fund Suriname (GHFS) is an environmental nonprofit organization, established in October 2005. Their main focus is creating a society that is consciously aware of environmental issues and therefore works towards the continued improvement of the environment and promoting sustainable development and the conservation and wise use of nature and natural resources in Suriname (GHFS,2015). The organization has two programs, the Xenarthra and Dolphin program, which focuses on terrestrial (Xenarthra) and aquatic (Cetacea) species.

The GHFS also studies forest fragments so that well-planned conservation actions can be taken prior to deforestation activities which could lead to protecting and providing a habitat for the animals that live in these forest fragments.

Weg naar Zee is a resort located in the district Paramaribo. The area is very well known for its open air crematorium and pilgrimage resort but also for its urban- and agriculture use. Weg naar Zee contains mainly swamp forest with fresh- and brackish water plants.

1.1 Problem Description

The giant anteater is a very rare species and is considered the most threatened mammal in Central America, vulnerable to extinction. According to studies there are no data on the longevity, survival rates, or reproductive rates of wild giant anteaters. According to customs in Suriname the giant anteater is forbidden for exporting, and is one of the species that has a national protection status. It is not quite clear if giant anteaters are declining in Suriname. The giant anteater population density estimate from the CSNR and the forest patches located in Paramaribo could give a better view of the giant anteater status in Suriname.

1.2 Research questions

Based on the above mentioned problem description, the following research questions can be formulated:

Main research question:

Is there a difference in the population density of giant anteaters in the research area in Central Suriname Nature Reserve and the forest patches located in Paramaribo, Weg naar Zee?

Sub research questions:

- How many individuals does the giant anteaters population count in CSNR between 2008 and 2015?
- How many individuals does the giant anteaters population count in the forest patches located in Paramaribo?
- How often in a year does the giant anteaters come across their predators in the area?
- What are the activity patterns of giant anteaters?
- How many ant- or termites nests are near the camera trap in the research areas?

1.3 Purpose (Goal)

The purpose of this study was to estimate the population density of the Giant Anteater (*Myrmecophaga tridactyla*) in the forest patches located in Paramaribo, Weg naar Zee and The Central Suriname Nature Reserve.

1.4 Scope

For this study the previous camera trap data from TEAM (Tropical Ecology Assessment and Monitoring) Network in the CSNR was used to estimate the population density of the giant anteater. The study areas were the Central Suriname Nature Reserve and the forest patches located in Paramaribo, Weg naar Zee. When analyzing the camera trap data, the focus of the study was only on the giant anteater, all other animals were excluded. The study lasted 2 to 3 months.

1.5 Research Relevance

The importance of this study was gathering more in depth information of giant anteaters, also to clearly indicate the size of its population, whether there are changes in the population originated in the CSNR and the forest patches located in Paramaribo, Weg naar Zee. This data can be used to assess the protection status of the giant anteater in Suriname.

1.6 Thesis Overview

This report is structured as followed:

- Chapter 1: Chapter 1 is an introduction to the research proposal.
- Chapter 2: In the second chapter a literature study has been done on the giant anteaters, aspects such as characteristics, diet, habitat and range, behavior and activity, reproduction and main threats are explained.
- Chapter 3: The third chapter describes the materials and methods that were applied during the research study.
- Chapter 4: In the fourth chapter the results and discussion are mentioned
- Chapter 5: In this chapter the conclusions for this study are summarized
- Chapter 6: In this chapter recommendations for future studies are summarized

2. LITERATURE STUDY

In this chapter the research species, which is the Giant Anteater (*Myrmecophaga tridactyla)*, is described. Also aspects such as characteristics, diet, habitat and range, behavior and activity, reproduction and main threats are explained.

2.1 The Giant Anteater (*Myrmecophaga tridactyla)*

Giant anteaters are edentate animals. In the wild, their life span is up to 14 years (Eisenberg, J.F. 1989). These animals have the longest tongue, which can extend 2 feet beyond its mouth (Eisenberg, J.F. 1989). Unlike the collared- or pygmy anteaters, giant anteaters are no tree climbers because of their weight and size, an indication of their climbing behavior is when their head is upwards, their front feet leaning against a tree trunk and their hind feet just on the ground (Smith, P. 2007). Also surprisingly these animals are capable swimmers and can cross wide rivers (Smith, P.2007). As of 2010, giant anteaters ranged from Honduras to Northern Argentina and is for the most part of Central America considered to be the most threatened mammal (IUCN, 2014). As mentioned before, giant anteaters are currently listed on Appendix II of CITES and in a threat category as “Vulnerable” in all regional and national Red Data Lists. Vulnerable is defined as an estimated population reduction of 20% in the next 10 years (IUCN, 2014). Appendix II is defined as a species not necessarily threatened to extinction but one that should be controlled in trade to avoid overuse (CITES,1975).

2.1.1 Physical Features

The Giant Anteater is like a living "vacuum-cleaner" with a long tubular head and a tiny, circular toothless mouth. Its rostrum is very elongated. Their 60cm cylindrical tongue is coated with a copious sticky saliva produced by a very much enlarged submaxillary glands. The Giant anteater’s head and body length ranges from approximately 1000 to 1300 mm, the tail length from 650 to 900 mm. On average the Giant anteater weighs between 22-39 kg (Eisenberg, J. F. 1989). The male’s weight ranges from 26.4kg to 36.4kg while the female’s ranges from 25.5 kg to 31.8 kg (Shaw et al. 1987). Giant anteaters are large mammals with a thick coat of coarse gray hair and a white bordered black strip on both of its shoulders. The long hair on the tail gives it a fanlike appearance and can be used as a camouflage shield in the wild. (Eisenberg, J.F. 1989). The animal must walk on its knuckles due to its powerful robust legs and extremely long claws curled inwards. Their front feet are very well developed with three viciously-hooked claws and two reduced toes and the hindfoot with five reasonably-sized claws, which enables the animal to correctly use the sole. The forelegs are for the most part white with large black patches just above the

forefeet. The hind legs are often black (Smith, P. 2007). Recognizable features between two different individual giant anteaters are for example the shape and the intensity of the white stripe above the black band on the shoulder of the animal, especially its distance to the ear. Also black shadows or dots on the forelegs facilitates discrimination (Möcklinghoff, L. 2008).

2.1.2 Diet

The Giant anteater diet consists mainly of ants and termites. It is very selective during the course of feeding, visiting many ant nests and termites mounds. Because of this selectiveness, they epitomize the concept of sustainable harvest: moving around their territory visiting ant nests and termite mounds without completely destroying the colony or exhausting the resource (Eisenberg, J.F. 1989). Their long, sharp claws are excellent for ripping open many ant nests and termite mounds discovered with their keen sense of smell while the extensible tongue aids in the feeding. A giant anteater stops feeding when it smells noxious chemical secretions used as a colony defense mechanism by soldier ants or termites (Eisenberg, J.F.1989). It can eat up to 30.000 insects in a single day. In captivity their diet consists of a mixture of milk, eggs, mealworms and ground beef, occasionally fruit (Smith, P. 2007).

Figure 1. Injured giant anteater feeding on a termite nest at the GHFS Sloth Wellness Centre

2.1.3 Habitat and range

The *Myrmecophaga tridactyla* range from Mexico to Central and South America. While they tolerate habitats at lower elevations, they prefer areas with reasonably well drained soil that support in high densities of ant and termite mounds, such as in the savanna regions of southern Brazil, central Venezuela, the Gran Chaco region of Bolivia, Colombia, Honduras, Paraguay and Argentina. Home ranges with high carrying capacity may be less

than 1 km^2 while home ranges with low carrying capacity may exceed to 25km^2. The giant anteater seems to be disappearing from parts of Costa Rica and is believed to be extinct in Belize; Uruguay; Guatemala; the state of Santa Caterina (Brazil); El Salvador. The animal's presence is still unknown in the west parts of the Andes Mountain. In the Brazilian States of Rio de Janeiro and Espírito Santo it is listed as Regionally Extinct, while in Paraná and in Rio Grande do Sul it is classified as Critically Endangered (Eisenberg, J.F.1989) (IUCN,2014). In Suriname giant anteaters have been spotted in the Commewijne, Saramacca districts, as well in the Weg naar Zee area. Giant anteaters are protected in Suriname and even customs authorities are paying attention to illegal exports of these animals (Douane Suriname, 2018).

2.1.4 Behavior and activity

Giant Anteaters are mainly solitary animals. Two anteaters are rarely seen together unless a male and a female are mating, or when a female is with her young. They are extremely docile creatures and are inoffensive unless threatened. Their activity varies depending on the ambient temperatures. These creatures are diurnal and are most active during the early morning hours, also they are nocturnal where human activity is high. During rainy seasons or cloudy days, their activity take place throughout the day (Smith, P. 2007). Unlike most mammals with a body temperature of around 36ºC-38ºC, anteaters have a body temperature of 33ºC. Their thick fur isolates 94% heat, which makes it possible for them to have a low average body temperature and low functioning metabolism. Their isolative property allows them to tolerate temperature ranges of 15ºC to 36ºC. Temperature < 15ºC cause their internal temperature to fall to approximately 2ºC. They react to high temperatures by decreasing their activity and change their habitat usage. Their sleeping-site selection also depend on the ambient temperatures. They prefer sleeping in sheltered places, generally dense clumps of shrubs, covering their body with their tail, primarily in savanna and grasslands during average temperatures and in forested areas at extreme cold and hot temperatures (Constança de Sampaio et al. 2006). Giant anteaters in captivity use the same spot as sleeping-site (Merrett, P.K. 1983). The Giant anteater is strangely a very good swimmer and likes to take nightly bathes. Anteaters are particularly quiet animals and will usually only vocalize when approached by predators or when defending its territory from another individual. Juveniles give sharp whistles to keep contact with their mother. When threatened or cornered giant anteaters will rear back on their hind legs, hook with their forelegs in the direction of their intruder or predator and undoubtedly rip them apart (Smith, P. 2007). In species interactions, giant anteaters have an important role, providing fresh water when surface water is unavailable to other animals. While digging into the ground with its claws, it creates a small water hole for animals like wolves, ocelots, raccoons,

marsh deer and bird species (Emmons et al. 2004). Figure 2 illustrates a female Giant anteater searching for food with its young (WWF Global, 2017).

Figure 2. Female giant anteater with its newborn on her back (WWF Global, 2017)

2.1.5 Reproduction

The mating system of *M. tridactyla* is not known. Reproductive behavior is primarily observed in captivity. The male stands over the female who lays on her side during copulation (Jones, 1982). This species reaches sexual maturity at 2.5 to 4 years. They have a sex ratio that varies between 3:1 to 2:1 (male : female) because the males tend to be more diurnally active than the females. Females give birth standing up and produce a single young, weighing approximately 1.3 kg, after a brief courtship period between May and July and a gestation of 190 days (± 6 months) (Smith, P. 2007).

2.1.5.1 Offspring behavior

Newborns open their eyes after 6 days, they are carried piggy-back ensuring that its black and white shoulder band alignment is the same with that of its mother and also to help break up its body shape. Some juveniles stay in a nest when the mother goes on feeding excursions while others stay on the mother's back until she's pregnant again. Their mother-offspring bond begins to change around the eight month leading to full independence by the ninth or tenth month (Smith, P. 2007).

Three types of play behavior are: Jumping in the air and landing on its extended limbs, playing with an object (stone, piece of wood or earth) on its ventrum while lying on its back and socially playing with its mother; stomping on her foreclaws with its hind feet.

2.1.6 Main threats

Giant anteater populations are threatened by habitat loss due to uncontrolled forest fires or flooding, habitat fragmentation due to human population growth and urban sprawl. As towns and cities enlarge, their demands for space and goods increase continuously. To provide land for housing and cities in tropical areas, forests must be removed. Also habitat flooding drives these animals to search for food on higher grounds leading them to come in possible contact with humans or predators. These animals possess a highly-flammable pelage which increases their vulnerability to fires causing them to burn to death during extreme uncontrolled fires. They end up as road kill due to their underdeveloped eyesight leading them to not recognize moving vehicles (Smith, P.2007). Furthermore, these animals are also hunted for their body parts; its skin intended as leatherwork, its pelage, tail hairs, bones and its fat are used to cure ailments (Smith, P.2007).

3. MATERIALS AND METHODOLOGY

This study was done in three phases. The materials that were used during this research are listed in this chapter. For this research two different study areas were chosen. The Central Suriname Nature Reserve, which is monitored for terrestrial animal activity using camera traps. The Weg naar Zee area, which is an urbanized area with forest patches where GHFS catches mostly sloths. These sloths which are mostly spotted on the resident's property, are further rehabilitated before being released into the wild. These two areas also differ in vegetation types.

3.1 Study area description

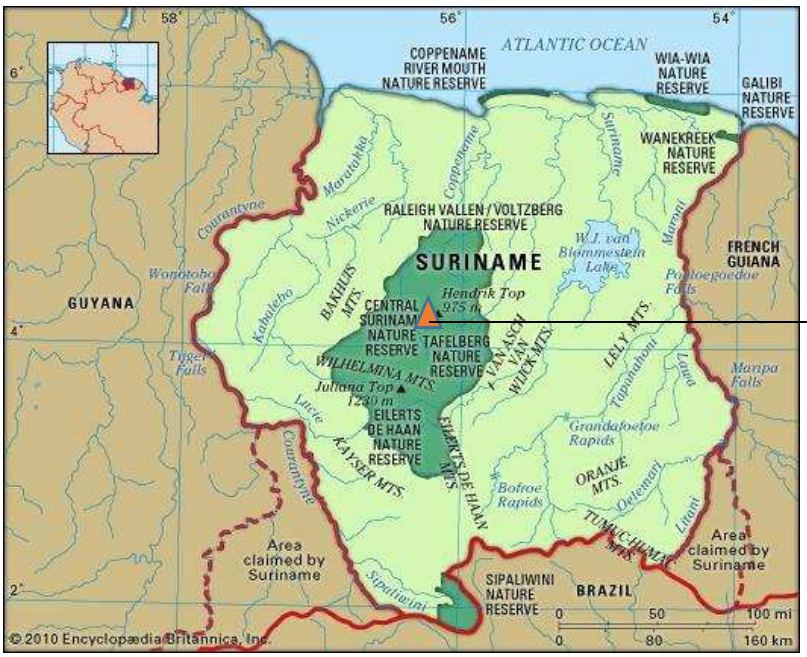
3.1.1. Weg naar Zee

Weg naar Zee is a resort in Suriname, located north west in the Paramaribo District. Weg naar Zee is bordered by the Atlantic Ocean in the north, by the resort Munder in the east, by the resort Welgelegen in the south and by the side street of the Kwattaweg, the Henry Fernandesweg, in the west. The side road lead to the muddy coast of the Atlantic Ocean. The area is popular for its urbanization and open-air crematorium built in 1968. There is also a pilgrimage built by a private organization strictly for the religious Hindus. The forest islands in the area is rich with a semi closed canopy and contains mainly swamp forests with fresh- and brackish water plants. It is for the most part flooded in the rainy season and is very well inhabited by various snake species such as the anaconda, labaria (*Bothrops atrox)*, reditere snake (*Chironius carinatus*), giant anteater, rabbits, various monkey species, birds, capybaras, iguanas, armadillos, caimans, crab-eating raccoons, sloths and various fish species. Many people also practice agriculture and hunt these various animal species. The total area of the study area is 9.52km^2. There is also illegal dumping in the area, mainly in the street Noordwijkweg. As seen in appendix 7, people tend to dump their waste such as televisions, plastic bottles, foam containers, beer bottles, old clothes, wood boards, car tires etc.

Figure 3. Swamp area and semi closed canopy in the Weg naar Zee area

3.1.2 The Central Suriname Nature Reserve (CSNR)

The Central Suriname Nature Reserve (CSNR) is located in west central Suriname, in the district Sipaliwini, between 130km and 330km southwest of the district Paramaribo. The reserve is a World Heritage Site and was officially designated on July 31, 1998 and is legally protected under the country's Nature Protection Act of 1954. As seen in figure 3, the reserve forms a corridor linking three important protected areas: Raleighvallen Nature Reserve (north), Eilerts de Haan Gebergte Nature Reserve (central) and Tafelberg Nature Reserve (south) (UICN, UNEP-WCMC.2011).



Location of the CSNR study area

Figure 4. The three protected areas within the Central Suriname Nature Reserve (Mardhatillah,Q. 2013)

The area protects the upper watershed of the Coppename River and the headwaters of the Curuni, Lucie, Oost, Zuid, Saramacca, and Gran Rio rivers. Also, waterfalls and rapids are present in the area (UICN, UNEP-WCMC.2011).

Despite containing infertile soils, the CSNR covers 16.000.000 ha of primary, undisturbed neotropical forest. The area has predominantly moist mesophotic forest and is dominated by moist lowland and montane rainforest. Also swamp forest, small fragments of marsh forest along the river and creeks, liane forest, isolated savanna forest, mountain savanna forest exist (WWF,1993). The canopy of the mesophotic forest grows up to a height of 30 to 50 metres and consists of tree species such as the kankantri (*Ceiba penandra*), ingipipa (*Couratari spp.*). The understory consists of palms such as paramacca (*Astrocaryum paramacca*), kumbu (*Oenocarpus bacaba*) and maripa (*Maximiliana maripa)*, the forest floor is covered with ferns and moss-ferns. The animals are typical of the region such as the jaguar, giant armadillo, giant river otter, tapir, sloths, several primates and bird species (UICN, UNEP-WCMC.2011). The core study area or the CSNR TEAM Field is only 200 km^2.

Within the nominated site there are no permanent inhabitants or human settlements. There are three communities nearby that may be affected by the creation of the CSNR, these are the Kwinti Maroon communities of Witagron and Kaaimanston and the Trio indigenous community of Kwamalasemutu. Members of the Witagron and Kaaimanston communities have acted as guards, porters and guides for researchers and visitors at the Raleighvallen Nature Reserve (UICN, UNEP-WCMC. 2011).

3.2 Materials

The materials used during the research are:

- GPS
- First aid kit
- Flagging tape
- A Nikon camera
- Camera traps
- Machete

3.3 Methodology

In this paragraph the methods used to select the locations of the camera traps in the Weg naar Zee area are explained, followed by the methods used for the identification of individual giant anteaters, and the estimation of population density and population size for

both the CSNR and Weg naar Zee areas. For the identification of giant anteater individuals in the CSNR area, previous TEAM camera-trap dataset collected in the CSNR from 2008 to 2015 were filtered and analyzed. For camera trapping TEAM uses the "TERRESTRIAL VERTEBRATE (CAMERA TRAP) MONITORING PROTOCOL", as seen in appendix 3.

3.3.1 Selecting camera trap locations in the Weg naar Zee area

Only 5 cameras of the WWF Suriname were available for deployment. Before selecting the camera trap locations, the Weg naar Zee area was first observed for possible camera trap placement. Secondly, interviews about giant anteater sightings were done with residents living in the Weg naar Zee area. Also, during interviews with three residents, permission was given for camera trap placement on or near their property. The interviews were done two months before deployment and 30 residents were interviewed. Based on the answers of the local residents during the interviews (Appendix 8) and the permission for the camera placement, two of the cameras were placed on private property while three cameras were placed near a hunting spot in the forest island. After selecting the locations for the camera traps, each camera was placed at its location, secured with a belt and metal safe box. These were attached on a tree at knee height or at least 50 cm above the ground. After this was done, a 'walk test' was done to see if the camera trap was working, this is shown in figure 5. The spatial coordinates of these camera trap locations were also recorded with a GPS unit. After a month and a half the camera traps were retrieved and the data collected from the camera traps was analyzed.

Figure 5. Walk Test done in front of a camera trap

Illustrated in figure 6 are the five camera trap locations that were chosen (yellow pinpoints), these were near the streets Brandtimakaweg, Zebedaweg and the Tiengieholoweg.

Figure 6. Camera trap locations in the Weg naar Zee area

3.3.2 Camera trap locations in the CSNR area

For camera trapping in the CSNR area, TEAM Network used the "TERRESTRIAL VERTEBRATE (CAMERA TRAP) MONITORING PROTOCOL IMPLEMENTATION MANUAL". This protocol provides a standardized and efficient way to monitor the status of species and communities of vertebrates using digital camera traps.
TEAM places 60 camera traps, 30 camera traps in each array, in a grid at a distance of 1.4 km from each other (one camera every 2 km^2). The camera trap points are georeferenced and spatial location of the traps are recorded with a GPS unit. The CSNR camera trap locations are illustrated in figure 7. The CSNR study area is split into two arrays, each array is on one side of the Coppename River. Array 1 of the CSNR study area lies on the right side of the Coppename River when entering the reserve from the north (Witagron) and array 2 lies on the left side (TEAM, 2011).

The process for field deployment are as followed:

- Equipment preparation and calibration. To ensure the highest possible quality and integrity of the data, one week before going into the field close attention must be paid to preparing and calibrating the camera traps before they are deployed.
- General field planning meeting. The crew leader should meet with the other crew members to review the deployment plan and schedule. This meeting explains the setup and movement of temporary camps as the field crew deploys the camera trap points, the order in which various camera trap points will be visited, and other general logistical issues (e.g., water acquisition and food preparation and schedule).
- Deployment of camera trap in the field (5-7 days for 30 camera trap points):
    - Navigate to the camera trap point.

- Checking if the point needs to be moved: Yes → establish a new camera trap point and record new location. No → Set up the camera trap, repeat until all camera traps have been deployed.
- Return to base camp.
- Upload spatial location of camera traps (if necessary). It is crucial that this information is uploaded as soon as possible to the TEAM data repository for adequate checking to ensure the quality of the data and that the camera trap points are properly spaced according to the standard sampling design. This can last up to 7 days.
- Final point locations approved by TEAM: Yes → use same points in next field deployment. No → establish new points in next field deployment.

- In case al points have been sampled: Yes → Prepare for camera trap retrieval trip after 30 days of deployment. No → prepare for camera trap retrieval and redeployment trip.
- Retrieve all camera traps and data.

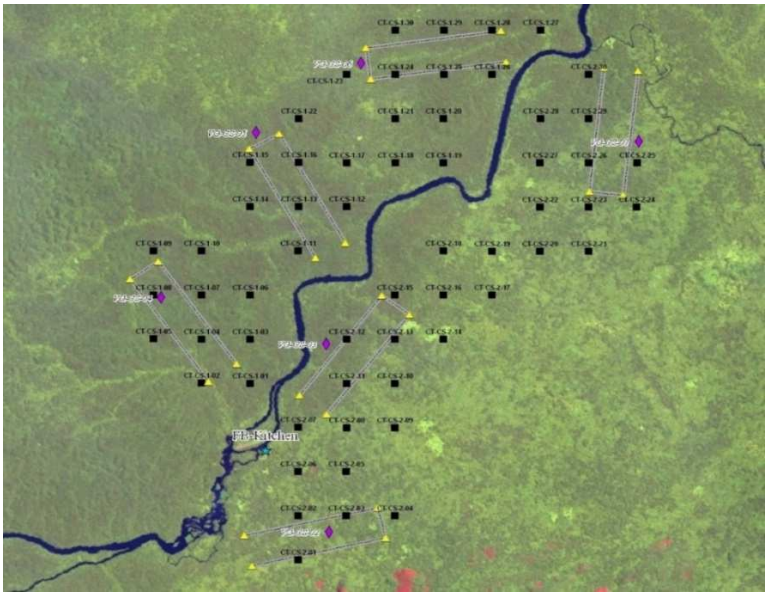


Figure 7. Camera trap locations (black squares) in the CSNR

4.2.4 Identifying individual giant anteaters

Due to logistical problems at CIS, helping with the camera trapping in the CSNR area for the terrestrial wildlife survey was not possible. For this study and with permission of TEAM, previous camera-trap data collected in the CSNR from 2008 to 2015 were used for the identification of giant anteater individuals.

As mentioned in appendix 1, the camera traps were set to capture three images per trigger. From the digital data, the best camera trap images of a set of three images per trigger were chosen and further sorted in a map, by year, by array, by camera trap location and as last by individual. These camera trap images of the giant anteater were compared with each other, looking at characteristics such as black shadows or dots on the forelegs, the intensity of the white stripe, especially its distance to the ear. In addition to comparing these images on a computer, printouts were also used to compare these individuals, first by year and then by all years together to match same individuals. Images of individual giant anteaters that could not be identified clearly were excluded from the analysis. All information including the date and time, the label of the images, the camera trap location and the GPS points, were also sorted by year and array and was later grouped together with the different individuals that were identified in separate MS Excel files. As seen in figure 8 individuals with different as well as same marks were circled with a pencil. In figure 8 it was clear that these were two different individual giant anteaters, because of the shape of their white stripe and black band. Also the black dots on the forelegs differ from each other, the giant anteater on the left has a softer dot color unlike the giant anteater on the right which has a much darker, almost black dot color. From the 409 giant anteaters images, 372 images were excluded due to being too blurry or only one part of the animal was shown i.e. the face, the backside (sometimes with a newborn) or the tail. Other images were zoomed in on a computer for more clarification. The amount of individuals was manually counted per array and for each year separate. Although some cat species have been photographed by the camera traps, such as the ocelot and puma. None of their encounters with the giant anteaters were caught by the camera trap.

Figure 8. Comparing the marks on the individuals

For the Weg naar Zee area, a total of 973 images were captured by the camera traps. Most images were triggered by the motion of tree leaves. Only one giant anteater was captured

by the camera traps, specifically in the third camera trap location (CT-WZ-03). Because of this outcome, the image was not compared with other camera trap images of the Weg naar Zee area. Information such as the date and time, GPS points, the label of the images and the camera trap location were also put in a MS Excel file.

4.2.5 Estimating population size with CAPTURE

To estimate the population size of the giant anteater in the study area, the program CAPTURE was used. CAPTURE can be downloaded from the internet (USGS CAPTURE, 2017). The program estimates capture probability and population size for closed population capture-recapture data. The CAPTURE program provides population estimates using different models. For this analysis the population is assumed closed for the observation period of each year, which means it is assumed that there are no births and deaths within the amount of camera trap days in each year. The population size was estimated per array for the CSNR area.
With the task read population jackknife in the program CAPTURE, the populations of the giant anteaters is estimated for the years 2008-2015 of the CSNR area, and for the year 2017 of the Weg naar Zee area. The number of trapping occasions is the same as the number of camera trapping days. The population was estimated separate for each year.

As seen in figure 9, the steps for CAPTURE were as followed:

- Input type → "ENTER POPULATION DATA" was selected
- A title was given → example: "Capture CSNR 2008"
- Occasions or trapping occasions were set equal to the camera trapping days → example: for the year 2008 the total camera trapping days were 112
- The task read jackknife was selected
- The capture frequencies were added → example: 0,0,0,0,1,1,0,0,2,0 etc.

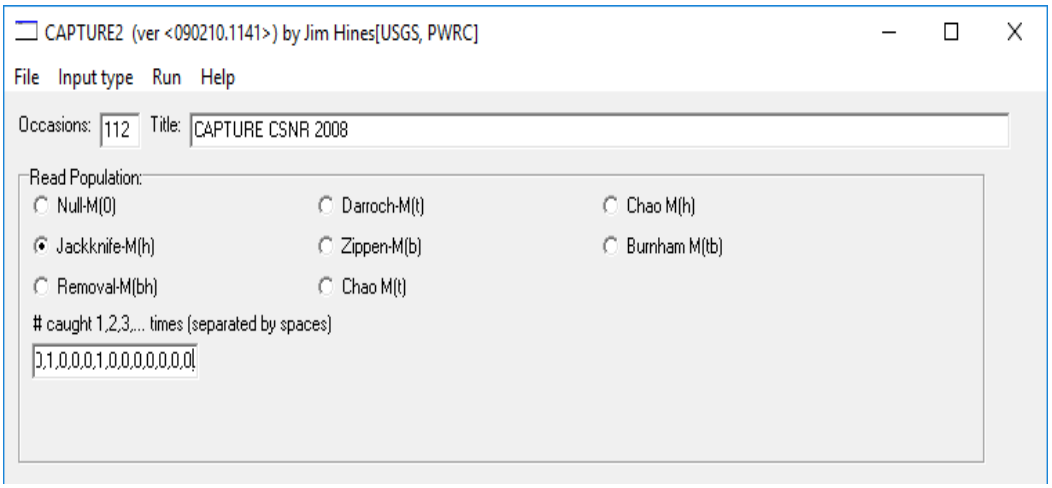


Figure 9. Example of the program CAPTURE

4.2.6 Estimating population density with Microsoft (MS) Excel

To estimate the population density for the giant anteater, the program MS Excel was used. The formula that was used to estimate the density is:

$$\frac{Number\ of\ identified\ individuals}{area}$$

The standard deviation was estimated with the formula" = STDEV" in MS Excel.

5. RESULTS AND DISCUSSION

The results of this research are explained in this chapter. Results from the interviews done with local residents in the Weg naar Zee area are discussed. Results such as the amount of individual giant anteaters, which have been identified by comparing camera trap images of the years 2008 - 2015 from the CSNR with each other, and of the Weg naar Zee area of the year 2017. Also the estimated giant anteater population density from the year 2017 in the Weg naar Zee area and in the CSNR from the years 2008-2015 are discussed.

5.1 Individual giant anteaters identified in 2017 in the Weg naar Zee area

For the year 2017, 5 camera traps were placed in 5 different camera trap locations (figure 20, appendix 2) in the research area Weg naar Zee for 42 days during the large dry season. Therefore, the total camera trap days for this sampled area was 42. It took one week to place the camera traps on location. Because the area is urbanized and mostly used for agricultural purposes, it is to be expected that sightings of these animals would be low. According to Smith, P. 2007, giant anteaters tend to be active during the early morning- and night hours, avoiding most human activity.

After viewing all the camera trap images, only one capture of a giant anteater was made on the 4th of October 2017 (figure 10). This animal looked curious at the camera trap and was captured on the 3rd camera trap station (CT-WZ-03) near the street Zebedaweg (figure 11), a side street of the street Henry Fernandesweg. This location was not far from the graveyard where a resident had seen one. Therefore, the total number of individuals identified in the sampled area Weg naar Zee for the year 2017 is 1. Having any chance of observing more giant anteater individuals, more camera traps are needed, especially in the forest islands (private areas – with permission) where deforestation have not yet taken place.

Figure 10. Giant Anteater captured on a camera trap in the Weg naar Zee area

The results of the interviews have shown that most of the residents have not seen any giant anteaters in the area. A few have heard of one accident where a giant anteater had killed a man out of self-defense (Nieuws-Suriname, 2017). Out of the 30 people who were interviewed only 4 people have seen a giant anteater in the Weg naar Zee area. One family, living in the street "Ingipipaweg", even witnessed a giant anteater walking from the street and into their house, mostly caused by deforestation for agricultural purposes. The animal was rescued by the GHFS and released on another location. As seen in figure 11, sightings of the giant anteater were near the streets Ingipipaweg, Henry Fernandesweg, Tiengieholoweg (near the graveyard) and Regenboogstraat.

Figure 11. Sightings location of giant anteaters in the WnZ area

The results of the interviews have also shown that the animal was spotted 2 times in the morning, in the evening and afternoon, mostly crossing a street. According to one local resident, many nearby residents assume that there was at least one female anteater with its young in the Weg naar Zee area.

Figure 12. The surrounded area of the camera trap location in Weg naar Zee, where the giant anteater has been captured (CT-WZ-3)

Figure 12 shows the surrounding area of the third camera trap location where the individual giant anteater was captured. At each camera trap point there were at least 2 termite nests. Termite nests are potential food sources. It is important to also take in account the nearby or surrounding termite nests, especially nests which have scratching marks which shows the presence of an anteater.

After removing the camera traps, it appeared that some plots in the area were deforested (figure 13). This may be the reason that the giant anteater was only captured one time, because giant anteaters tend to avoid areas disturbed by high human activity. In the area Weg naar Zee it is nevertheless a risk to install camera traps due to possible theft, so it is important to check the camera traps every 2 weeks. Therefore, it is important to contact the owners of the different plots where camera traps are placed to check if the camera traps are still there and if they are still working.

Figure 13. Deforested area near the camera location where the giant anteater has been captured

Figure 13 shows a huge plot that was deforested after six weeks of camera trap placement in the Weg naar Zee area.

In Table 1 the population size estimates for the giant anteaters in the CSNR from CAPTURE are combined for the years 2008-2015. The same is done for the year 2017 in the Weg naar Zee area.

Table 1. Population estimates for the giant anteater with CAPTURE from 2008-2015 in the sampled area CSNR

Population Estimate	
Year	Total Array
2008	5 ± 0.2985
2009	10 ± 0.0
2010	7 ± 0.0
2011	1.0 ± 1.0
2012	5.0 ± 0.0
2013	5.0 ± 4.2024
2014	3.0 ± 0.0
2015	5.0 ± 0.3354

According to Table 1 the population size differed with a population size of 1-5 giant anteaters throughout the years. The camera traps were placed on both sides of the Coppename river, only one side captured giant anteater individuals between the years 2011 and 2014. This should have shown a very low population size in comparison with the other years, however the population size for the years 2012 and 2013 seemed consistent with the first year (2008).

Population estimates for the giant anteater with CAPTURE from 2017 in the sampled area Weg naar Zee is 1.0 ± 1.0.

5.2 Individual giant anteaters identified in 2008–2015 in CSNR area

According to Möcklinghoff, L. 2008. individual giant anteaters can be distinguished from each other by their features. However, while comparing the individuals of the different years with each other, mistakes could have been made, because there was only one camera trap at a camera trap location, thus only one side of the animal was shown. Also most of the photographs were black and white and not colored, making it difficult to compare the features of the individuals with each other. Colored photographs (figure 15) make it easier to compare the shape and the intensity of their white stripe, the shape of its black band and the dark grey or black dots on their legs. Although some cat species have been photographed by the camera traps, such as the ocelot and puma. None of their encounters with the giant anteaters were caught by the camera trap. Because of not being able to go on the camera trap deployment in the CSNR area, ant- or termite nest observations near the camera trap points were not done in the CSNR.

Figure 14. Clear and blurry camera trap photographs of a female giant anteater with its offspring in the CSNR array 1

As mentioned in chapter 4.2.4. blurry images as in figure 14 were excluded from identification. Figure 15 shows two different giant anteaters. The individual captured on location CT-CSN-2-25 differs by its more crooked and intense white stripe, its width and size of its black band, bigger tail size and black dot on its front leg from the one captured on location CT-CSN-1-30. Also its coat above the white stripe is much darker, whereas the coat above the white stripe on the individual captured on location CT-CSN-1-30 has a

much lighter color. The coat under the black band of the individual captured on location CT-CSN-1-30 has a dark brown to white color towards the elbow regions of the foreleg, whereas of the individual captured on location CT-CSN-2-25 has a more light brown, almost white color.

Figure 15. Two different giant anteaters

According to Table 2 and figure 16, the highest number of observed individual giant anteaters was in the year 2009 with a total of 10 individuals followed by the year 2010 with a total of 7 and the lowest amount was in the year 2011 with a total of 1. Also figure 16 illustrates that the number of observed individual giant anteaters has increased slowly since 2011. But in order to assess trends over longer time periods, continued monitoring is necessary.

Table 2. Number of giant anteater individuals identified in the sampled area CSNR year 2008-2015

Year	CSNR (array 1)	CSNR (array 2)	Total Individual Giant Anteater
2008	4	1	5
2009	6	4	10
2010	3	4	7
2011	0	1	1
2012	0	5	5
2013	5	0	5
2014	0	3	3
2015	3	2	5

Two possible recaptures were found comparing the camera trap images from 2008-2015. These were two different giant anteater individuals. One giant anteater that was captured in 2008 at the camera trap location CT-CSN-1-26 was recaptured in 2009 at the camera trap location CT-CSN-2-08. Another giant anteater that was captured in 2012 at the camera trap location CT-CSN-2-16 was recaptured in 2013 at the camera trap location CT-CSN-1-04. According to Smith, P. 2007, giant anteaters can have a large home range of up to

about 25km^2, their territories still frequently overlap, however these individuals still keep their distance from each other. This causes camera-traps to capture completely different individual giant anteaters, but can also recapture the same giant anteater if it does not change its home range. TEAM camera trap points are changed if necessary, mostly when the camera trap is not properly spaced according to the standard sampling design. If their home range falls in the standard camera trap design, there is a chance that giant anteaters will be recaptured more than once. Since 2011 till 2014, the camera traps had observed giant anteaters only on one site of the study area. According to chapter 2.1.6 one of the reasons for this happening could be hunting. The Kwinti Maroon communities and the Trio indigenous community live close the CSNR reserve, thus having easy access to hunt animals in the area. However, it is still not proven if these animals are hunted for their meat or other intended purposes by these communities. Other reasons could be searching for food on higher grounds, in other areas where there are no camera traps placed. In these areas the giant anteaters may also come across their predators such as the jaguars. Although there are no deforestation activities in the CSNR area, the deforestation activities around the protected area may have negative impacts on animals living in this protected area, especially animals that require a large habitat range. According to Constança de Sampaio et al. 2006, climate change may also have an impact on these creatures because as a reaction to high temperatures, they decrease their activity and change their habitat usage.

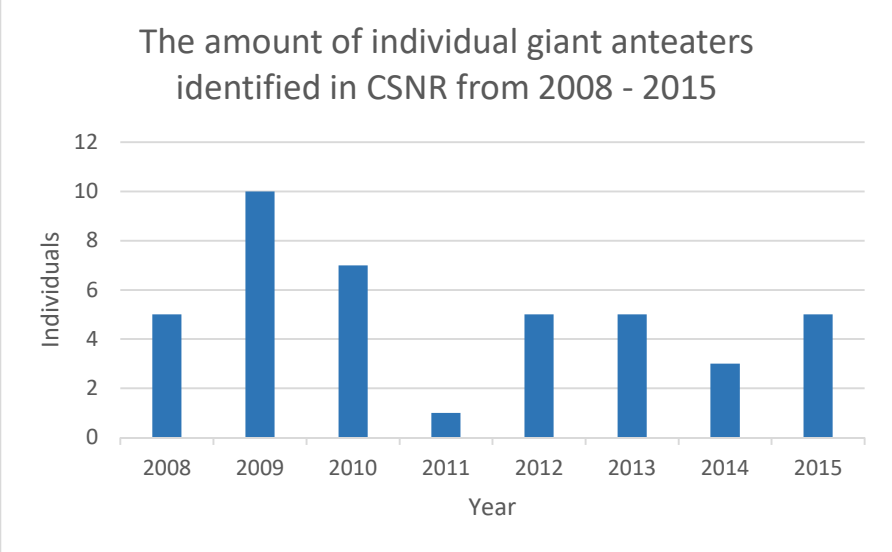


Figure 16. The amount of individual giant anteaters for the years 2008 – 2015

Table 3 illustrates the total camera trap days for the sampled area CSNR for the year 2008-2015. The camera trap days are defined as the number of days that a camera trap was operational in the field. According to Table 2 and Table 3 it seems that the number of capture is independent of the amount of camera trapping days because the year (2013) with the most camera trapping days (121), has only 5 sightings of giant anteaters and the year (2014) with the fewest camera trapping days (84) has only 3 sightings of giant anteaters, while the year 2009 with an amount of 110 camera trapping days has the highest sightings

(10) of giant anteaters. Also, the year 2011, with an amount of 92 camera trapping days, has the least (1) sightings of giant anteaters. According to Table 2 array 1 has overall more sightings (21) than array 2 for the years 2008-2015, with no sightings for the years 2011, 2012 and 2014. However, for the years 2011, 2012 and 2014 array 2 seems to have had more sightings than array 1, varying between 1 and 5. The different amount of the individual giant anteaters in each array for each year can be explained by the availability of food sources in the array and the season in which the camera traps were deployed (Table 3). Most of the giant anteaters were seen in the short rainy season than in the dry season and according to Smith, P. 2007, they are highly dependent on the daily ambient temperatures. Difference in seasons probably by climate change and a decrease to almost no termites or ant nests to feed on, giant anteaters will most likely change habitat. If these animals change habitat, where no camera traps are placed, there is a very small chance that one will be captured were these camera traps are, because TEAM research site only covers an area of 200 km^2 while the Central Suriname Nature Reserve covers an area of 160.000 km^2 of primary forest.

Table 3. Total Camera Trap Days for the sampled area CSNR year 2008-2015

Year	Array 1		CT Days	Array 2		CT Days	Total CT Days	Stations
	Start date	End date		Start date	End date			
2008	11/22/2008	1/20/2009	60	1/21/2009	3/13/2009	52	112	60
2009	8/24/2009	10/14/2009	52	10/14/2009	12/10/2009	58	110	60
2010	9/22/2010	11/2/2010	42	11/6/2010	1/20/2011	76	118	60
2011	11/9/2011	12/14/2011	36	12/15/2011	2/8/2012	56	92	60
2012	10/4/2012	11/12/2012	40	11/14/2012	1/25/2013	73	113	60
2013	11/13/2013	2/3/2014	83	2/4/2014	3/13/2014	38	121	60
2014	9/16/2014	10/28/2014	43	10/31/2014	12/11/2014	41	84	60
2015	10/22/2015	12/7/2015	47	12/10/2015	2/17/2016	69	116	60

CT = Camera Trapping

5.3 Giant Anteater population density estimate from 2008 – 2015 in the CSNR and for the year 2017 in the Weg naar Zee area

Population density is a measure of the number of individuals that make up a population in a defined area and can be applied to all organisms, from small plants to animals and humans. No matter where a population of organisms live, those organisms make up the population density for a given area. The population density has been calculated by dividing the number of observed individuals by the area. In Table 4 the manually calculated density rates of the population density of the giant anteater in CSNR are shown. This was done manually because using CAPTURE to estimate density was not easy. The method of entering data for the density estimates in the last version of the user manual of CAPTURE was not completely clear. After several trials, the program CAPTURE still failed to give

the desired density estimates. Also, programs such as DISTANCE and MONITOR, used in previously published studies, were not the right programs to calculate, due to the fact that a transect line method was not applied. The population density estimate was calculated using the program MS Excel.

Table 4. Population density of the giant anteater in CSNR

Year	N (Identified individual giant anteaters)	A (Area in km²)	D (population density in individual giant anteater/ km²)	In 100km²(/ha)
2008	5	200	0.025 ±0.00	2.5
2009	10	200	0.050± 0.33	5
2010	7	200	0.035±0.17	3.5
2011	1	200	0.005±0.00	0.5
2012	5	200	0.025±0.67	2.5
2013	5	200	0.025±0.25	2.5
2014	3	200	0.015±0.50	1.5
2015	5	200	0.025±0.00	2.5

Figure 17 shows the population density of giant anteaters in the CSNR area with their different standard errors. The giant anteater population density of the year 2012 has the highest standard error. Because of the sample population being very small, it is possible to have high standard errors compared to larger sample populations with lower standard errors. These standard error bars show that the data is not precise. The data would be more precise if the range of the standard error bars was smaller.

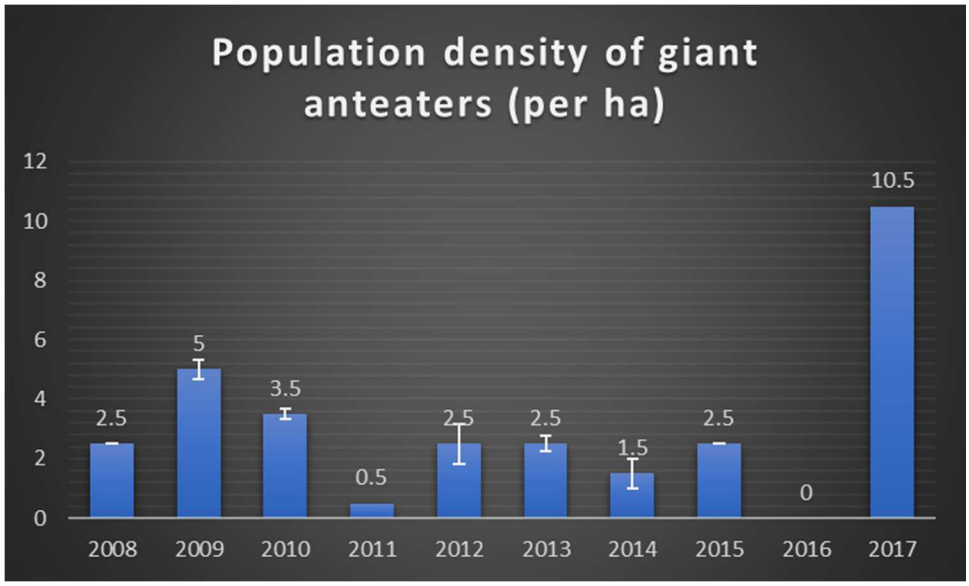


Figure 17. Population density with standard error chart of the giant anteater population density

In Table 5 shows that for the years 2008,2012,2013 and 2015 the population densities for the giant anteater is the same (0.025 ind./km^2), with a standard error difference of 0.42

between the years 2012 and 2013. Although there is a standard error difference, figure 17 shows that there is no difference in population between the years 2012 and 2013. The year 2009 has the largest amount, with a population density of 0.050 ind./km^2 and the year 2011 has the smallest amount, with a population density of 0.005 ind./km^2. Giant anteaters are rarely seen together in close proximity unless it is mating season or if a female is with its young. According to TEAM data of the year 2009 most giant anteaters captured by the camera traps were females with their young. Overall there is a slight decrease in population since 2009, however it kept a stable trend between the years 2012 and 2015. Also, the population density estimation for the year 2017 in the Weg naar Zee area is 0.105 ± 0.00 ind./km^2, which makes the average population density for that same year and area 0.105 giant anteater/km^2. This however is not comparable with the population density for the period 2008-2015 in the CSNR because camera trap TEAM data lacked for the year 2017. According to Monique Pool, giant anteaters are also killed for their meat in Suriname, mostly spotted in rural areas. Therefore, in the Weg naar Zee area, giant anteaters are not only threatened by deforestation but also by possible hunting activities, as local Surinamese residents also hunt in that area, which can lead to a low population of giant anteaters.

Table 5. The population density (D) of the Central Suriname Nature Reserve compared to that of the Weg naar Zee area

Year	D CSNR (giant anteater/ km^2)	D Weg Naar Zee (giant anteater/ km^2)
2008	0.025	-
2009	0.050	-
2010	0.035	-
2011	0.005	-
2012	0.025	-
2013	0.025	-
2014	0.015	-
2015	0.025	-
2016	-	-
2017	-	0.105

6. CONCLUSIONS

To answer the research question "Is there a difference in the population density of giant anteaters in the research area in Central Suriname Nature Reserve and the forest patches located in Paramaribo, Weg naar Zee?", the following can be concluded that:

- In the period 2008-2015, only 41 individual giant anteaters were identified for the TEAM research/field area in the CSNR, including the individuals that were recaptured. The average number of observed individual giant anteater per year was 5.125 individuals.
- In the year 2017 only 1 individual giant anteater was identified in the Weg naar Zee area. In rural areas such as the Weg naar Zee, giant anteaters are not only threatened by deforestation but also by possible hunting, which can lead to a lower population than usual.
- The average population density in the period 2008-2015 in CSNR was 0.026 giant anteater/km^2. The density seems to be slightly decreasing since 2009 but kept a stable trend between the years 2012 and 2015.
- Giant Anteaters may come across their predators such as jaguars or pumas, however this was not captured by the camera traps in both research areas. According to TEAM data, these predators were captured separately by the camera traps.
- Giant anteaters are solitary animals and are most active during the early morning and evening hours. During these hours they are mostly searching for food and keep to their standard route when searching for food. Females often carry their young piggy-back during these food excursion. During the other hours they tend to take nap sessions with their tail covering their body. Also these animals take nightly swims or baths. If the ambient temperature is very suitable for the giant anteater, it will be active on his daily route throughout the day.
- In the Weg naar Zee area there were at least two termite nests at each camera trap location. The amount of termite nests at each camera trap location in the CSNR area was not determined.

7. RECOMMENDATIONS

To better further population density studies on giant anteaters, the following points are recommended.

- More yearly population density studies on giant anteaters in Suriname must be done to make a better statement of the population size. Not only in the CSNR area of Suriname, but in other areas as well. Because it turns out that there is very little information or data available on this subject.
- Repeat the study in the CSNR and in the Weg naar Zee area with two cameras at opposite sites in relation to the trail on which the giant anteater walks on. This will make it easier to help identify this species, because their marks are not as quite unique as the spot patterns of the jaguar or ocelot.
- In case of uncertainty, if identified individuals, especially ones without unique marks, are indeed different, it is better if more researchers discuss their results (from the same database) with each other. Results that may have been overlooked can ensure for a better conclusion.
- Also an updated version on the user manual of the statistical program CAPTURE is required to make working with this software easier.
- Using software programs that are ideal and precise for managing camera trap data would be better, making it easier for researchers to identify individual species, especially individuals with unique marks. This means less drawing, less printouts or staring less at the camera trap photos.

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APPENDIX 1 CAMERA TRAPPING

Camera traps are useful tools for monitoring medium- and large-sized mammals and terrestrial bird species. Camera traps go by many names such as remote camera, game- and trail camera. They can be left in the field to continuously watch an area of habitat for a long period, recording events which occur in nature. It offers a window into the behavior of animals relatively undisturbed by humans. Camera trapping is done by remotely triggered cameras that automatically takes pictures of passing animals. These camera trap models are mostly triggered by a passive infrared sensor, which detects moving objects (people, animals, vehicles) which are a different surface temperature (warm/cold) to the background environment (Wearn, O.R., Glover-Kapfer P. 2017)
Camera traps can be used for faunal inventories, gathering information on habitat preferences and activity patterns, scientifically robust and also for occupancy and density estimations (Rovero et al. n.d.).

The purpose of camera trapping

Camera trapping is ideal to study wildlife, because it has a minimum impact on the animal species. Camera traps are most often used to capture pictures of medium to large sized terrestrial mammals and birds. The images and data can be used for further studies i.e. occupancy, abundance and population density (Wearn, O.R., Glover-Kapfer P. 2017).

The benefits of camera trapping

The most important benefit of camera trapping is that it is a non-invasive method with minimal impacts to the animal species. Left unattended for a long period and depending on the batteries and SD card, it can continuously record a broad range of animal species especially elusive, rare and nocturnal ones that avoid humans with minimal labour costs. The images provide a lot of information on i.e. the behavior, its presence, body condition, activity patterns (from the date and time stamps), pelage characteristics that enable individual information and even local habitat characteristics. Camera trap images can also serve as a kind of digital specimen, similar to a museum voucher specimen, which is verifiable and can be stored indefinitely. Detections are made with an electronic infrared sensor, reducing human observer biases and increasing the potential for replicability and repeatability. (Wearn, O.R., Glover-Kapfer P. 2017). Some of the camera trap models are simply rainproof, while others such as the Reconyx and Bushnell Trophy Cam are waterproof and resistant to humidity.

The use of camera traps

Camera traps are mostly used by researchers, non-governmental organizations (NGO's), wildlife conservation groups such as Panthera, Wildlife Conservation Society (WCS), World Wildlife Fund (WWF), to monitor wildlife and by hunters (in the USA) who search for trophy deer and other big game species (Hance,2011).

TEAM Network recommends placing 60-90 camera traps in a grid at a distance of 1.4 km from each other (one camera every 2 km^2). To maximize trapping success, camera traps are best placed on trails where animals frequently pass.

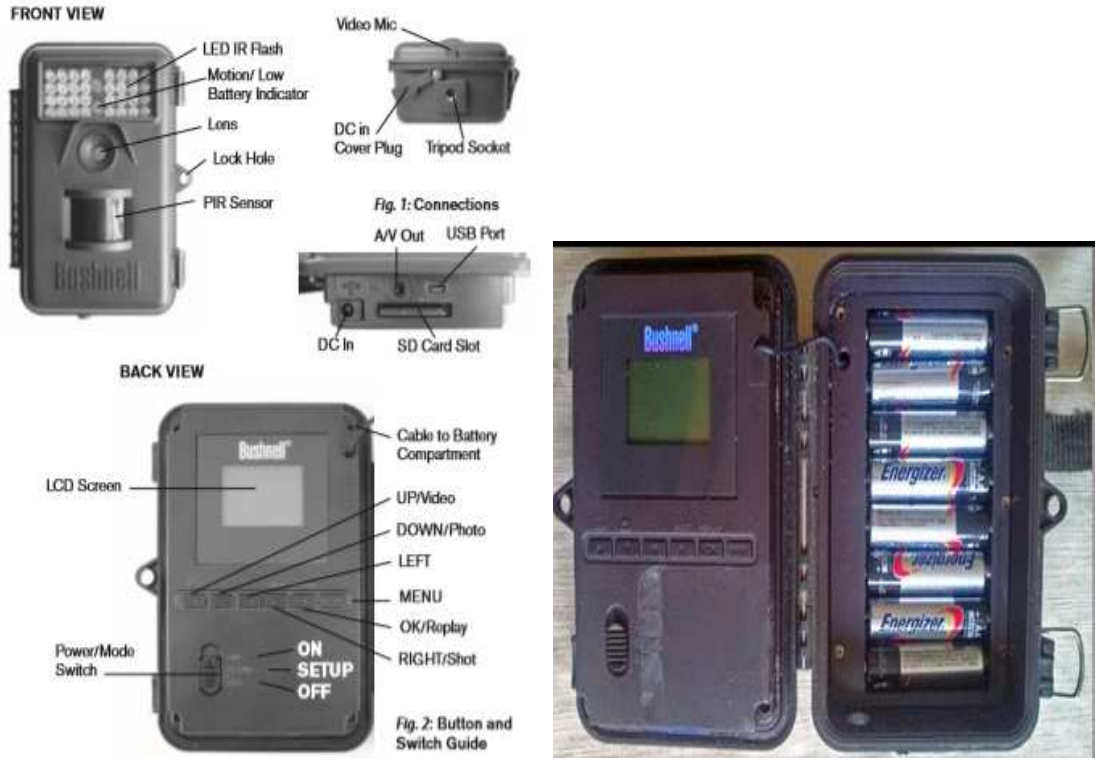

Figure 18. Camera trap with its internal and external features

Steps to set up the camera trap (Bushnell,2011):

- Before placing the cameras in the field, they have to be cleaned.
- The batteries and SD memory card are then installed.
- Use only 12 new Energizer Lithium batteries or Alkaline AA batteries. High-quality NiMh rechargeable batteries (AA cell) can also be placed in the camera, but do not mix these types of batteries. The camera accepts SD cards up to 32GB (SanDisk SD and SDHC), but normal users will find 4GB more than enough to work with, as this can store approximately 10.000 images.

A 3-way power switch is used to select the main operating modes: OFF, SETUP and ON (Figure). A control key interface with six keys is primarily used in SETUP mode to select operational functions and parameters, these keys are UP, DOWN, LEFT, RIGHT, OK and MENU. Also four of the keys can perform a second function: DOWN (used to set the camera to Photo mode), UP (used to set the camera to Video mode), RIGHT (serves as the shutter/ SHOT button), OK (used to set the camera in REPLAY mode).

Set up and programming:

- After the SD card is installed, turn the camera on using the ON-OFF switch
- Put the 3-way power switch on SETUP
- Mode: Camera
- Image Size: 8M
- Capture Number: 3
- Interval: 3M
- Sensor Level: High
- Time Stamp: On
- Set Clock: Digital
- Set Date: J/M/D
- Field Scan: Off
- Camera traps are usually attached on a tree or pole at approximately 50 cm above the ground or at knee-height
- Mount camera with an adjustable Web belt or with a "Bear Safe" metal camera box (model # 119653C) and Deluxe Tree Bracket (model #119652C) to secure it.
- Unlike the Reconyx, the Bushnell does not have the option to add a label that will be included on all pictures taken by the camera.
- User Label (Reconyx): For the CSNR this begins with CT of Camera Trap, CSN of Central Suriname Nature Reserve, 1 or 2 depends on which array, and a number that ranges from 1-30, that refers to the camera trap point (e.g. CT-CSN-1-15). For the Weg naar Zee this begins with CT of Camera Trap, WZ of Weg naar Zee, and a number that ranges from 1-5 for the camera trap location (e.g. CT-WZ-01).
- Aim camera: make movements in front of the camera ("walk test") to see if the motion indicator LED lights blink. The blinking red light indicates motion.

Figure 19. Attaching a camera trap to a tree in the Weg naar Zee area

APPENDIX 2. MAP OF THE STUDY AREAS

In appendix 2 is shown the camera trap locations which were chosen for the Weg naar Zee area and also the size of the study area in the CSNR

Figure 20. The camera trap locations in the forest islands of Weg naar Zee

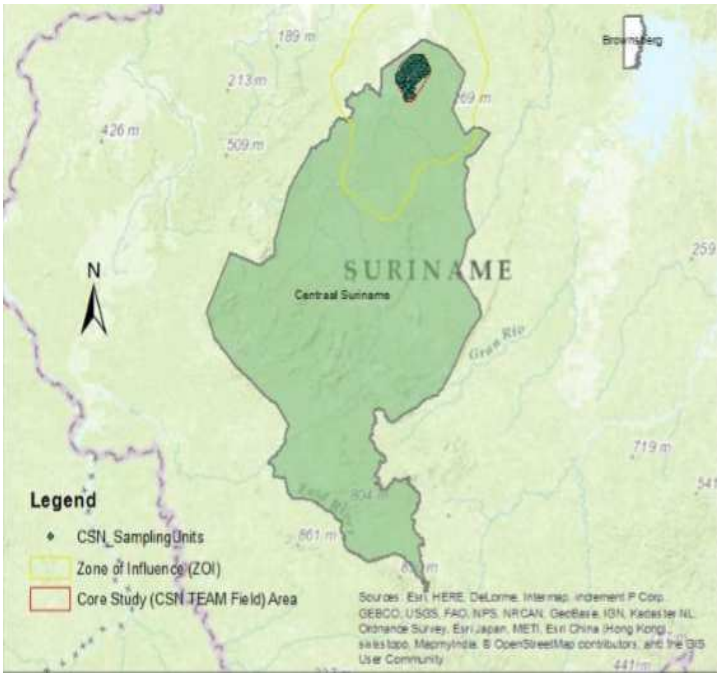

Figure 21. Map of the study area within CSNR

The green area represents the CSNR. The study area for this research lies within the red line, which contains the camera trap points. The area within the yellow line is the zone of influence

APPENDIX 3. TEAM TERRESTRIAL VERTEBRATE PROTOCOL

In appendix 3 is shown the deployment workflow of the Terrestrial Vertebrate Protocol used by TEAM.

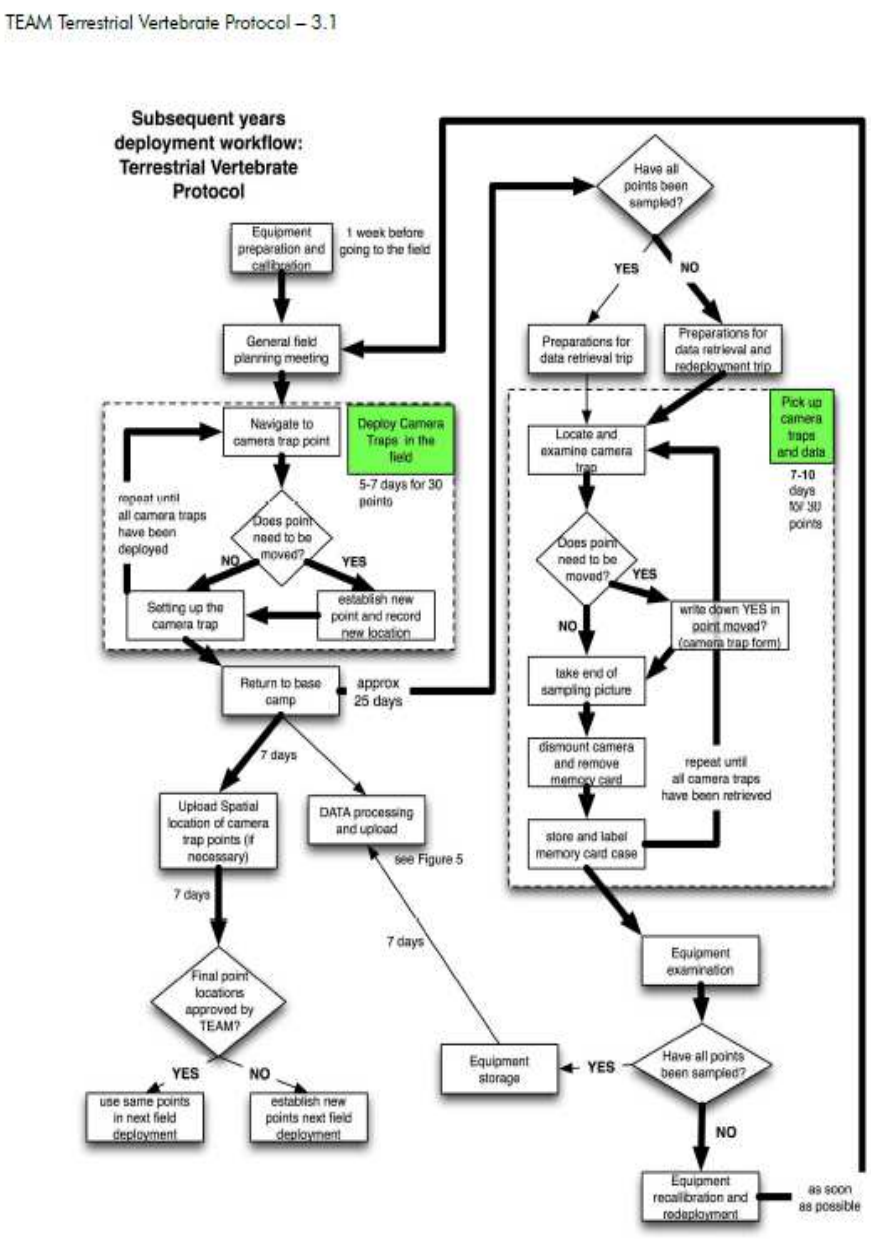

Figure 22. The deployment workflow of the Terrestrial Vertebrate Protocol

APPENDIX 4. TYPES OF FORESTS

According to the FAO Forestry Department, forests are defined as "all vegetation formations with a minimum of 10 percent crown cover of trees and/or bamboo with a minimum height of 5m and generally associated with wild flora, fauna and natural soil conditions" (FAO, 1998).

Swamp Forest

Swamp forest or peat forest are tropical moist forest where dead soil and vegetation (leaves, plant material) becomes waterlogged and creates an up to 20 meters thick layer of acidic peat. Peat forms when plant material is unable to decay fully by the acidic conditions and an absence of microbial activity. These swamp forests are typically surrounded by lowland rain forests on better-drained soils, and by brackish or salt-water mangrove forests near the coast. The high levels of humus and humic acids give the water a dark brown to black colour. Acting as a natural sponge, the peat withholds moisture at times of little rainfall and can easily ignite when drained for agriculture projects. During heavy rainfalls it has a limited capacity of absorption. Their continued survival depends only on naturally high water level that prevents the soil from drying out to expose combustible peat matter. Fires caused in peat swamps are very difficult to extinguish, because it continues in the deeper layers of peat (UNDP, 2006).

Marsh forest

This forest type is periodically flooded and is characterized by insufficient drainage, causing seasonal fluctuation in moisture conditions from very dry to very wet (FAO, 2010). It can be found in river and creek valleys and has two storeys: one between 15 - 25m and one between 5 - 15m. It also has a well developed shrub layer and consists of among others palulu (*Ravenala guianensis*) and grasses (Reichart,1993).

Periodic swamps

Periodic swamps are characterized by habitat. They are periodically (daily, monthly or seasonally) flooded by river water. Periodic swamps are further subdivided into tidal and flood plains (FAO,1998).

Tidal forests

Tidal forests can be found on higher grounds than mangroves. These forest types are influenced by tidal movements and may be flooded almost twice a day by fresh or somewhat brackish water. The vegetation is more diverse than that of mangroves but less diverse as that of dense inland forests (FAO,1998).

Flood plains

Flood plains can be described as seasonally flooded areas by fresh water as a result of rainwater. These forest types contain productive ecosystems with abundant and species-rich wildlife (FAO,1998).

Tropical rainforest

Tropical rainforests can be found, mainly where the climate is hot and humid with an abundant rainfall throughout the year. Tropical or primary forest refers to the world's most diverse land-based ecosystem, as it is host to many rare, endemic and endangered plant and animal species. It is untouched, pristine and it exists in its original condition. The rainforest vegetation is rich with a full ceiling canopy (often up to 50-60m high) with several layers of understory and also with some emergent trees that stick out above the closed canopy. The ground floor of the forest is mostly clear of heavy vegetation because the canopy lets very little light through, which is necessary for plant growth. Only when canopy trees fall, a temporary gap exist resulting in some plant and understory growth. This forest exist following natural disturbances and under natural processes and has also been relatively unaffected by human activities. The only human activities known are the traditional lifestyles of the indigenous and local communities, which are relevant for the conservation and sustainable use of biological diversity (CBD,2017).

Lowland rainforest

The lowland rainforest is found at elevations of up to ± 1000 meters within the tropical belt. These types of forests provide the ideal environment for animals and plants, because of the tropical climate, the constant warm temperatures and high rainfall, suitable for a great biodiversity. Of all the types of rainforests, the lowland rainforest contains the tallest trees with the largest variety of species (Rainforest Concern,2008).

Montane rainforest

These types of forests look entirely different than other forest areas and can be found in mountainous areas within the tropical belt. The lower montane forest is found at altitudes of 1000 – 2500 m and the upper montane forest at 2500 – 3000 m. In general their upper limit is at 3000 m. The damp weather (moisture from the swirling clouds) overwhelms these forests, resulting in the cooler temperatures than that of the lowland rainforest. In comparison to the lowland rainforest, there is less tree growth and more epiphytic plants and ferns due to the cooler temperatures (Rainforest Concern,2008).

Savanna and mountain savanna forest

Savanna and mountain savanna forest have one or two storeys. Its canopy height varies from 10 – 20 m. Thin-trunked trees are typical trees found in these forest types. Unlike the low savanna, mountain savanna forest can be seen in the highest parts of the area. It consists of thin-trunked trees and irregular tree canopy (Reichart,1993).

APPENDIX 5. CAMERA TRAP PICTURES OF A GIANT ANTEATER (*MYRMECOPHAGA TRIDACTYLA*)

Appendix 4 illustrates a moment where a female anteater with its young on her back walks past a camera trap.

Figure 23. Female giant anteater with its young walking past a camera trap (CT location: CT-CSN-1-02)

APPENDIX 5. CAMERA TRAP PICTURES OF ANIMALS IN THE WEG NAAR ZEE AREA

In appendix 5 is shown the different animal species caught on camera in the Weg naar Zee area.

Figure 24. Agoutis caught at the camera trap locations CT-WZ-01 and CT-WZ-03

Figure 25. Lesser anteater caught at the camera trap location CT-WZ-02

Figure 26. Crab-eating raccoons caught at the camera trap location CT-WZ-02

Figure 27. Rufescent Tiger-Heron caught at the camera trap location CT-WZ-03

Figure 28. Capybara caught at the camera trap location CT-WZ-03

Figure 29. Common squirrel monkey caught at the camera trap location CT-WZ-03

APPENDIX 6. PICTURES OF LOCAL RESIDENTS HUNTING IN THE WEG NAAR ZEE AREA

In appendix 6 is shown the local residents hunting in the Weg naar Zee area.

Figure 30. Local resident hunting at the camera trap location CT-WZ-02

Figure 31. Local resident hunting at the camera trap location CT-WZ-03

Figure 32. Local resident hunting at the camera trap location CT-WZ-04

APPENDIX 7. DUMPING SITE AT THE NOORDWIJKWEG

In appendix 7 is shown the dumping site in the street “Noordwijkweg”, not far from the study area in the Weg naar Zee area.

Figure 33. Illegal dumping on the left side of the Noordwijkweg

Figure 34. Illegal dumping on the right side of the Noordwijkweg

APPENDIX 8. INTERVIEW SHEET FOR THE LOCAL RESIDENTS IN THE WEG NAAR ZEE

In appendix 7 is shown the interview sheet used during the research study

Interview sheet (Weg naar Zee – Estimating population density Giant Anteater)

Adress:

1. Have you ever seen animals coming out of the forest ?
   a. No
   b. If so, what kind of species have you seen?

2. How many times have you seen these animals?
   a. Everyday
   b. Once a week
   c. Once a month
   d. Occasionally / Regularly

3. At what point of time have you seen these type of animals?
   a. Morning
   b. Afternoon
   c. Evening
   d. All day

4. Have u experienced any changes in animals compared to the past?
   a. Yes, ...
   b. No
   c.
5. Have you ever seen a Giant anteater in the neighbouring forest?
   a. Yes
   b. No

6. How many times have you seen this animal?
   a. Everyday
   b. Once a week

c. Once a month
d. Occasionally / Regularly

7. At what point of time have you seen this type of animal?
   a. Morning
   b. Afternoon
   c. Evening
   d. All day