KU LEUVEN

FACULTY OF SCIENCE

Master of science in biology

A survey of reptiles and amphibians

Boé region, Guinea-Bissau

Tom Cabuy

External internship professionalization G0W49A
February – June 2014

Colofon

Text: Tom Cabuy
With the cooperation of:
Dorien Van Montfort, Utrecht University, Utrecht, The Netherlands
Annemarie Goedmakers, Chimbo Foundation, Kesteren, The Netherlands
Henk Eshuis, Chimbo Foundation, Beli, Guinea-Bissau
Jos Snoeks, KU Leuven University, Leuven, Belgium
Olivier Honnay, KU Leuven University, Leuven, Belgium
On behalf of: Chimbo Foundation & KU Leuven
Cover picture: *Agama boensis*, photo by Tom Cabuy

Way of quote: Cabuy T., 2014. A survey of reptiles and amphibians in the Boé region, Guinea-Bissau. Chimbo Foundation, Kesteren, The Netherlands & KU Leuven, Leuven, Belgium.

Table of contents

Introduction

The Boé region (visualized in figure 1 in the next chapter), located south-east in Guinea-Bissau was once the centre of revolution as the independence of Guinea-Bissau was signed right in the middle of the region (United Nations General assembly – Twenty-eight session, 1973). In spite of all that the lack of decent roads and the rather poor development of Guinea-Bissau has led to the current isolated status of the Boé region. This isolated status protected the region from most of the western influences which led to the remaining of large areas of pristine forests. The region has one of the largest unbroken natural habitats for chimpanzees in Western Africa. Therefore Chimbo foundation is cooperating to get a protected status for the region, using the chimpanzee as an umbrella species to protect the whole ecosystem.

Very little is known about the distribution and diversity of reptiles and amphibians in the region. The IUCN Red List of Threatened Species (IUCN, 2014) sums up a total of at least 14 species of amphibians for Guinea-Bissau. The largest online encyclopaedia http://www.amphibiaweb.org/ speaks of at least 17 species that are possibly present in Guinea-Bissau. For reptiles, the IUCN Red List of Threatened Species (2014) sums up a total of at least 3 species of reptiles for Guinea-Bissau. One of the largest online encyclopaedia http://www.reptile-database.org/ speaks of at least 48 species that are possibly present in Guinea-Bissau.

Species inventories and distribution surveys could reveal valuable information about the area. The discovery of new species or new distributions of existing species wouldn't be surprising. This new information and discoveries could confirm the need of a protected status of the Boé region.

Silvavir forest consultants, a consulting office located in the city of Arnhem (The Netherlands), has made a research proposal in the beginning of 2013 for Chimbo foundation to carry out a survey on small terrestrial mammals and amphibians. In October 2013 Roy Mol and Sil Westra from Silvavir forest consultants started up the survey for a period of three weeks in the surroundings of Beli, the main village of the Boé region. Amber Baele, a graduated Belgian biologist, was trained by Roy Mol and Sil Westra and continued the research for about 3 months. Dorien Van Montfort, a Dutch biologist student, replaced here from the beginning of February till the end of April being responsible for the small terrestrial mammal research. The author of this report, Tom Cabuy, took charge of the amphibian research for about 4 months and expanded it with a reptile survey to create a full herpetological survey. Silvavir Forest consultants proposed Chimbo foundation to conduct the research for one calendar year with the help of biology students or (eco-) volunteers.

The Boé region and Chimbo Foundation

The former Portugese colony Guinea-Bissau is an autonomous country since 1974 and is bordered by Senegal in the north, Guinea in the east and south, and by the Atlantic Ocean in the west, visualized in the map below.

Figure 1: The geographic position of Guinea-Bissau bordered by Senegal in the north, Guinea in the east and south, and by the Atlantic Ocean in the west. The Boé region is outlined with a red line.

It covers an area of approximately 36.125 km² between 10°52' and 12°40' N and 13°38' and 16°43' W. According to recent data, its human population is estimated at 1.693.398 (July 2014, The World Factbook 2014. The country can be divided into three characteristic types of landscape: (1) scattered plain islands together with the flooded valleys describe the coastal zone, (2) coastal estuaries or "rias" outlined with mangrove swamps extend deep into the continent on the main rivers Rio Cacheu, Rio Mansoa, Rio Geba, Rio Grande de Buba and Rio Cacine, and (3) this second zone borders a moist savannah on a very low elevated shelf with the highest peak of 310 m above sea level in the southeast of Guinea-Bissau, the foothills of the Fouta Djallon.

It is in this last region that the heart of the research took place, the north-western spur of the Fouta Djallon highland with his characteristic massive plateaus and a mosaic of rolling savannah and forest patches intersected by shallow river valleys, which have a wide variety of flora and fauna. The region is called “The Boé region” (outlined with a red line in the map) which has a surface of about 3200 km² and orientated southeast in the country. The accessibility of the region is limited by poor infrastructure and a 200m wide river, the Rio-Corubal. Because the area is so isolated, it is relatively unaffected by human interference which creates favourable values for natural conservation.

Located in the tropical savannah climate zone, the Boé region has daytime temperatures between 30ºC and 33ºC, while during the night temperatures will drop between 18ºC and 23ºC. The dry season starts in November and lasts until May, during this time precipitation is very low, whilst the rainy season is extremely wet and accessibility is further limited by puddles and gulleys.

It is in this region that Chimbo foundation (Stichting Chimbo) is active. The mission of Chimbo foundation is to conserve and, where appropriate, regain the chimpanzee population in West Africa and the natural environment in which they live. This foundation has been established in memory of David Goedmakers and is doing everything it can to fulfil its mission:

- Assist regions to obtain protected status;
- Take measures to guarantee protected status;
- Educate others;
- Invest in sustainable tourism;
- Develop supplemental or alternative sources of income for the local population that support the foundation’s mission;
- Encourage relevant scientific and applied research;
- Create broad support for the foundation’s mission through communication;
- Promote partnerships;
- Seek financial resources that will help us fulfil our mission.

Objectives

Study objectives

As a Master student in the Biology there was an option to do an internship for one school semester (from the beginning of February till the end of June). I was fortunate to conduct 18 weeks of research in the Boé region for this organisation named “Chimbo”.

The main goals of this external internship professionalization are:

- The student is able to plan, execute and interpret the collected data in a scientific study on the basis of input from team members and scientific literature;
- Besides that he’s able to incorporate his existing biological knowledge and include other field qualities;
- He’s able to work independently and has a certain flexibility, responsibility and enough respect to work as a team. Inside his team, the student is able to bear responsibility for the final result;
- The student is aware of the ethical, social and legal aspects of his job and has the necessary communicative skills to report properly to the university and the organisation he’s working for.

Research objectives

This research project aims to support the purpose of conservation and reduction of poverty in the Boé:

- **Nature conservation**

Chimbo has set up a research station with the aim of researching and conserving the biodiversity in the Boé. Proper knowledge of the various habitats and current status and trends in biodiversity are essential. Therefore, next to the current ones, additional surveys and monitoring schemes need to be setup. Adequate financial resources, availability of research materials, researchers, a biodiversity database, structural collection of data, and build-up of local knowledge (training local people as assistants) are key to the setup of a broad ranged research station in which various groups of species can be researched.

This survey is one of the first in line of many others to come and a great deal of knowledge about biodiversity and project management can be learned. By continuing this survey with help of students, volunteers or staff the possibilities and feasibility of different research methods and species can be explored more extensively. The collected data could lead to needed different conservation management strategies. Training of local people to become field assistants contribute to the local awareness and knowledge about the need for protection of the environment.

- **Poverty reduction**

The chances for economic development in the Boe region are limited. The local population is largely illiterate and especially dependent on small scale agriculture on degraded farmlands. Chimbo and her local sister-organisation Daridibo are looking for alternative resources. Tourism has high potential, however for the time being focus has to lie on specific groups like eco-volunteers. There is global growth and therefore perspective for the Boé but regular tourism to Guinea-Bissau is little developed and the political situation is too instable to offer the right perspective in the short term.

Eco-volunteers contribute actively to international conservation. For them participation in a relatively easy monitoring survey could be one of the activities of their holiday to the Boé. Alternatively there are eco-volunteers that are specialized in species groups like mammals, bats, birds, invertebrates, reptiles and amphibians. For them it could be a challenge to come to the Boé to discover new species. Chimbo and Daridibo offer eco-volunteers the facilities and guidance for a unique experience in the Boe. With targeted marketing the mentioned eco-volunteers will be approached.

Eco-volunteers would offer opportunities for economic development. Tourists will have to be fed and housed, providing work and clientele for shops, cooks and housekeepers. They will also need guidance and assistance from locally trained nature guides or field work assistance. Furthermore their contribution to the project will provide financial benefits to Chimbo that can be invested into the project.

1 Survey locations

Five survey locations were chosen by Roy Mol and Sil Westra from Silvavir forest consultants who wrote the initial research proposal in January 2013 by Chimbo Foundation order and setup the research in October 2013. Their aim is to survey small terrestrial mammals and amphibians in representative natural habitats in the surrounding area of Beli village. Therefore two locations were selected in a savannah biotope, another two were selected in a forest corridor and one site was located in an overgrown rice field. These five locations were located in a radius of approximately 5 km from Beli village to make sure that the sites were easily accessible by bike.

As written in the introduction the author of this report, Tom Cabuy, expanded the research with a survey on reptiles. Because of the close collaboration with the researcher responsible for the small terrestrial mammals (Dorien van Montfort, Utrecht University, The Netherlands), the survey locations chosen for the small terrestrial mammals and amphibians were extended to fulfil as reptile research areas.

An extra location, location 6 was created in substitution for location 1 which has become a distressed area due to a bush fire and the nocturnal visits of large scavenging mammals. Location 1 was abandoned 25 February, one week later on the 4th of March location 6 was created. One would think that location 1 was substitute for a location within the same habitat type. Instead there was chosen for a new location where water is even present in the heart of the dry season and which is close to the most popular cultivation type, the cashew plantation, in Guinea-Bissau. As we believed this is a growing habitat type in the area of Beli and therefore interesting to attach as new research location.

A detailed map of the geographic position of the 6 locations can be found in the figure on the next page.

- **Location 1:**

Described by Silvavir forest consultants as a savannah biotope covered with tall grassy vegetation next to a small gallery forest in wet season. While the area can be described as an arid, burned, former grassland with a south sided gallery forest containing tall scrubs and small trees from which the stream is driedup. The soil consists of red clay, mixed with coarse gravel and large rocks.

A picture together with the exact coordinates of this location taken at the end of the dry season can be found in the attachments.

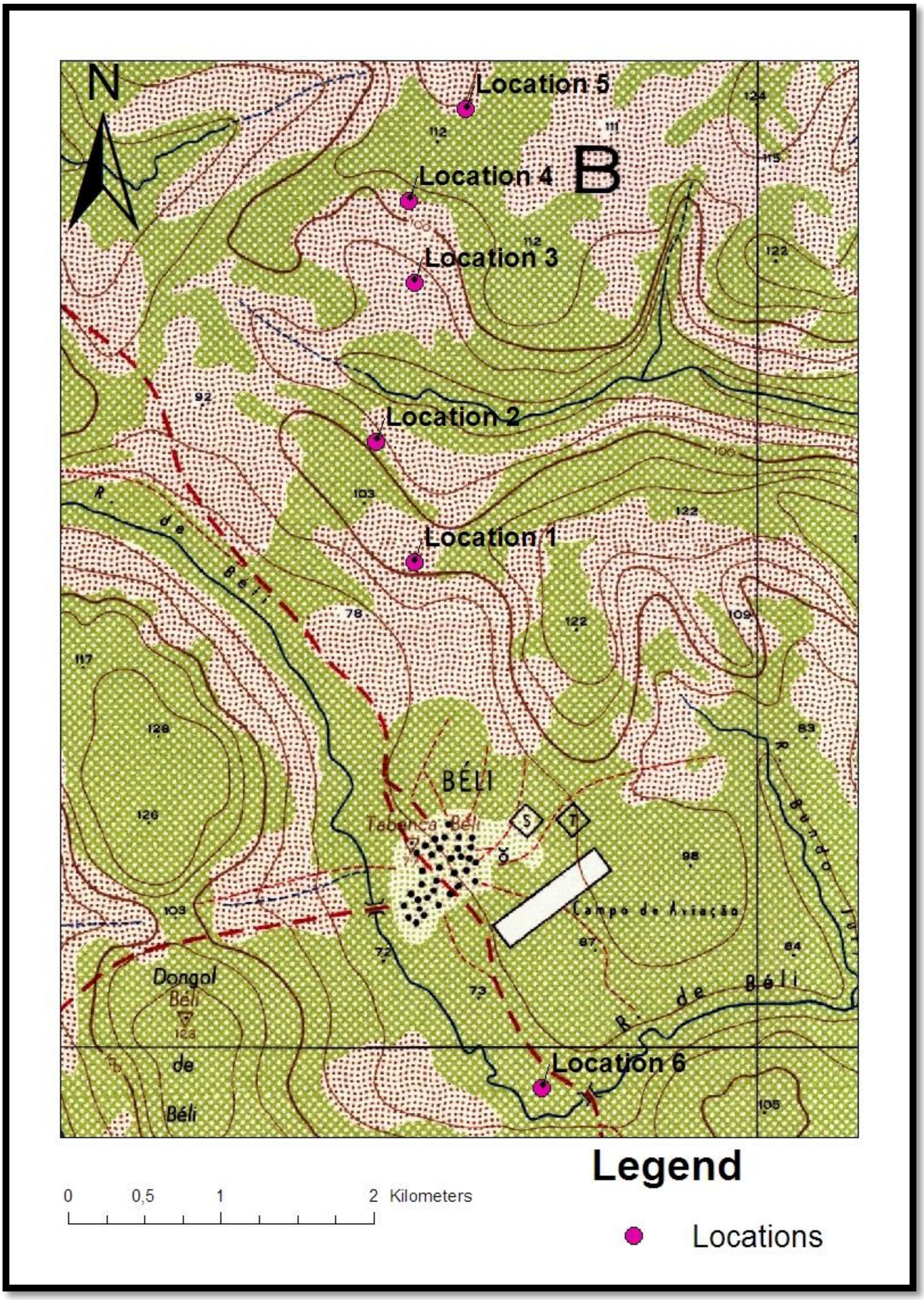


Figure 2: Map showing the geographic position of the six locations, symbolized by the purple dots. The red dotted lines are the main road going through or passing by Beli village. Green areas with white dots are supposed to be more forested areas while white areas with brown dots are supposed to be more savannah patches. As this map dates from 1958 the size of Beli village and the forest and savannah patches are slightly different from the current situation.

- **Location 2:**

An abandoned agricultural field, used for dry rice production. The field is overgrown with low shrubs and tall bunches of grass. The soil consists of sand and organic materials, mixed with clay.

A picture together with the exact coordinates of this location taken at the end of the dry season can be found in the attachments.

- **Location 3:**

Silvavir forest consultants described the place as a savannah biotope. The area is covered with tall grassy vegetation in the wet season. The location is sided by a small gallery forest to the east, which is comprised of tall shrubs and some trees. On the west side the location is bordered by a small, slow flowing stream. While in the dry season a minor part of this grassy vegetation is left and the stream is totally driedup. The soil consists of red clay, mixed with coarse gravel and large rocks.

A picture together with the exact coordinates of this location taken at the end of the dry season can be found in the attachments.

- **Location 4:**

A larger gallery forest amid the savannah area. The area is covered by tall trees and shrubs. Halfway through the cross-section the forest is cut by a seam of very high grass. The soil consists of red clay and organic materials.

A picture together with the exact coordinates of this location taken at the end of the dry season can be found in the attachments.

- **Location 5:**

A savanna biotope, the area is covered with tall grassy vegetation in the wet season. While in the dry season the major part of the grassy vegetation is left. The location is sided by a small gallery forest to the east, which is comprised of tall shrubs and some trees. On the west side the location is bordered by a small, slow flowing stream. The soil consists of red clay, mixed with coarse gravel and large rocks.

A picture together with the exact coordinates of this location taken at the end of the dry season can be found in the attachments.

- **Location 6:**

As this location is newly added to the research no data nor description is available from it during wet season. It is thought that the area will be partial flooded during the wet season. In dry season this area consist of a small, very dense gallery forest cut through by slow flowing stream. On the south-west side enclosed by a wet grassland with some smaller scrubs, while the south-east side is planted with cashew trees. The north-east side consists of partial cut scrubs and naturally grown oil palms.

A picture together with the exact coordinates of this location taken at the end of the dry season can be found in the attachments.

2 Materials and methods

To capture reptiles and amphibians three main methods are used: Actual capture using pitfalls, visual encounter in the field and encountering using artificial refugia.

Besides these three main methods some effort was done in the making of one Ortmann's funnel trap (Drechsler et al., 2010) and 4 Griffith funnel traps (Griffith, 1985) and a dip net. As water bodies were shrinking at an exceptional speed during the dry season, the Orthmann's funnel trap, the 4 Griffith funnel traps and the dip net were only a few weeks active before they were stored again due to the lack of remaining decent water bodies. No appreciable results were reached with the Orthmann's funnel trap and the 4 Griffith funnel traps and the period of usage was too short. Due to this reason this part will be neither in the results nor in the discussion.

During the end of February a message on Radio Beli was broadcasted to the people of Beli and neighbour villages that killed reptiles (accidently killed on the road or killed when encountered during agricultural work) could be brought to Beli for scientific purpose and preserved on Formaldehyde.

2.1 Capture using pitfalls

On the five selected locations pitfall traps are installed in combination with associated drift fences. Note that location 6 is the replacement of the abandoned location 1 after troubles with large terrestrial mammals, more details can be found in the discussion section. The drift fences consist of a plastic fence that is about 40cm high. Along the fence buckets are dug in at a spacing of five meters. Small terrestrial animals will walk along the fence in order to get around the obstruction. When they encounter a bucket, they will fall in and will not be able to get out on their own.

The assembly of the pitfalls with the associated drift fence is fairly easy. On a straight line, five 10L. buckets are dug every 5 meters, so the total length of the line will reach approximately 20 meters. To ensure drainage, the holes for the buckets are dug about 20 cm deeper than the bottom of the bucket. All buckets are covered with a lid in which a hole is cut in the middle, so that a three or four cm wide border along the rim of the bucket remains wen the lid is on. This ring prevents animals climbing back out from the inside along the side of the bucket once they are caught. The round pieces of plastic that are cut from the lid should be kept in order to close the buckets completely off when the traps are not in use. In order to be able to close the pitfalls, small crossbeams are attached to the cut-outs from the lids. This is done to make sure that the cut-outs won't fall into the buckets.

The bottom of the buckets are perforated to drain excess of rainwater. Furthermore, a medium sized rock is put in the bucket for shelter or refuge. For this project emptied sauce-buckets are used, which can easily be bought on the markets of Gabu and Bissau. A wooden stake is placed right beside every bucket, in the distance between the stakes three more are evenly spaced. The stakes measure about 80 cm in length and have a diameter of about 10 cm, one end is cut into a point and is bashed about 30 centimetres into the ground. Stakes are made from local wood with a reasonable durability. Agricultural plastic foil with a width of 50cm is fastened onto the pickets with staples using a stapler. It is installed in such a manner that the foil runs straight across the middle of the pitfall buckets. The foil is 40 cm in height, and a seam of 10 cm drapes over the ground. In the initial assembly described by Silvavir forest consultants this seam is covered with dirt so that animals cannot crawl underneath the drift fence. This could be a good method during rainy season when the covered dirt stays wet and thereby fairly heavy. During the dry season the remaining seam of 10 cm became lose at several locations as the covered earth dried-up and wasn't heavy enough to fixate the seam. This way animals could escape under the plastic foil instead of falling in the buckets. Larger terrestrial mammals damaged the foil when they crawl under the seam. At the beginning of May all the drift fences where renewed and several wooden stakes which were heavily damaged by termites were replaced. During the construction of this new drift fence a slot of 10 cm deep and 5 cm wide was dug over the total length of the drift fence. This way the remaining 10 cm seam could be dug in to prevent loosening during the next dry season. A second adaptation of the initial assembly described by Silvavir forest consultants was the placement of long thin wooden sticks on top of the wooden stakes. Long straight wooden sticks were cut near each location and placed horizontal, using metal nails, on top of the wooden stakes. The top of the plastic foil was then secured to the wooden sticks using drawing pins. The second adaptation was done to prevent cows and goats to walk over or pass the drift fence instead of through, creating irreparable damage to the drift fences. This phenomenon was observed several times during the end of the dry season when large herds of cow scatter the savannah for some remaining food. The foil is cut straight above the bucketholes in order to create a gap in the fence that makes the bucket accessible from both sides. To make sure that animals won't get "stuck" on the backside of the fence, in the corners between the fence and the stakes, these corners are also filled up with a heap of dirt. The same is done with every bucket-rims that would be coming out of the ground.

All pitfall traps will be set at a certain day (initially Sunday afternoon but this could fluctuate as planning sometimes changes) by removing the cut-outs from the lids of the pitfalls. Every week 10 checks are being performed simultaneously with the checks of the live traps from the small terrestrial mammal research. The traps are checked during daylight; every morning as soon as possible and every afternoon as late as possible. This way captured animals won't be trapped longer than strictly necessary. The traps are closed using the lids during the morning at the fifth monitor day. Captured animals are documented and photographed. In the case of a species that hasn't been encountered previously, the specimen is taken along for further determination at the office. After determination, these animals will be released at the same location on the next control-round. Animals that are unidentifiable with the use of the present literature will be euthanized and put in 70% alcohol for further determination in Belgium or the Netherlands. See the next chapter “Work protocol Live traps and pitfall traps” for detailed protocol on trapped animals.

Below two lists are given. First one with the characteristics that will be documented per amphibian species:

Table 1: Documented values per amphibian species.

Record ID	Description	Tympanum diameter	Upper-Eye horns
Species	Colour pattern	Eye diameter	Webbing formula
Location	Weight	Nose-Eye length	Genus
Date	Foot+Tarsus length	Nose-Snout length	Time of day
Catch number	Shank length (tibia)	Vocal sac / Gular flap	Weather
Record number	Thigh length	Skin / Warts	Trap number
State of catch	Snout-vent length	Parotid glands	Trap type
Biotope	Head width	Tubercles	Other remarks

Second one with the characteristics that will be documented per reptile species:

Table 2: Documented values per reptile species.

Record ID	Biotope
Species	Description
Location	Nose-cloaca length
Date	Family
Catch number	Time of day
Record number	Weather
State of catch	Other remarks
Observation method	Trap type

2.1.1 Work protocol Live traps and pitfall traps

Note that this work protocol was initially made both the small terrestrial mammal and amphibian research by Silvavir forest consultants. Later it has been extended by the author of this report for reptiles.

A. A (presumably) new species is caught:
- Put the animal in a temporary cage;
- Write down the unique record id of the animal on a temporary label on the cage;
- Take the animal back to the office for recording and determining the species;
- Measure, weigh and sex the animal and fill in all the data fields on the“20140605_Mammalia_Amfibia_Squamata_Datasheet_Mastersheet.xls”;
- Take photographs of all relevant characteristics of the species;
- Name the photographs by editing the file name and turning them into record id of the specimen;
- Consult relevant literature and try to determine species.

A1. The species cannot be determined:
● Euthanise the animal by injecting a small quantity (10-25 ml) formaldehyde into its abdomen. If the animal is large also inject its limbs after death;
● Preserve the animal by putting it in a container, filled with alcohol (for amphibians) or formaldehyde (for reptiles). It has to be completely submerged;
● Label the pot well with a permanent sticker with at least date, location and unique record id linking it to all the info on the master datasheet.

A2. The species can be determined:
- ● If mammal mark the animal by clipping hair at the base of the tail;
- ● Put the animal back into the temporary cage and cover it with a cloth;
- ● At the next round of fieldwork take the animal to the original catch location;
- ● Always release the animal on the exact spot where it was caught.

B. A new individual is caught:
- If a new individual is caught and the species is readily determined measure, weigh and sex the animal in the field and if mammal mark it by clipping hair at the base of the tail;
- Fill in all the recorded data in: "20140605Mammalia_Amfibia_Datasheet_Mastersheet.xls";
- Take photographs of all relevant characteristics of the species;
- Name the photographs by editing the file name and turning them into record id of the specimen;
- The animal can now be released at the spot.

C. A re-catch of an already caught and marked individual (only small mammals):
- The animal can now be released at the spot.

2.2 Visual encounter

While visiting the locations, men can encounter various animals. As this research is based on amphibians and reptiles, specimens that belongs to these groups were noted when encountered in the field. When arriving at each of the five locations some handlings were done in order to see reptiles (and/or amphibians). Walk slowly, treading lightly, and scanning the area at least 3-4 m in front. Pay particular attention to potential basking spots. Shadows can disturb basking reptiles so be aware of the direction the sunlight is coming from; it is best to look with the sun behind you, so that you are looking into the basking spots. Listen for rustles in the vegetation. The sounds produced by reptiles as they flee for cover after being disturbed are particularly useful for survey purposes. If you hear rustles in the vegetation as you walk past, or if you catch a fleeting glimpse of an animal, note the spot and return ten minutes later. This technique is species dependent. (Froglife, 2014)

If an encounter with a reptile (or amphibian) specimen occurs and the family, genus or in best case the species name could be identified before the animal disappears into the vegetation, this will be noted and placed in the master sheet. If there is uncertainty of the exact animal seen, the encounter will be ignored. Visiting the same spots 5 times a week, twice a day, a lot of reptiles are encountered. When the observer sees a reptile several times in a row at approximately the same spot, the animal is only one time recorded in the data as there is a high chance it's the same individual.

On a regular base late evening walks were made in the surroundings of Beli village using a strong head torch scanning the ground, trees, walls and other objects for reptiles or amphibians to cover the night active specimen.

Note that the success of visual encounter highly depends on the experience of the researcher concerning visual encountering and his knowledge of the specimen occurring in the research area and is thereby individually depended.

2.3 Artificial refugia

All species can be found using visual search. But artificial refugia greatly increase chances of detection (for some species) (NARRS, 2014)

2.3.1 Metal plates

Reptiles are often found under or on top of objects resting on the ground. These refuges can act as a place to shelter from predation and disturbance, and as an aid to absorbing heat. Certain materials, particularly sheets of corrugated iron ("tins"), trap heat and provide an opportunity for animals to warm up without exposing themselves to obvious danger. Artificial refuges can sometimes act as reptile "magnets", attracting animals from the immediate vicinity, and can be useful aid to survey if placed on the site carefully. It is worth noting, however, that using refuges alone may not be sufficient. It can be easy to fall into the habit of only checking refuges and neglecting the rest of the site; this will mean that some animals will be missed. It is best to combine checking refuges with searching the rest of the habitat as described above. (Froglife, 2014)

On the first of March, 32 tins measuring 70 cm x 60 cm, were placed in the field. Eight tins per location were placed in the neighbourhood of location 2, 3, 4 and 5 (another eight tins were placed on location 6 during the construction) forming a survey transect. The tins were placed so they would catch the first sunrays away from public view and livestock being in deep cover or on the edge of dense vegetation. The vegetation under the tins was pressed down close to the ground to create a microhabitat. The tins were left undisturbed for 3 weeks to ensure a habituation period. After the habituation period, the tins were lifted and replaced once a week, giving one check per week. Therefore a stick was used to ensure safety against defensive or poisonous animals. During the weekly check of the tins reptiles or amphibians encountered while walking the survey transect (between the tins) were also noted.

2.3.2 PVC-tubes

In the late 80's, researchers have begun to take advantage of the propensity of hylid treefrogs to use cavities as diurnal shelters (McComb and Noble 1981; Ritke and Babb 1991; Walters and Kneitel 2004) by deploying artificial refuges that mimic natural cavities to sample hylid populations (Meshaka 1996; Moulton et al. 1996). Polyvinyl chloride (PVC) pipe refuges are perhaps the most popular method for studies of hylid population ecology and ongoing monitoring efforts (e.g., Boughton et al. 2008; Moulton et al. 1996; Pittman et al. 2008; Zacharow et al. 2003). The PVC refuges are more effective for hylid sampling than traditional drift-fence arrays, and passively attract (rather than trap) frogs. As this effectively eliminates trap mortality, there is no need to remove or close "traps" between sampling periods, making PVC sampling less labour-intensive than many trapping methods. Sampling can be conducted throughout the day without fear of heat stress to "captured" animals. It was this passage out of Hoffmann's work in 2009 (Hoffmann et al., 2009) that gave the idea of the construction of PVC tube "traps" and the evaluation of it in West-African habitat in the Boé region, Guinea-Bissau.

During the end of April 2014 PVC tube traps were constructed, consisting out of 3 different diameters (13 mm, 26 mm and 38 mm). The 13 mm tubes were translucent while the 26 and 38 mm tubes were non-transparent. Four PVC tube traps of 13 mm diameter and 60 cm length were placed into the dense vegetation into a holy forest within the village of Beli. The bottom of these cylindrical traps was sealed using water resistant plastic tape and the first 10 cm of the trap was filled with water from a shallow pond inside the forest. Two pairs of PVC tube traps of 26 mm and 38 mm were cut at a length of 60 cm while another pair of PVC tube traps of 26 mm and 38 mm were cut at a length of 80 cm. The bottom of these traps was sealed as well with water resistant plastic tape and filled with 10 cm of the locally collected water. These 3 pairs of PVC tube traps were hanged up in trees, using iron wire, about 1, 5 m above the ground in the same dense holy forest. These PVC tube traps were randomly checked for the presence of amphibians when there was time left besides the other work.

3 Results

The initial idea of this herpetological survey is the creating of a species list and thereby assess the herpetological diversity of the Boé region. A comprehensive species list can be found in the table on the next page. The IUCN red list, the catalogue of life and the reptile database were used as reference works to divide the specimen in the current accepted families. As some of the used literature to identify specimen in the field were outdated concerning the taxonomical divisions, especially families tend to change from time to time.

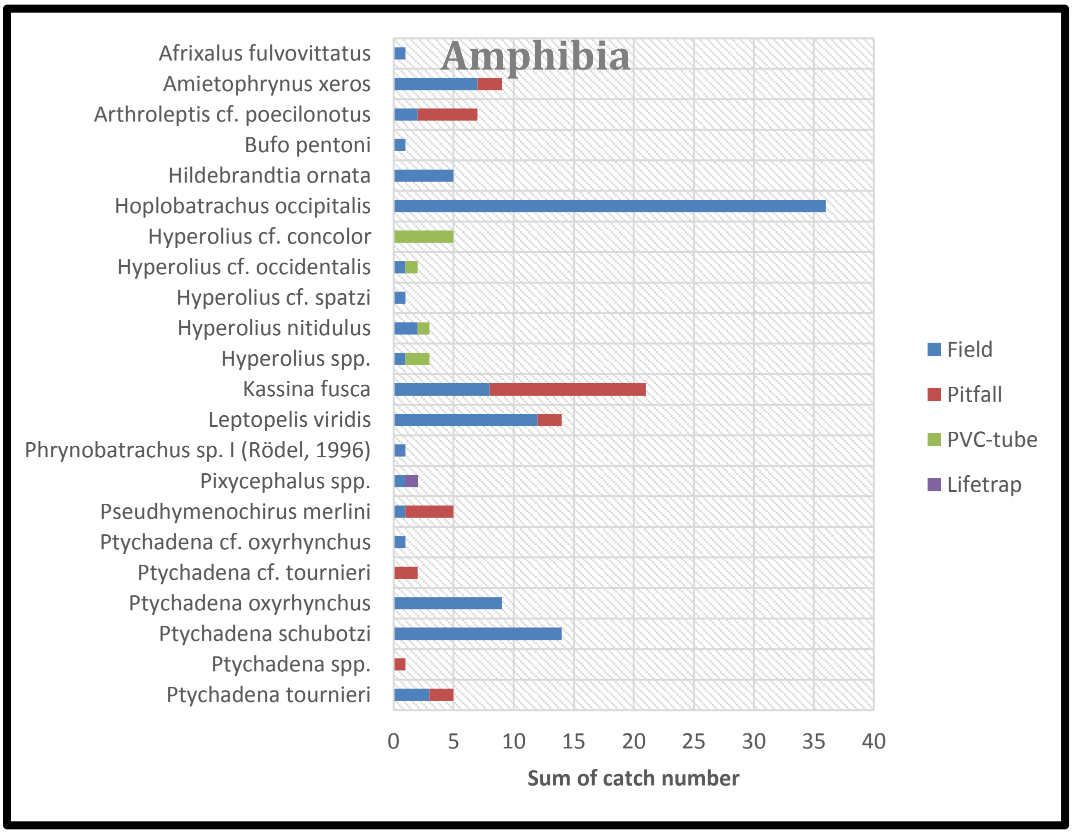
Note that the survey period for Amphibia differs from Reptilia, approximately 8 months for Amphibia compared with approximately 4 months for Reptilia.

Table 3: Comprehensive species list, with subdivisions Kingdom, Phyllum, Class, Order, Family and Species. The IUCN red list, the catalogue of life and the reptile database were used as reference works to divide the specimen in the current accepted families.

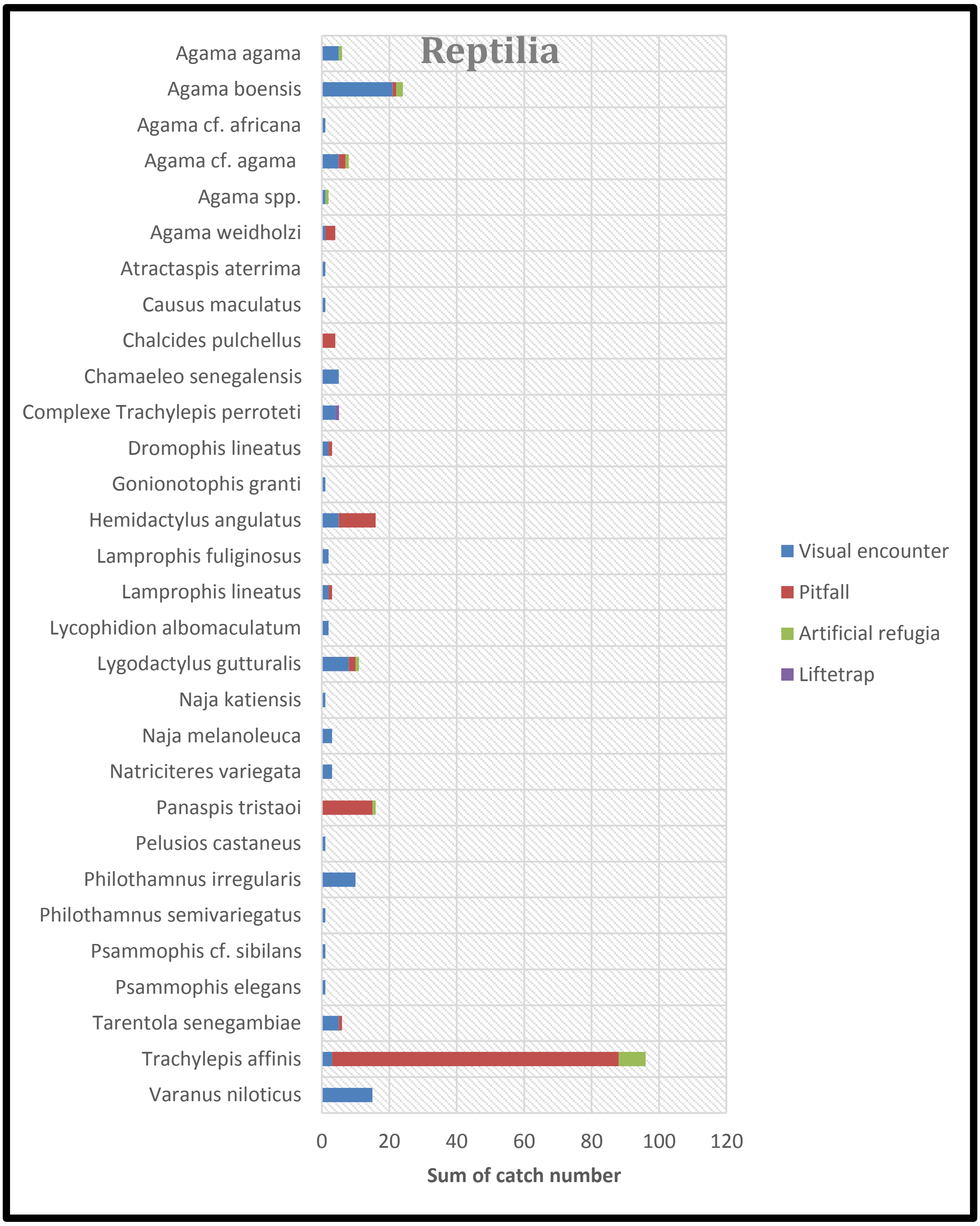
Kingdom	ANIMALIA		
Phyllum	CHORDATA		
Class	AMPHIBIA		REPTILIA
Order	ANURA		SQUAMATA
Family	ARTHROLEPTIDAE	**Family**	AGAMIDAE
	Arthroleptis cf. poecilonotus		*Agama agama*
	Leptopelis viridis		*Agama boensis*
Family	*BUFONIDAE*		*Agama cf. africana*
	Amietophrynus xeros		*Agama cf. agama*
	Bufo pentoni		*Agama spp.*
Family	DICROGLOSSIDAE		*Agama weidholzi*
	Hoplobatrachus occipitalis	**Family**	ATRACTASPIDIDAE
Family	HYPEROLIIDAE		*Atractaspis aterrima*
	Afrixalus fulvovittatus	**Family**	CHAMAELEONIDAE
	Hyperolius cf. concolor		*Chamaeleo senegalensis*
	Hyperolius cf. occidentalis	**Family**	COLUBRIDAE
	Hyperolius cf. spatzi		Philothamnus irregularis
	Hyperolius nitidulus		Philothamnus semivariegatus
	Hyperolius spp.	**Family**	ELAPIDAE
	Kassina fusca		*Naja katiensis*
Family	PHRYNOBATRACHIDAE		*Naja melanoleuca*
	Phrynobatrachus sp. I (Rödel, 1996)	**Family**	GEKKONIDAE
Family	PIPIDAE		Hemidactylus angulatus
	Pseudhymenochirus merlini		Lygodactylus gutturalis
Family	PTYCHADENIDAE	**Family**	LAMPROPHIIDAE
	Hildebrandtia ornata		*Psammophis lineatus*
	Ptychadena cf. oxyrhynchus		*Gonionotophis granti*
	Ptychadena cf. tournieri		*Lamprophis fuliginosus*
	Ptychadena oxyrhynchus		*Lamprophis lineatus*
	Ptychadena schubotzi		*Lycophidion albomaculatum*
	Ptychadena spp.		*Psammophis elegans*
	Ptychadena tournieri	**Family**	NATRICIDAE
Family	PYXICEPHALIDAE		*Natriciteres variegata*
	Pixycephalus spp.	**Family**	PELOMEDUSIDAE
			Pelusios castaneus
		Family	PHYLLODACTYLIDAE
			Tarentola senegambiae
		Family	PSAMMOPHIIDAE
			Psammophis cf. sibilans
		Family	SCINCIDAE
			Chalcides pulchellus
			Complexe Trachylepis perroteti

			Panaspis tristaoi
			Trachylepis affinis
		Family	VARANIDAE
			Varanus niloticus
		Family	VIPERIDAE
			Causus maculatus

The following two graphs depict the total amount of individuals per species caught and observed (total length of the bars) during the whole survey period. On the x-axis the sum of the value "Catch number" (see Table 1 & 2), which is in fact the amount of individuals per species caught, was calculated. Colours show the amount of individuals per species per observation method. Same colours depict similar or the same observation methods. Note that the observation method "Field" in the Amphibia graph has the same meaning as the observation method "Visual encounter" in the Reptilia graph but the name was chosen by different survey starters and thereby continued as in the original datasheet.

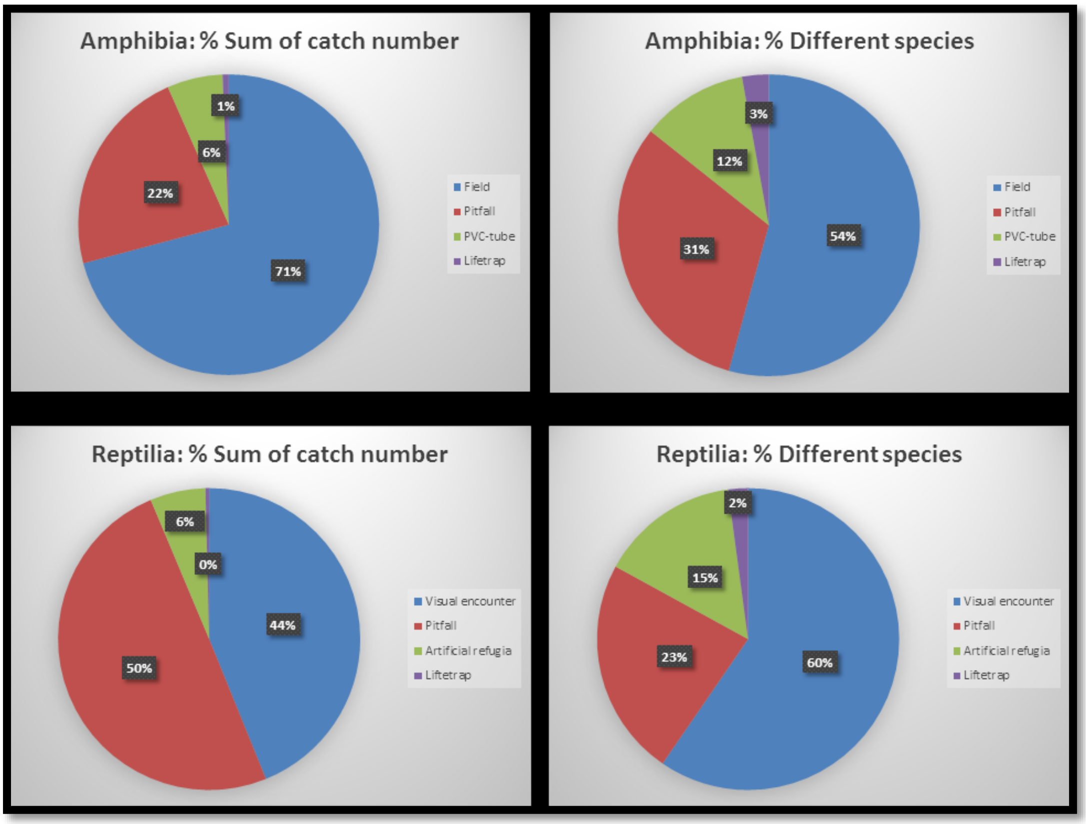


Graph 1: Sum of catch numbers per amphibian species per observation method. The blue parts represents the sum of catch numbers (ea. total amount of individuals) of those that were caught and/or observed in the field. The red parts represents the sum of catch numbers (ea. total amount of individuals) of those that were caught in the pitfalls. The green parts represent the sum of catch numbers (ea. total amount of individuals) of those that were caught and/or observed using the PVC-tubes. Finally the purple parts represent the sum of catch numbers (ea. total amount of individuals) of those that were caught using the lifetraps from parallel small mammal research.



Graph 2: Sum of catch numbers per reptile species per observation method. The blue parts represent the sum of catch numbers (ea. total amount of individuals) of those that were caught and/or observed by visual encounter. The red parts represent the sum of catch numbers (ea. total amount of individuals) of those that were caught in the pitfalls. The green parts represent the sum of catch numbers (ea. total amount of individuals) of those that were caught and/or observed using the tin (metal) plates. Finally the purple parts represent the sum of catch numbers (ea. total amount of individuals) of those that were caught using the lifetraps from parallel small mammal research.

The pie charts in the graph on the next page gives a detailed comparison on the percentage per observation method from the amount of individual species caught for both amphibians and reptiles (pie charts on the upper and lower left) and the percentage of different species per observation method as well for both amphibians and reptiles (pie charts on the upper right and lower right). Same colours depict similar or the same observation methods. Note that the observation method "Field" in the Amphibia graph has the same meaning as the observation method "Visual encounter" in the Reptilia graph but the name was chosen by different survey starters and thereby continued as in the original datasheet.

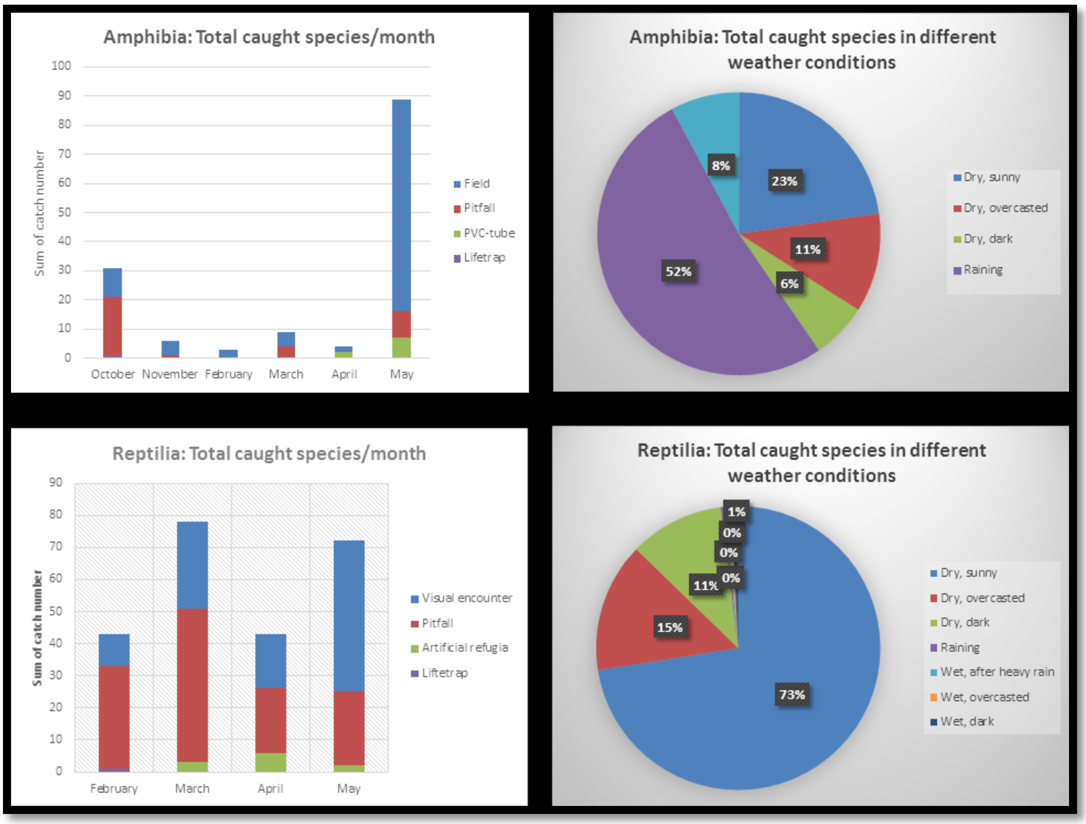


Graph 3: Detailed comparison on the percentage per observation method from the sum of the value catch number for both Amphibia and Reptilia (pie charts on the upper and lower left) and the percentage of different species per observation method as well for both Amphibia and Reptilia (pie charts on the upper right and lower right)

In the summarized graph on the next page a division was made between amphibians and reptiles, respectively the upper part and the lower part.

The two bar charts on the left side of the summarized graph give the total amount of species caught per month, the colours symbolize the different observation method. Note that December and January are not visible in the bar chart of the amphibians. This is simply due to the fact that during December and January no amphibians were seen. The month of June was left out of the bar chart because only a handful of fieldwork days were done in the beginning of June as the author of this report left Guinea-Bissau the 13th of June. The last remark goes also for the bar chart of the reptiles, also here the month of June was left out. It's important to mention that the 12 February is the first fieldwork day of February, as the author of this report arrives in Beli, Guinea-Bissau on 11 February. So February is missing some fieldwork days. This last remark implies both for the Amphibia and the Reptilia graph.

On the right side of the summarized graph two pie charts are visible, again the upper one contains the data of the amphibians whilst the lower one contains that of the reptiles. These pie charts show the total caught individual species in different weather conditions, symbolized as different colours and the accompanying percentages. Note that also for this two pie charts the total amount of caught species (ea. sum of catch number) was calculated.



Graph 4: A summarized graph that displays the total caught species per month for both amphibians and reptiles (bar charts on the left) and the total caught species in different weather conditions (pie charts on the right).

One would notice that this result section doesn't contain any information on the different species in the different biotopes, this was done on purpose as the results are not straightforward. Nevertheless some bar charts and pie charts containing habitat information can be found in the attachments.

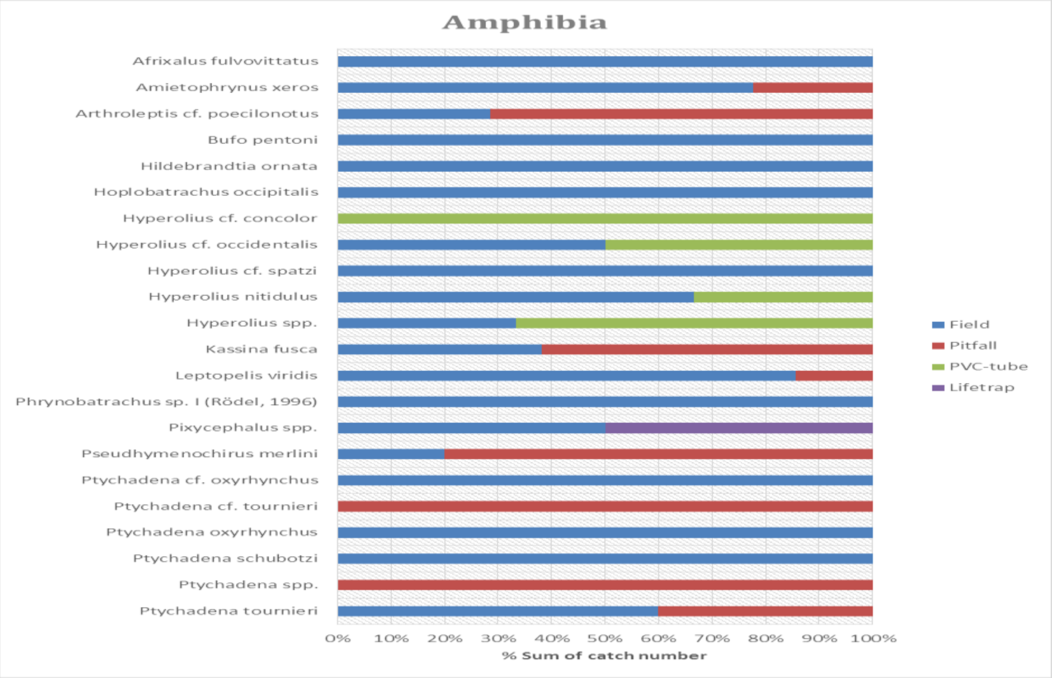
As a lot of effort was put into the building of the pitfalls with the accompanying drift fence the following graphs will try to assess the value of this main method for the total research. In the table that follows an attempt was done to calculate the catch efficiency of the pitfalls at the six different locations. As described in the "Material and methods" chapter each location should be visited 10 times in a week. Due to changings in the planning this wasn't always exactly 10 times. That's the reason that during the calculation of the catch efficiency, two visits in two days (one in the morning of day X and another in the late afternoon of day Y) were seen as one full fieldwork day. To calculate the amount of catch days, the data was examined and every day a species (which could be several species per location) was caught at a particular location it counts as one catch day. Note that the amount of individuals from a particular species caught at a certain location during a particular day or the amount of different species caught at a certain location was not taken into account in this calculation. In fact if a reptile or amphibian was caught at a certain day, this day counts as one catch day. The amount of catch days was then divided by the amount of full fieldwork days and multiplied with 100 to obtain a percentage.

Table 4: Catch efficiency of the pitfalls for amphibians and reptiles calculated as the division of catch days and full fieldwork days multiplied with 100 to obtain a percentage.

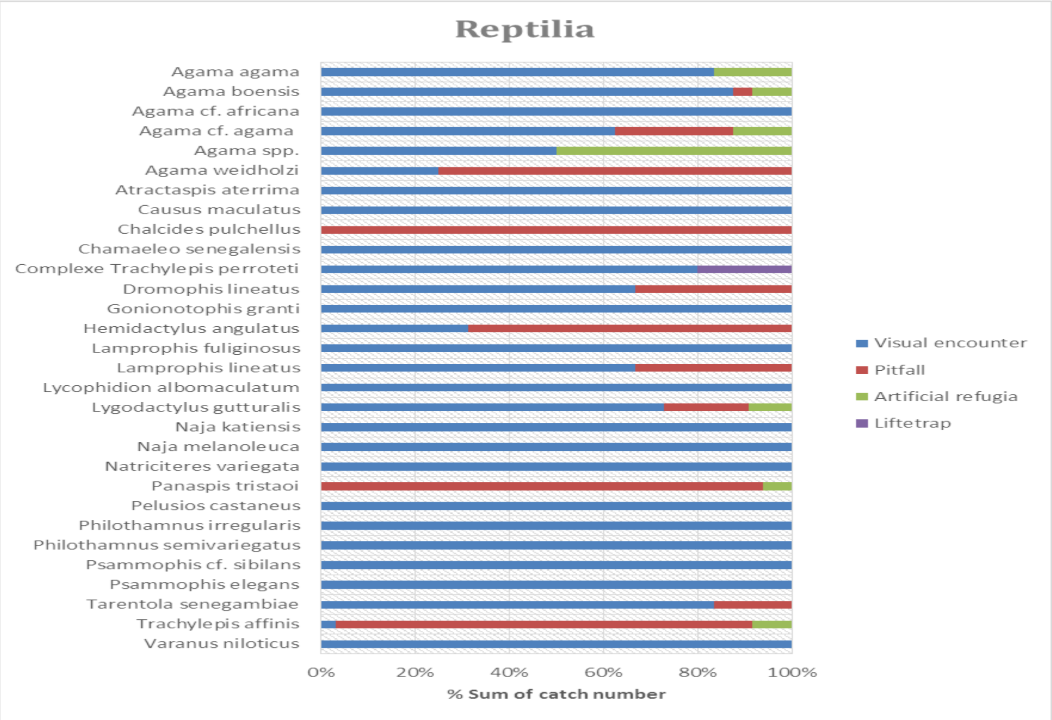
Amphibia caught in pitfalls						
	Location 1	**Location 2**	**Location 3**	**Location 4**	**Location 5**	**Location 6**
Catch days	1	9	6	3	2	5
Full fieldwork days	55	99	99	99	99	99
Catch efficiency	1,8%	9,1%	6,1%	3,0%	2,0%	5,1%

Reptilia caught in pitfalls						
	Location 1	**Location 2**	**Location 3**	**Location 4**	**Location 5**	**Location 6**
Catch days	2	13	17	22	30	22
Full fieldwork days	10	54	54	54	54	40
Catch efficiency	20,0%	24,1%	31,5%	40,7%	55,6%	55,0%

In order to get an idea of the percentage of each species (amphibians and reptiles) caught in the pitfalls, the following two graphs were added. Giving per species the percentage of individuals (ea. sum of catch numbers) from this particular species caught with the pitfalls (symbolized with the red colour). Other colours symbolize other observation methods.

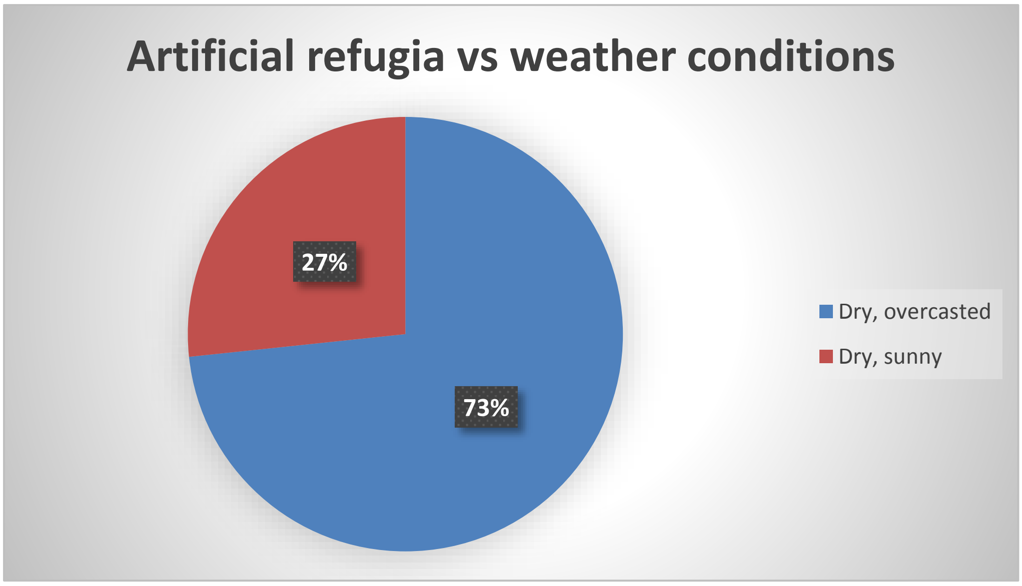


Graph 5: Percentage from the sum of catch numbers per amphibian species per observation method. The blue parts represent percentage from sum of catch numbers (ea. total amount of individuals) of those that were caught and/or observed by visual encounter. The red parts represent the percentage from the sum of catch numbers (ea. total amount of individuals) of those that were caught in the pitfalls. The green parts represent the percentage from the sum of catch numbers (ea. total amount of individuals) of those that were caught and/or observed using the tin (metal) plates. Finally the purple parts represent the percentage from the sum of catch numbers (ea. total amount of individuals) of those that were caught using the lifetraps from parallel small mammal research.



Graph 6: Percentage from the sum of catch numbers per reptile species per observation method. The blue parts represent percentage from sum of catch numbers (ea. total amount of individuals) of those that were caught and/or observed by visual encounter. The red parts represent the percentage from the sum of catch numbers (ea. total amount of individuals) of those that were caught in the pitfalls. The green parts represent the percentage from the sum of catch numbers (ea. total amount of individuals) of those that were caught and/or observed using the tin (metal) plates. Finally the purple parts represent the percentage from the sum of catch numbers (ea. total amount of individuals) of those that were caught using the lifetraps from parallel small mammal research.

Because the artificial refugia were added later by the author of this report, it would be interesting to assess the value of these method for the total research. For amphibians PVC-tubes were used while metal plates were used for the reptiles. As the PVC-tubes were not controlled on a regular base (ea. only when there was time left) this method has been left out this section. As mentioned in the chapter “Material and methods” the tin plates were checked once in a week for the presence of reptiles. The percentage of total species (ea. sum of catch number) and the percentage of different species are already given in graph 3. The only thing to add here is a pie chart giving the total amount of species (ea. sum of catch number) caught in the different weather conditions, this graph can be found below.



Graph 7: Percentage of total individual species caught with the artificial refugia in different weather conditions.

4 Discussion

The survey of amphibians and reptiles with the use of pitfalls, visual encounter and artificial refugia in the Boé gives a considerable species list as visualized in table 3.

In a period of approximately 8 months (from October 2013 till the beginning of June 2014) a total of 22 species were found. As there is almost nothing known about the amphibian diversity in Guinea-Bissau, not to mention the Boé region one would expect that the diversity is much higher than the 17 expected species by amphibiaweb.org. This is an indication that the area could possess a high species richness. When we compare both lists, the comprehensive species list found in table 3 and the list of amphibiaweb.org found in the attachments, one would say that there are still species missing in the survey list that are listed on the amphibiaweb list and vice versa. On the other hand in a period of approximately 4 months (from beginning of February till the beginning of June 2014) the reptile species list is fairly larger with a total of 30 species. As opposite to the expected species of amphibians described by amphibiaweb.org, the species list given by reptile-database.org gives a total of at least 48 species in Guinea-Bissau. One could say, only looking to the number of listed species without looking to the exact species, that 63% of this total listed species by the reptile-database.org was observed in such a short timeframe. This is an indication that the area could possess a high species richness. Herpetological surveys in the neo-tropics have proven that it can take a lot of time and effort to record every species present in an area (Duellman, 2005). When we compare both lists, the comprehensive species list found in table 3 and the list of the reptile-database.org found in the attachments, one would say that there are still species missing in the survey list that are listed on the amphibiaweb list and vice versa.

The pie charts on the left of graph 3 give us an overview of the percentage of individuals caught per observation method (calculated as the sum of the value catch number) For example if we have caught 57 individuals of species X using pitfalls, the number 57 counted to the total caught individuals of all the other species. While the pie charts on the right give us an overview of the percentage of real different species. Using the same example, if we have caught 57 individuals of species X using pitfalls, we count this as one single real species found (no matter the amount). As this is explained, we are able to interpret the pie charts correctly.

For amphibians it’s visible that we caught more individuals of species using visual encounter (symbolized as “Field” with the colour blue) then the amount of real different species which is more or less logical (71% versus 54%). Striking is that this doesn’t go up for the other observation methods. One would think that this indicates the actual value of this methods for observing those species. This statement can be easily taken down looking to graph 1, which shows the total amount of individuals per amphibians species per observation method. In this figure we can see that species which were for example observed using pitfalls, PVC-tubes or lifetraps (symbolized respectively with the red, green and purple colour) are usually more or at least equally observed using visual encounter (symbolized with the blue colour). This emphasized the value of the observation method, visual encounter, as already visible in the pie charts as the method with the highest percentage. Some species like for example Hyperolius species and the rare Pseudhymenochirus merlini are respectively more observed using the PVC-tubes and the pitfalls. Given the fact that the PVC-tubes were only checked when there was time left, it can be interesting to use this method on a regular base with a strict check-up schedule.

Talking about reptiles (the bottom pie charts in graph 3) we can see the same mechanism as in amphibians but this time for the observation method pitfall. Namely the fact that we caught more individuals of species using pitfalls (symbolized as “Pitfall” with the red colour) then the amount of real different species which is more or less logical (50% versus 23%). Which thereby diminishes the value of the pifalls as observation method. For the observation methods visual encounter, artificial refugia and lifetrap (symbolized respectively with the blue, green and purple colour) we can see a higher percentage for the amount of real different species caught using the previous mentioned observation methods. One would say that this indicates the value of these three observation methods but again this statement can be easily taken down if we take a closer look to graph 2, which shows the total amount of individuals per reptile species per observation method. One could easily see that those species that were observed using artificial refugia were usually much more observed with visual encounter. Which underlines again the value of the observation method, visual encounter.

We can conclude that when we left out the observation method visual encounter in this herpetological survey we will miss a serious amount of species.

The discussion of graph 4 speaks for itself and was only added to underline the importance of the survey period including both period of the year as weather conditions. It isn’t surprisingly that more amphibians are observed during the rainy season, while it is raining effectively. The dry season starts in November and lasts until the beginning of May. For reptiles the data isn’t so clear as for amphibians, nevertheless we can observe a lower amount of total caught reptiles in the heart of the dry season, namely April, but it isn’t that extreme. What would probably surprise no one is that almost all observations were done during dry and sunny weather.

Since the pitfalls are the initial method of the research, started by Silvavir forest consultants, an evaluation of this method is essential for this report. In table 4 the catch efficiency of the pitfalls per location for both amphibians and reptiles was calculated, details on the calculation could be found in the result chapter. The percentages shown in the table are more or less depressing, with an efficiency not more than 9,1% for the use of pitfalls in the amphibian survey and a bit more motivated maximum percentage of 55,6% for the use of pitfalls in the reptile survey. Alongside these depressing catch efficiencies we can clearly see in graph 5 and 6 that the species found in those pitfalls both for amphibians and reptiles are mainly the same species, ignoring some exceptions. The reason for this is unknown but I personally think that the drift fence is not high enough and the buckets are not deep enough. I observed frogs who easily jumped out the pitfalls. This could explain why the same species are observed in the pitfalls time after time. Simply because those species are the species who can't escape. This indicated the need of extra methods for the survey like they were added by the author of this report.

One of the main extra methods added during the research period was the use of tin plates (metal plates) as artificial refugia as warm-up shelter for reptiles. As seen before in graph 3 the amount of total individuals caught with the tin plates as well as the amount of real different species is rather small. An effort is done to explain the poor results of this well-established survey method. First of all this method is usually implemented in surveys located in more temperate zones suggesting that they don't work that well in tropical zones because the tin plates might become too hot. This is exactly what's visible in graph 7 where one could see the percentage of total individual species caught with the artificial refugia in different weather conditions. Here our conjectures are confirmed as we can see that there is a much higher percentage of individual reptiles caught when it is dry and overcasted (read less hot plates because the sun beams cannot reach the tin plates directly) then when it's dry and sunny.

To finish this discussion chapter I would like to add my personal recommendations. I would advise Chimbo foundation to continue the survey for one more year trying to close the holes in the data, in other words, find volunteers or students to continue the amphibian survey for the months who lack in the data. Especially the period May/June till August could reveal very satisfying results because this is the beginning of the wet season, with his first rains that stimulate amphibians and reptiles coming out of their dry season retreats while the grass and other vegetation in the field is still fairly small so the options for visual encounter are high. Despite the low catch efficiencies and the minor species found with the pitfalls I would continue this method as it is a low effort. But I would diminish the visits with only one visit in the morning. My main advice is to increase the visual encounter method in time and persistence, to gain scientific valuable data. I would advise to create a monthly schedule with a certain amount of obliged search actions in a number of beforehand specified weather conditions. For example in each month the researcher has to do 15 observation periods in the field, each of two hours exactly from which there are 5 during sunset (from which at least 2 visits are during rain or after heavy rain, if possible in that season) and 10 during nightfall using a good head torch with focussed beam (from which 1/3 of the visits are during rain or after heavy rain, if possible in that season). The reason is that night-time observations have to be higher because when using a focussed light beam scanning the ground and trees before you I found the most surprisingly reptiles and amphibians. Also after heavy rain I usually encountered more amphibians and reptiles.

Concerning the artificial refugia of the amphibians, the PVC-tubes, I advise to made a schedule as described above so there is a constantly check-up which will make data more statistically relevant. About the tin plates (artificial refugia method for reptiles) I think it’s better to quit them and use the time gained for the visual encounters. The method “Lifetrap” is self-evident and can be removed if the small mammal research isn’t implemented together with the pitfall check-ups.

For the pitfalls I would recommend to heighten the drift fence from 40 cm to 80 cm when the current installed plastic films are old and shabby. At the same time the buckets can be replaced by 20 L buckets or if that would imply too hard labour and digging in the rocky soil the lids can be replaced with lids with a smaller entrance to reduce escapes. An adaptation of the drift fence could be done to catch other species like small to medium terrestrial snakes or reptiles that are able to climb out of the pitfalls. This adaptation implies the creation of a funnel like structure to both ends of the fence as described by Burgdorf et al., 2005; Christiansen et al., 2000; Clark, 1966; Enge, 1997; Fitch, 1951, ending in some sort of box as retreat.

5 Side-line research

Except of the herpetological research in the Boé, some efforts were done to find spiders from the Theraphosidae family and centipedes from the Scolopendridae family. Samples were taken to Belgium for further examination. Details on this will be briefed later to Chimbo when there is more clearance on the identification of the specimen.

Locally I kept some animals in cages to observe their behaviour. I noticed that unlike written literature a young Lamprophis lineatus snake doesn't accept small mice as food and only accepted geckos as food source. This during a period of 3 months in which this specimen moulted twice.
I observed the behaviour of female Theraphosidae specimen being introduced an adult male of the same species. A mating and successful penetration was observed and the female was kept in wet conditions like outside with enough food with the hope for making an egg sack. Unfortunately she moulted a few weeks before I left Guinea-Bissau. When Theraphosidae shed skin they lose the stored sperm too.

Word of thanks

I would like to express a word of gratitude toward all the people working with Chimbo- and Daridibo foundations and especially Annemarie Goedmakers and Piet Wit for approving my internship and thereby making this report possible. Furthermore I would like to thank Dorien Van Montfort from the University of Utrecht, The Netherlands, who visited the field location twice a day with me from February till April. Henk Eshuis could not be forgotten for all his assistance as fieldwork manager concerning problems and issues faced during my stay in Guinea-Bissau or just for listening to my exited stories or my little frustrations. The second last local person I would like to thank is Balu Siera for the joy, the enthusiasm, help and extra eyes in the field when Dorien left Guinea-Bissau. And last but not least, I would like to thank Joost van Schijndel for his everlasting hospitality and practical assistance at Beli. Not forgetting IBAP, Instituto da Biodiversidade e das Áreas Protegidas, Guinea-Bissau, for the export permits to be able to get my samples safely to Belgium.

Back in Europe there are a couple of persons to thank also. Professor Jos Snoeks from the University of Leuven and the Royal Museum for Central Africa of Tervuren for all his help and effort to obtain import licences for my samples, giving me all the materials I need for taking vouchers and to get me in contact with the right persons like Danny Meirte, who spent half a day explaining me the tips and tricks for a herpetological survey and gave me access to a tremendous amount of literature.

A big gratitude to all the members of the Yahoogroupe “Herpnet” for replying my questions regarding identification problems. One member needs a special mention, namely Johannes Penner from the Museum für Naturkunde - Leibniz-Institut für Evolutions- und Biodiversitätsforschung in Berlin, Germany, for all his tips, tricks, scientific papers and materials regarding the research and identification of West-African amphibians.

At last I should almost forget my girlfriend, parents, family and friends for supporting me with this internship.

List of figures, graphs and tables

References

Arntzen, J.W., R.S. Oldham, D.M. Latham, 1995. Cost effective drift fences for toads and newts. Amphibia-Reptilia 16: 137–145.

Barnett LK., C. Emms, C. Santoni, 2001. The herpetofauna of Abuko Nature Reserve, The Gambia. Herpetological Bulletin. 77: 5–14.

Bennett D., 1999. Reptiles and Amphibians – Expedition Field Techniques. London.

Böhme, Wolfgang, et al., 2011. The reptiles (Testudines, Squamata, Crocodylia) of the forested southeast of the Republic of Guinea (Guinée forestière), with a country-wide checklist, Bonn zoological Bulletin 60.1: 35-61.

Boughton, R.G., J. Staiger, R. Franz, 2000. Use of PVC pipe refugia as sampling technique for hylid treefrogs. The American midland naturalist 144: 168-177.

Burgdorf, S.J., D.C. Rudolph, R.N. Conner, D. Saenz, R.R. Schaeger, 2005. A successful trap design for capturing large terrestrial snakes. Herpetological Review 36: 421-424.

Bury, R.B., M.G. Raphael, 1983. Inventory methods for amphibians and reptiles, p. 416-419. In: J.F. BELL & T. ATTERBURRY (Eds). Renewable Resource Inventories for Monitoring Changes and Trends. Corvallis, Oregon State University.

Chippaux JP., 2001. Les serpents d'Afrique occidentale et centrale. IRD (Inst. de Recherche pour le Developpement) Editions, Collection Faune et Flore tropicales 35, Paris.

Chirio L. and Lebreton M., 2007. Atlas biogéographique des Reptiles du Cameroun, IRD (Inst. de Recherche pour le Developpement) /MNHN, Paris.

Chirio, L., 2012. Inventaire des reptiles de la région de Sangarédi (Guinée maritime). Bulletin de la Société herpétologique de France 144: 67-100.

Christiansen, J.L., T. Vandewalle, 2000. Effectiveness of three trap types in drift fence surveys. Herpetological Review 31: 158-160.

Clark, D.R., Jr, 1966. A funnel trap for small snakes. Transactions of the Kansas Academy of Science 69: 91-95.

Draaiboek Externe stage professionalisering, KULeuven.

Drechsler, A., D. Bock, D. Ortmann, S. Steinfartz, 2010. Ortmanns funnel trap–a highly efficient tool for monitoring amphibian species. Herpetology Notes, 3(1).

Duellman, W. E. 2005. Cusco Amazonico: the lives of amphibians and reptiles in an amazonian rainforest.

Enge, K.M., 1997. Use of silt fencing and funnel traps for drift fences. Herpetological Review 28: 30-31.

Etheridge, R., 1996. Methods for preserving amphibians and repriles for scientific study.

Fitch, H.S., 1951. A simplified type of funnel trap for reptiles. Herpetologica 7: 77-80.

Greenbaum, E., J.L Carr, 2005. The herpetofauna of Upper Niger National Park, Guinea, West Africa. Scientific Papers of the Natural History Museum University of Kansas, 37, 1–21.

Griffiths, R.A., 1985. A simple funnel trap for studying newt populations and an evaluation of trap behaviour in smooth and palmate newts, Triturus vulgaris and Triturus helveticus. The Herpetological Journal 1: 5-10.

Hillers A, N-A. Loua, M-O. Rödel, 2008. A preliminary assessment of the amphibians of the Fouta Djallon, Guinea, West Africa. Salamandra 44: 113–122.

Hillers, A., Ródel, M.O., 2007. The amphibians of three national forests in Liberia, West Africa

Hoffman, KE, Johnson, SE & McGarrity, ME, 2009. Interspecific variation in use of polyvinyl chloride (PVC) pipe refuges by hylid treefrogs: a potential source of capture bias. Herpetological Review 40, 423–426.

Jackson, K., D. C. Blackburn, 2010. A Survey of amphibians and reptiles at degraded sites near Pointe-Noire, Kouilou Province, Republic of Congo, Herpetological Conservation and Biology 5.3: 414-429.

Leaché A., Rödel M.O. 2006. Biodiversity in a forest island: reptiles and amphibians of the West African Togo hills.

McComb, W.C., R.E. Noble, 1981. Herpetofaunal use of natural tree cavities and nest boxes. Wildl. Soc. Bull. 9: 261-267.

Meshaka, W.E., 1996. Retreat use by the Cuban treefrog (*Osteopilus septentrionalis*): Implications for successful colonization in Florida. J. Herpetol. 30: 433-445.

Moulton, C.A. W.J. Fleming, B.R. Nerney, 1996. The use of PVC pipes to capture hylid frogs. Herpetol. Rev. 27: 186-187.

Pittman, S.E., A.L. Jendrek, S.J. Price, M.E. Dorcas, 2008. Habitat selection and site fidelity of Cope’s gray treefrog (*Hyla chrysoscelis*) at the aquatic-terrestrial ecotone. J. Herpetol. 42: 378-385.

Ritke, M.E., J.G. Babb, 1991. Behaviour of the gray treefrog (*Hyla chrysosclelis*) during the non-breeding season, Herpetol. Rev. 22: 5-8.

Rödel M-O., 2000. Herpetofauna of West Africa Vol. I Amphibians of the West African Savanna, 1st impression, Edition Chimaira, Frankfurt am Main.

Rödel M.O., 2005, The amphibians of the forested parts of South-western Ghana.

Rödel, M. O., L. Sandberger,, J. Penner, Y. Mané, A. Hillers, 2010. The taxonomic status of Hyperolius spatzi Ahl, 1931 and Hyperolius nitidulus Peters, 1875 (Amphibia: Anura: Hyperoliidae). Bonn zoological Bulletin, 57, 177-188.

Santoni, C., 2007. A Survey of Reptiles and Amphibians That Can Be Found At Abuko Nature Reserve, The Gambia.

Schiøtz, A., 1999. Treefrogs of Africa, Edition Chimaira, Frankfurt am Main.

Simmons, J. E., 2002. Herpetological collecting and collections management. Revised Edition. Salt Lake City, Utah, Society for the Study of Amphibians and Reptiles.

Trape J-F., Y. Mané, 2006. Guide des serpents d'Afrique occidentale : savane et désert, IRD (Inst. de Recherche pour le Developpement) Editions., Paris.

Trape J.-F., S. Trape and L. Chirio, 2012. Lézards, crocodiles et tortues d'Afrique occidentale et du Sahara, IRD (Inst. de Recherche pour le Developpement) Editions, Marseille.

The World Factbook, 2012. Washington, DC: Central Intelligence Agency, https://www.cia.gov/library/publications/the-world-factbook/geos/pu.html, Consulted at 16-06-2014.

United Nations General assembly, 1973. Illegal occupation by Portuguese military forces of certain sectors of the Republic of Guinea-Bissau and acts of aggression committed by them against the people of the Republic A/RES/3061(XXVIII), http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/3061(XXVIII), Consulted at 15-06-2014.

Villiers A., 1975. Les serpents de l'Ouest africain. IFAN, Dakar (3ème éd.).

Walters, E.C., J.M. Kneitel, 2004, Use of water-filled redcochaded woodpecker cavities by other organisms. In R. Costa and S.J. Daniels (eds), Red-cockaded Woodpeckers: Road to Recovery, pp. 492-497. Hancock House Publishers, Baline, Washington.

Westra, S. A., R. R. Mol, 2014. Small mammal and amphibian survey Boé region, Guinea-Bissau. Silvavir forest consulants, Arnhem.

Wright, H.E., J. McCullough, M.S. Diallo, 2006. A rapid biological assessment of Boké Préfecture, northwestern Guinea. RAP Bulletin of Biological Assessment 41, Conservation International, Washington D.C., 192 pp.

Zacharow, M., W.J. Barichivich, C.K. Dodd, 2003. Using ground-placed PVC pipes to monitor hylid treefrogs: Capture biases. Southeast. Nat. 24: 575-590.

http://www.amphibiaweb.org/

http://www.catalogueoflife.org/

http://www.chimbo.org

http://www.froglife.org/

http://www.iucnredlist.org/

http://www.narrs.org.uk/

http://reptile-database.org/

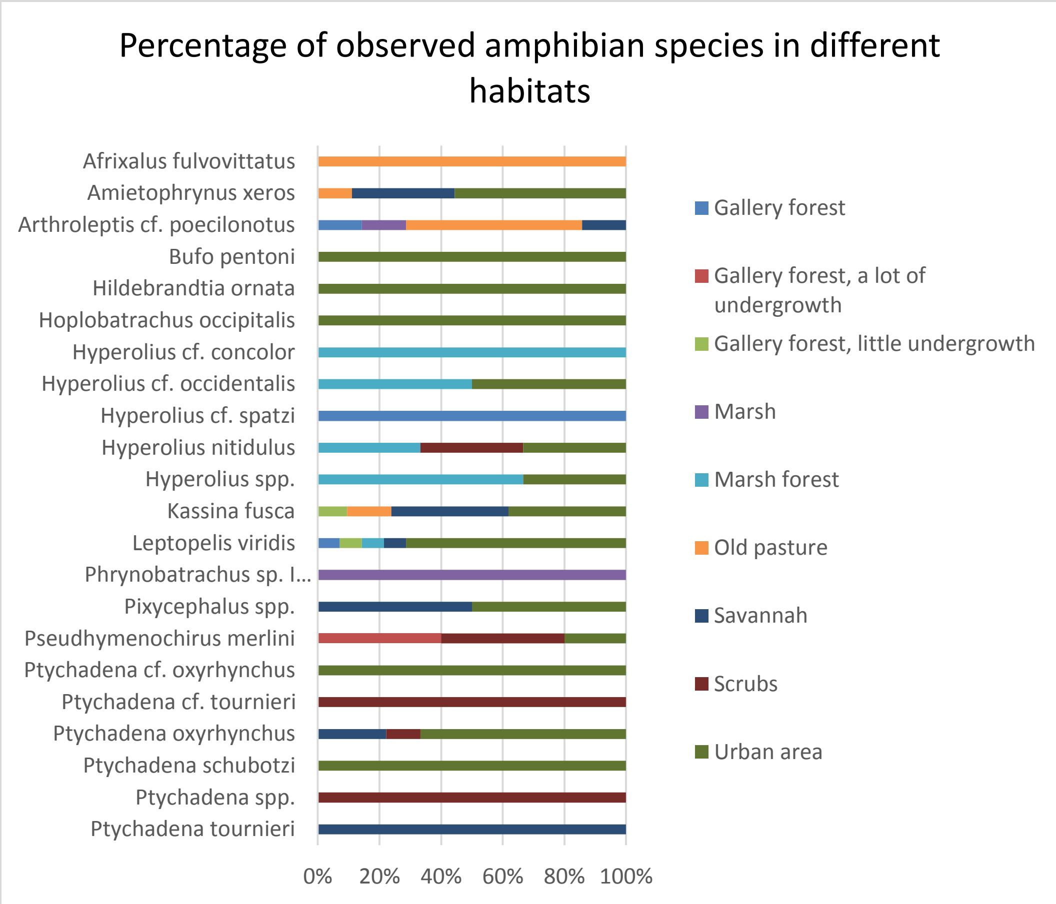
Attachments

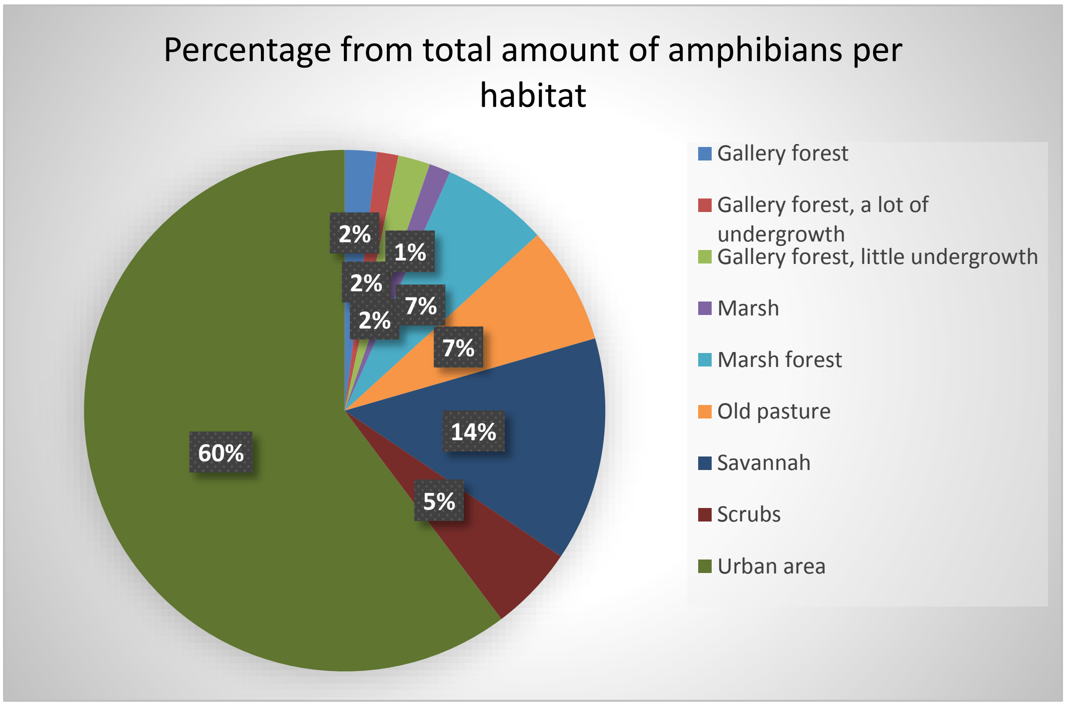
- **Survey locations**

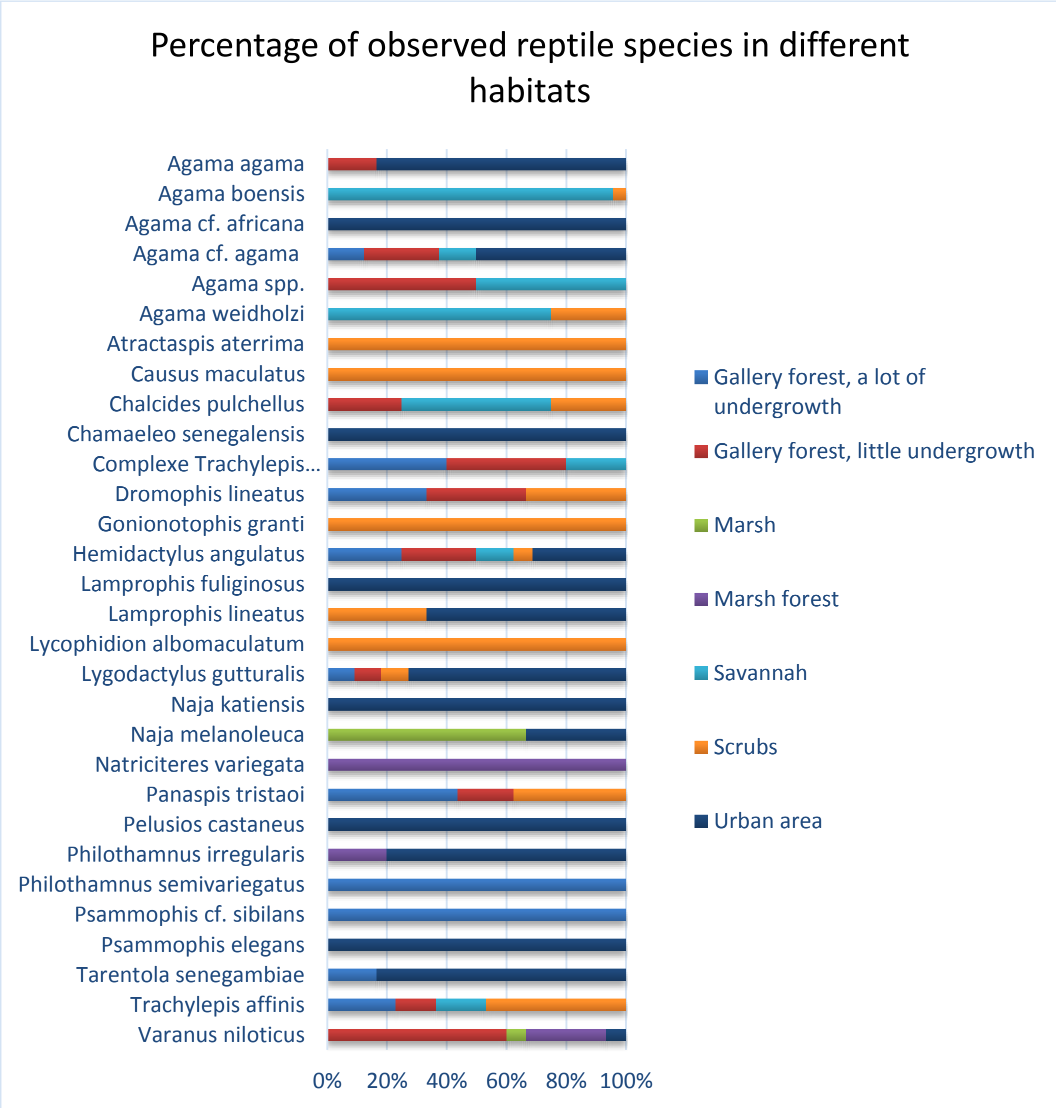
<table>
<tr><td rowspan="3">Location 1</td><td>Wet season</td><td>Dry season</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Coordinates: N11,8612370
W13,9371810</td></tr>
<tr><td rowspan="3">Location 2</td><td>Wet season</td><td>Dry season</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Coordinates: N11,8688910
W13,9386090</td></tr>
<tr><td rowspan="3">Location 3</td><td>Wet season</td><td>Dry season</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Coordinates: N11,8767270
W13,9366700</td></tr>
</table>

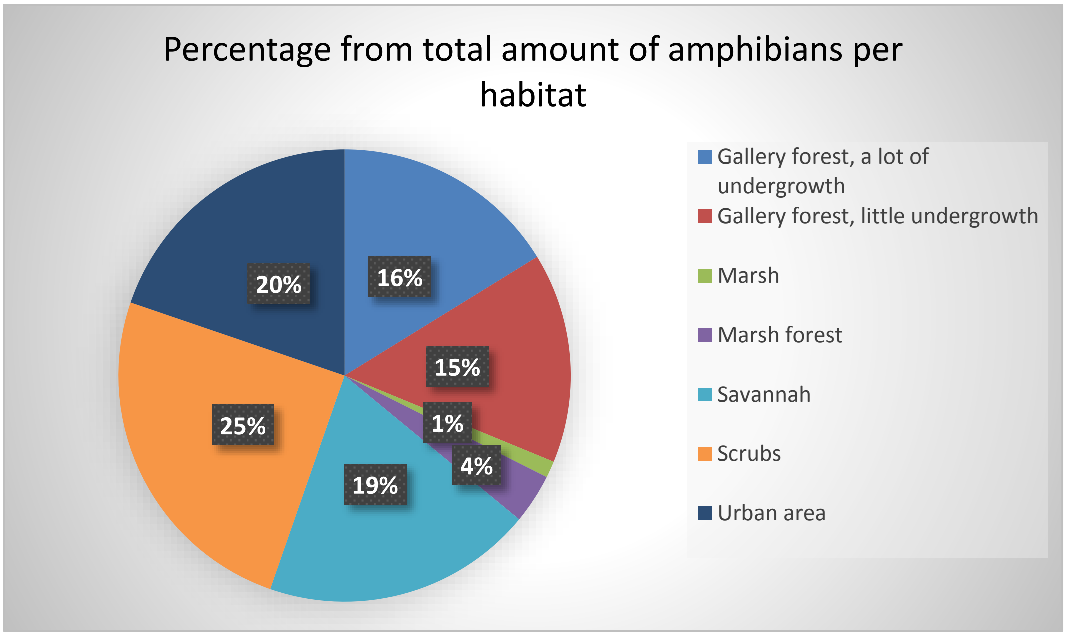
Location	Wet season	Dry season
Location 4		
	Coordinates: N11,8817920 W10 13,9376400	
Location 5		
	Coordinates: N11,8767270 W13,9366700	
Location 6	Not available	
	Coordinates: N11,831080 W13,929980	

- **Percentage bar charts on observed amphibian and reptile species in different habitats and percentage pie charts on total amount of amphibians and reptiles in a certain habitat**






Percentage of observed reptile species in different habitats
Agama agama
Agama boensis
Agama cf. africana
Agama cf. agama
Agama spp.
Agama weidholzi
Atractaspis aterrima
Causus maculatus
Chalcides pulchellus
Chamaeleo senegalensis
Complexe Trachylepis...
Dromophis lineatus
Gonionotophis granti
Hemidactylus angulatus
Lamprophis fuliginosus
Lamprophis lineatus
Lycophidion albomaculatum
Lygodactylus gutturalis
Naja katiensis
Naja melanoleuca
Natriciteres variegata
Panaspis tristaoi
Pelusios castaneus
Philothamnus irregularis
Philothamnus semivariegatus
Psammophis cf. sibilans
Psammophis elegans
Tarentola senegambiae
Trachylepis affinis
Varanus niloticus
0%
20%
40%
60%
80%
100%
Gallery forest, a lot of undergrowth
Gallery forest, little undergrowth
Marsh
Marsh forest
Savannah
Scrubs
Urban area


Percentage from total amount of amphibians per habitat
16%
15%
1%
4%
19%
25%
20%
Gallery forest, a lot of undergrowth
Gallery forest, little undergrowth
Marsh
Marsh forest
Savannah
Scrubs
Urban area

- **Amphibiaweb.org: Possible occuring species in Guinea-Bissau**

Scientific Name	IUCN Red List Status	Vernacular Name	Family
Arthroleptis poecilonotus	Least Concern (LC)		Arthroleptidae
Leptopelis viridis	Least Concern (LC)		Arthroleptidae
Amietophrynus regularis	Least Concern (LC)	Common African toad	Bufonidae
Hoplobatrachus occipitalis	Least Concern (LC)	Crowned bullfrog	Dicroglossidae
Hemisus guineensis	Least Concern (LC)		Hemisotidae
Hemisus marmoratus	Least Concern (LC)	Shovel-nosed frog	Hemisotidae
Afrixalus fulvovittatus	Least Concern (LC)		Hyperoliidae
Hyperolius spatzi			Hyperoliidae
Phrynobatrachus fraterculus	Least Concern (LC)		Phrynobatrachidae
Phrynobatrachus gutturosus	Least Concern (LC)		Phrynobatrachidae
Phrynobatrachus natalensis	Least Concern (LC)	Natal puddle frog	Phrynobatrachidae
Pseudhymenochirus merlini	Least Concern (LC)		Pipidae
Xenopus tropicalis	Least Concern (LC)	Tropical Clawed Frogs	Pipidae
Ptychadena mascareniensis	Least Concern (LC)	Mascarene ridged frog	Ptychadenidae
Ptychadena oxyrhynchus	Least Concern (LC)	Sharp-nosed ridged frog	Ptychadenidae
Ptychadena stenocephala	Least Concern (LC)		Ptychadenidae
Hylarana galamensis	Least Concern (LC)	Galam white-lipped frog	Ranidae

- **Reptile-database.org: Possible occurring species in Guinea-Bissau**

Agama boensis MONARD, 1940
Agama weidholzi WETTSTEIN, 1932
Amblyodipsas unicolor (REINHARDT, 1843)
Atractaspis aterrima GÜNTHER, 1863
Bitis arietans (MERREM, 1820)
Bitis rhinoceros (SCHLEGEL, 1855)
Boaedon fuliginosus (BOIE, 1827)
Boaedon lineatus DUMÉRIL, BIBRON & DUMÉRIL, 1854
Caretta caretta (LINNAEUS, 1758)
Causus rhombeatus (LICHTENSTEIN, 1823)
Chamaeleo senegalensis DAUDIN, 1802
Chelonia mydas (LINNAEUS, 1758)
Cyclanorbis senegalensis (DUMÉRIL & BIBRON, 1835)
Dasypeltis confusa TRAPE & MANÉ, 2006
Dasypeltis fasciata SMITH, 1849
Dasypeltis gansi TRAPE & MANÉ, 2006
Dasypeltis scabra (LINNAEUS, 1758)
Dendroaspis polylepis GÜNTHER, 1864
Elapsoidea semiannulata BOCAGE, 1882
Eretmochelys imbricata (LINNAEUS, 1766)
Gonionotophis grantii (GÜNTHER, 1863)
Gonionotophis stenophthalmus (MOCQUARD, 1887)
Grayia smithii (LEACH, 1818)
Hapsidophrys lineatus FISCHER, 1856
Hapsidophrys smaragdina (SCHLEGEL, 1837)
Hemidactylus angulatus HALLOWELL, 1854
Latastia ornata MONARD, 1940
Lycophidion albomaculatum STEINDACHNER, 1870
Lycophidion semicinctum DUMÉRIL, BIBRON & DUMÉRIL, 1854
Lygodactylus picturatus (PETERS, 1871)
Naja senegalensis TRAPE, CHIRIO & WÜSTER, 2009
Osteolaemus tetraspis COPE, 1861
Philothamnus carinatus (ANDERSSON, 1901)
Philothamnus heterodermus (HALLOWELL, 1857)
Philothamnus irregularis (LEACH, 1819)
Psammophis elegans (SHAW, 1802)
Psammophis lineatus (DUMÉRIL, BIBRON & DUMÉRIL, 1854)
Psammophis phillipsi (HALLOWELL, 1844)
Psammophis praeornatus (SCHLEGEL, 1837)
Psammophis sibilans (LINNAEUS, 1758)
Rhamphiophis oxyrhynchus (REINHARDT, 1843)
Rhinoleptus koniagui (VILLIERS, 1956)
Tarentola ephippiata O'SHAUGHNESSY, 1875
Telescopus variegatus (REINHARDT, 1843)
Thelotornis kirtlandii (HALLOWELL, 1844)
Toxicodryas blandingii (HALLOWELL, 1844)
Trachylepis affinis (GRAY, 1838)
Trachylepis perrotetii (DUMÉRIL & BIBRON, 1839)

ECOLOGY, EVOLUTION AND BIODIVERSITY CONSERVATION SECTION
Charles Deberiotstraat 32 - box 2439
3000 LEUVEN, BELGIUM
www.kuleuven.be