NABU's Biodiversity Assessment at the Kafa Biosphere Reserve

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Naturschutzbund Deutschland (NABU) e.V.
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10117 Berlin, Germany
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First published 2017

This project is part of the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) supports this initiative on the basis of a decision adopted by the German Bundestag.

Supported by:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

based on a decision of the German Bundestag

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Proposed citation:

The Nature and Biodiversity Conservation Union (NABU) (eds.), 2017: NABU's Biodiversity Assessment at the Kafa Biosphere Reserve. Berlin, Addis Ababa.

Editor's note:

Although it was part of the overall assessment, the report does not include a study on fish taxa. As of the date of publication (January 2017), no report has been submitted by the expert in charge.

Print:

DBM Druckhaus Berlin-Mitte GmbH, FSC-certified, produced according to the rules of the environmental management system EMAS III and printed on 100% recycled paper

EMAS GEPRÜFTES UMWELTMANAGEMENT

Design:

springer f3, corporate communication, Cologne

Photographs cover an back side:

Cover: Bruno D'Amicis; back side: Holger Meinig (birds), Thies Geertz (assessment participants), Tom Kirschey (butterfly), Bernhard Walter (group in forest)

Order/ISBN:

The book is available at NABU's shop www.NABU-Shop.de (item number 9048). ISBN 978-3-925815-30-0

NABU's Biodiversity Assessment at the Kafa Biosphere Reserve

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Organisational Profile

For 117 years, NABU (The Nature and Biodiversity Conservation Union) has promoted the interests of people and nature, drawing on its unwavering commitment, specialised expertise and the backing of its 600,000 members and supporters. Its members, among them 37,000 volunteers, are organised across more than 2,000 local groups and 15 federal associations.

The NGO, the largest of its kind in Germany, has clearly defined aims: providing environmental education, preserving habitat and species biodiversity, promoting sustainable agriculture, forestry and water management and enhancing the profile of nature conservation within society. NABU's work also includes combating global warming, promoting species conservation, providing sustainable policy on settlement, transport infrastructure and waste and protecting consumers. NABU headquarters' permanent staffs of around 160 people work in Berlin to represent environmental interests on a national and international level. A further 40 employees work in visitor centres, research institutes and project offices. NABU runs project offices in several countries in Africa, Central Asia and The Caucasus and has a permanent representative in Brussels. Africa, Asia and The Caucasus form the geographical focus of NABU's international commitment. NABU's work combines ecological and social efforts ranging from protecting the climate, conserving habitat and species diversity and promoting ecotourism and environmental education to building capacity, alleviating poverty and strengthening civil society.

NABU is the German partner of BirdLife International and supports partner organisations around the world. Together with its national partners and local and national stakeholders, NABU supports activities to conserve natural heritage. NABU is and experienced partner in this field, widely sought after by developmental aid organisations, government ministries and business.

In 2009, NABU founded the 'NABU International Foundation for Nature' to support NABU's international projects.

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Acknowledgements

The biodiversity assessment at the Kafa Biosphere Reserve (BR) is part of the NABU project 'Biodiversity under Climate Change: Community-Based Conservation, Management and Development Concepts for the Wild Coffee Forests.' The project is funded within the framework of the International Climate Initiative (IKI) by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

We would like to express our thanks to the international team of Ethiopian, German and Dutch volunteer experts who participated in the fieldwork, contributed to the assessment and produced excellent reports. Sincere thanks go to Dr Juan Carlos Montero, who acted as the team leader on behalf of NABU, for planning and conducting the assessment and compiling the reports. In addition, we would like to thank the students, volunteers and many local supporters for making this assessment a success. Local guides, translators and assistants provided crucial support in the field, as did the NABU logistics team composed of the Project Office Bonga and Headquarters Berlin. The Kafa Development Association (KDA) Guesthouse hosted most of the participants and served as permanent headquarters for the assessment.

We would also like to thank the Ethiopian Biodiversity Institute (EBI) and the Genetic Resource Access and Benefit Sharing Directorate within the EBI, who granted the material transfer agreements to the team of experts for further analysis and investigation outside of Ethiopian territory. In particular, we want to thank Mekonnen Amberber Degefu who actively participated in the field assessment and helped obtain permission to transfer the materials.

We would also like to thank the Ethiopian Ministry of Science and Technology, our longstanding partner, for providing support to facilitate this process. We also thank the regional Environmerntal Protection and Forest Agency for supporting us as the host region. The Kafa Zone Administration and in particular the Department of Agriculture (DoA) actively supported the assessment at the field level. We would also like to thank the local community members for their openness to our field study and the welcoming atmosphere they provided to our international teams in the field.

We further want to thank our NABU project teams in Bonga (particularly Mesfin Tekle and Asaye Alemayehu), Addis Ababa (particularly Bekele Haile) and Berlin (particularly Bianca Schlegel and Nils Horstmeyer). We would also like to thank Muluken Mekuria and the NABU ranger team, who played a vital role in selecting sampling sites and planning and implementing the fieldwork. Sincere thanks also go to the following dedicated researchers who, thanks to their ongoing NABU project work, were able to use their wide knowledge of the reserve to provide enormous contributions to identifying and defining sampling sites and generating thematic maps: Dr Arun Pratihast, Dr Benjamin Devries, Mathieu Decuyper (Wageningen University) and Elisabeth Dresen (geoSYS ltd).

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Executive Summary

From December 3rd to December 13th 2014, NABU conducted an biodiversity assessment at the Ethiopian Kafa Biosphere Reserve (BR). A multidisciplinary team of 18 international and 12 Ethiopian experts supported by 23 local field guides carried out intense field work at selected sites at the Kafa BR.

The goal of the assessment was to specify and verify flora and fauna assessments, which have previously been conducted in the Kafa Zone, record and list species, identify indicator and flagship species and determine their threat status. This report presents the results from the **first in-depth assessment of biodiversity ever conducted in the Kafa BR**. By highlighting the main findings for various taxa, namely plants, birds, mammals, insects, amphibians, molluscs and fungi, this report is a major step forward in verifying and significantly expanding existing knowledge about species, their habitats and their major threats in the Kafa BR. By identifying indicator and flagship species, the biodiversity assessment establishes the basis for regular monitoring of the biodiversity in the Kafa BR, complementing the already established forest and carbon monitoring schemes.

Overall, the biodiversity assessment found **high biological diversity in the Kafa BR**, reflected by both high diversity at the habitat level and by species per habitat. The investigated habitats exhibit high heterogeneity, despite being only a short distance from each other. Particularly outstanding is the record of **approximately 50 species which are new to science or recorded for Kafa area for the first time**. Some of these are still under taxonomic analysis for final confirmation. The species comprise three fungi species (*Ascocoryne kafai* ined., *Cerinomyces bambusicola* ined., *Coniolepiota kombaensis* ined.), one mollusk species (*Pisidium* sp.), one species of Hyperoliidae (genus *Leptopelis*), two beetle species (*Pachysternum* sp. nov. *Tachinoplesius schoelleri* Schülke 2016), four fly species (family Diopsidae), one bee species (genus *Colletes*) and one species of *Rhinolophus* from the horseshoe bat family. At least further 40 insect species species new to science are to be expected.

Another remarkable result is the **extremely high rate of endemism** found in the Kafa BR. Most of the assessed taxa consist of about 30% endemic species, which were found in the area despite the extremely short timeframe of the fieldwork. This high degree of endemism can be explained by the area's vast and isolated highlands surrounded by dry lowlands, along with its geological and tectonic history. The high diversity at both the habitat and species level, the heterogeneity of the landscapes and the exceptionally high rate of endemism combine to make **Kafa BR an exceptional area for biodiversity protection**.

Based on expert knowledge and the subsequent analysis of the results, **29 indicator species and 17 flagship species** were selected from the recorded species. 13 out of 17 flagship species also serve as indicator species. Of the 29 indicator species, 15 were found for Afromontane, bamboo and floodplain forests (five trees, three birds, two tree frogs, two bats, two fungi and one primate) and 14 are indicators for wetland and river areas (nine birds, four insects and one mollusc). **Deforestation was assumed to be the major threat** for both indicator and flagship species occurring in forest areas, followed by habitat fragmentation and forest/habitat degradation. For river and wetland areas, **drainage activities, agricultural run-offs, fertiliser and domestic and urban waste** are identified as key threats to biodiversity. Further research is needed to specify and quantify these threats.

Some idea for practical conservation and monitoring action can be derived from the analysis of indicator and flagship species and their threats. We suggest es-

tablishing a monitoring system based on three components: **a) monitoring indicator species**, **b) monitoring threats**, **forest and land use and c) monitoring sites**. Monitoring at the species level should provide data on the abundance of each of the indicator species' in the Kafa BR. In addition, remote sensing techniques for deforestation, deteriorating activities such as fuelwood collection or fertiliser use should be applied as part of monitoring threats to biodiversity. Site monitoring should be based on a comparative and long-term analysis of the sites that were already investigated in this biodiversity assessment. More sites can be added over time. Rangers can perform this site monitoring with the support of local land users.

Basic conservation measures such as controlling the restrictions imposed on the different protection zones of the BR should be complemented by **threat-based conservation activities** such as promoting agro-forestry, improving cultivation techniques to avoid further expansion of agricultural areas, raising awareness of possible alternative tree species for fuelwood and timber and the promoting efficient cooking stoves. All such measures need to be planned and implemented by the local communities and facilitated through **participatory methods** for joint planning of conservation and sustainable livelihoods.

The biodiversity assessment is part of NABU's project 'Biodiversity under Climate Change: Community-Based Conservation, Management and Development Concepts for the Wild Coffee Forests' (2014-2017). This project is part of the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) supports this initiative on the basis of a decision adopted by the German Bundestag.

Background and summary of findings

Juan Carlos Montero with contribution by Svane Bender-Kaphengst

1. Introduction

From the 3rd to the 13th of December 2014, NABU coordinated the biodiversity assessment at the Kafa Biosphere Reserve (BR). For this period, a team of 18 international and 12 Ethiopian experts supported by 23 local field guides conducted extensive field work on various taxa. The assessment was part of the NABU project 'Biodiversity under Climate Change: Community-Based Conservation, Management and Development Concepts for the Wild Coffee Forests'.
This report presents the results from the first in-depth assessment of biodiversity ever conducted in the Kafa BR. In highlighting the main findings for various taxa (amphibians, birds, fungi, insects, molluscs, mammals and plants), the report is a major step in verifying and significantly expanding existing knowledge about species, their habitats and their major threats in the Kafa BR. By identifying indicator and flagship species, this biodiversity assessment establishes the basis for regular monitoring of the biodiversity in the Kafa BR, complementing the already established forest and carbon monitoring schemes.

The report is structured as follows:
The introduction outlines the objectives of the assessment and its role and merits for NABU's work in the Kafa region. It is followed by a description of the research area (Chapter 2). The analytical framework of the biodiversity assessment is outlined in the methodology section (Chapter 3). Chapter 4 highlights the overall results of the assessment, including the main findings of the individual taxa assessments, the recommended indicator and flagship species and the main threats to biodiversity. Chapter 5 summarises the key results and presents recommendations on future monitoring and conservation measures in the Kafa BR.

1.1 Objectives of the biodiversity assessment

The Kafa BR in southwest Ethiopia (SNNPR, Southern Nations, Nationalities and Peoples' Region) combines a distinctive richness of culture and biodiversity, which is unique among paleotropical regions. Kafa is located in the most ethnically and linguistically diverse region in Ethiopia and is also home of the last surviving cloud montane forests where the wild coffee tree with more than 50 varieties can be found. The highly diverse fauna and flora occurring in complex habitats are of international conservation value and of economic value to the local communities. Existing studies of the region's flora, fauna, biomass and biodiversity have documented a high diversity of species (e.g., 300 species of mammals including 14 carnivores and 8 primates, 300 bird species, 244 plant species and more than 110 tree species) (NABU 2014). Such studies have also detected a high degree of endemism and species which are endangered according to the IUCN Red List and Ethiopia and Eritrea's Red Lists (Vivero et al. 2005). A "Rapid Biodiversity Assessment for Kafa" published by EWNHS in 2008 was the first report on a broader range of flora and fauna species. The assessment concluded that, in order to conserve the threatened biodiversity, changes to habitat structure and their effects on landscape function must be regularly assessed.

However, the immense local biodiversity is still inadequately documented. Taxa such as bats, amphibians, fungi and dragonflies have never been assessed. The numerous complex and significant rivers and wetlands have barely been explored. Similarly, a large part of the montane dense forests have only been partially investigated. At the same time, the natural richness of the Kafa BR is heavily threatened by deforestation, habitat fragmentation and degradation.

Therefore, the main goal of the biodiversity assessment was to create a reference base for regular biodiversity monitoring in the Kafa BR. To achieve this, a systematic and comprehensive assessment of the abundance and characteristics of different taxa was conducted.

Besides verifying, updating and increasing knowledge of the various organisms in the region, flagship and indicator species from different taxa were identified. Flagship species are charismatic species used in a socio-political context to attract public attention and funding for larger environmental objectives, while indicator species are used to assess the magnitude of anthropogenic disturbances or to monitor population trends for a wider range of species (see Groves 2003). In the field, the experts tried to collect as much data on flora and fauna as possible in the available timespan, covering a great variety of habitats.

In summary, the goals of the assessment were:
- To verify and substantially increase knowledge of selected taxa of flora and fauna
- To identify indicator and flagship species as target species for monitoring and conservation
- To make recommendations for future conservation and monitoring

All the data on biodiversity will be incorporated into the existing forest and carbon monitoring schemes by NABU's partner Wageningen University until end of 2016 the latest.

1.2 NABU's work in Kafa

NABU has supported people and nature in Ethiopia for more than 12 years. In close cooperation with NABU's Ethiopian BirdLife partner Ethiopian Wildlife and Natural History Society (EWNHS), small scale environmental education projects were started and endangered birds such as the common crane (*Grus grus*) are regularly monitored. This cooperation also involves livelihood support projects for local communities. From 2006 to 2010, NABU supported the development of Kafa BR from application up to recognition by UNESCO in a public-private partnership (PPP) project with other German partners such as DSW, GIZ, GEO Rainforest Conservation and Original Food. Due to its expertise, NABU supervised the development of a UNESCO biosphere reserve in Kafa. The concept opened new opportunities to the region and to the country as a whole: untouched core zones of nature, surrounding buffer zones and a large development zone, would offer room for conservation, research and development. After an official consultation at regional and community level, planning workshops were held and governmental staff became trained. Subsequently, "demarcation committees" were nominated and a time-consuming resource mapping with all affected local communities was conducted. When all stakeholders had agreed upon a zoning scheme, the actual demarcation work could be started. Incredibly, the process of zoning the biosphere reserve area with the aim of establishing an appropriate management scheme and ensuring the protection of the forests, took place with the support and involvement of more than 500 representatives of the region.

After the successful establishment of Kafa BR, NABU, the Ministry of Science and Technology (MoST) of the Federal Democratic Republic of Ethiopia and UNESCO signed a memorandum of understanding to establish further biosphere reserves in Ethiopia. In 2010, the Kafa BR was recognised by UNESCO as one of the first biosphere reserves in Ethiopia. To invigorate the Kafa BR, NABU expanded its activities in the region, including establishing an effective administration and increasing information campaigns and public relations in the reserve. Moreover, in 2009, NABU initiated a four-year project on "Climate Protection and Preservation of Primary Forests" funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) within the framework of the International Climate Initiative. According to Bender-Kaphengst (2011), the project supported the reforestation of 700 ha of natural forest with native tree species and the planting of 1,500 ha of fast growing trees in community forests next to the villages to ensure the population's wood supply. Furthermore, 10,000 wood-saving stoves were introduced in selected communities to reduce the communities' reliance on the forest resources. About 10,000 ha of natural forest were jointly identified by the Kafa Zone and the Kafa BR management following the principles of sustainable PFM. Tourist infrastructure such as hiking trails, wildlife and bird watching towers and a historical outdoor museum were built and locals were trained as guides. After the successful completion of the project, NABU continued its work at the Kafa BR with another three years project.

This follow-up project aims to conserve and restore the Afromontane cloud forests and wetlands in order to preserve the ecosystem's resilience and unique biodiversity. It also intends to avoid carbon dioxide emissions and secure ecosystem services for the local population. In collaboration with the local population, ecosystems will be explored and restored (e.g. reforestation, restoration of catchment areas), secured (e.g. real-time monitoring, rangers) and transferred to sustainable, participatory community management. In order to simultaneously create awareness for the effects of global warming on biodiversity and in order to promote regional development, targeted development programmes for crafts, ecotourism and regional products as well as educational programs for children and youths and energy-efficient stoves will be introduced. The project supports the implementation of Ethiopia's Climate-Resilient Green Economy Strategy, ties climate and biodiversity conservation to regional development and helps the local population to independently ensure the long-term conservation of nature and natural resources as basis of their livelihood. The biodiversity assessment is part of this project.

More information at:

www.kafa-biodiversity.com

www.international-climate-initiative.com/en/projects/projects/details/365/

2. Physical and Cultural Context of the Research Area

2.1 Geomorphology

Ethiopia's geological and tectonic characteristics are strongly shaped by the Ethiopian magma dome and the development of the East African Rift system. The soils originate from rocks formed during the tertiary period and the subsequent geomorphic processes. They are characterised as deep, red, brown-grey and brown-clay soils. The Ethiopian magma dome, shaped by a series of volcanic activity and geological formation in the Precambrian, Paleozoic, Mesozoic, Tertiary and Cenozoic periods, forms the foundation of the Ethiopian Highland (Dennis Moss Partnership 2009). As a result of these complex geological processes, the Ethiopian landscape is very diverse, ranging from vast plains to Alpine-like mountain ranges. Sometimes referred to as the "Roof of Africa", the Ethiopian Highlands form the largest continuous area of its altitude in the whole continent, with little of its surface falling below 1500 meters above sea level (m a.s.l.) and peaks of up to 4550 m a.s.l. The Kafa Zone situated in the Western plateau of these highlands is located on the Tertiary layers, consisting mainly of sandstone and limestone, and of Tertiary volcanic rocks.

The topography of the study area is characterised by a complex system of highlands, steep valleys and large flatlands, which drops to the lowlands in the south. The area's altitude ranges from 500 m a.s.l. in the south to 3300 m a.s.l. in the northeast. This great variety of landforms is responsible for highly diverse climate, soil and vegetation. The most remarkable highlands include the Gurgura Mountains, Shonga Mountains, Yatana Mountains and Gola Mountains, along with Koma Summit and Saja Summit. The most extensive wetlands are the Alemgono and the Gojeb wetlands. Mountains and wetlands are connected by numerous fertile valleys and lowlands, which extend mostly through the central part of the biosphere reserve (Figure 1).

According to the soil map produced by the WBISPP (2004), the dominant soils in the Kafa Zone are dystric nitosols (Nd). Adiyo, the southwestern part of Telo and north and northwest of the Gewata woredas are dominated by orthic acrisols (Ao). In addition, eutric fluvisols (Je), chromic luvisols (Lc), chromic vertisols (Vc) and pellic vertisols (Vp) can be found in the Kafa BR to varying degrees (EWNHS 2008).

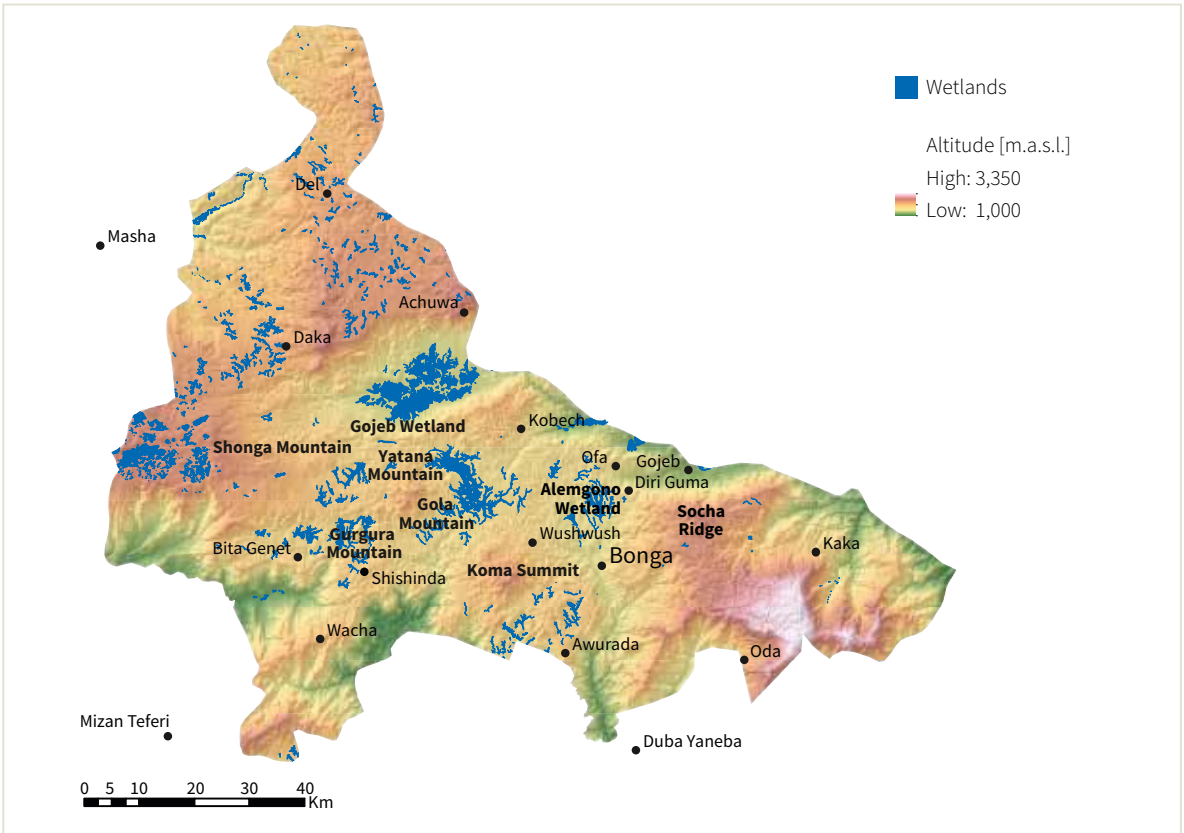

Figure 1: Topographic features of the Kafa Biosphere Reserve

2.2 Climate

In general, the climate is characterised by a bimodal rainfall pattern, with the main rainy season between June and September and a short rainy period from February to April. Kafa receives its rainfall from the Southwest monsoon, which reaches its maximum intensity during July and August. The average annual rainfall ranges from 1500 mm in the lowlands up to 2000 mm at the highest elevations (EWNHS 2008). Thus, the Kafa BR is in the most humid part of the country, with only two to four dry months in the year. According to Gamachu (1977), annual temperatures vary between 15 and 24°C. Due to the high variety of landscapes and altitudes within the Kafa BR, there are many microclimatic deviations from the usual rainfall patterns.

2.3 The Kafa Biosphere Reserve

The Kafa BR is located in the southwestern highland region of Ethiopia (Figure 2), in the Southern Nations, Nationalities and Peoples' Region (SNNPR). The Kafa Zone has a total area of around 10000 km² and a little over a million inhabitants.

According to a background study by Chernet (2008), the ethnic composition of the Kafa Zone is dominated by Kaffecho (81%), followed by Bench (6%), Amara (6%) and Oromo (2%). The remaining 5% also include marginalised groups like Manjo (Manja). The biggest religious group are Orthodox Christians (67%), followed by Protestants (20%) and Catholics (10%). There is also a small Muslim community (3%).

The overall population density of the Kafa BR is 98 inhabitants per km², ranging from 52 inhabitants per km² in the least densely populated woreda (Decha) to 210 inhabitants per km² in the most densely populated woreda (Chena). Subsistence farming plays a major role for local livelihoods. The people in the region mainly live from subsistence farming, the sale of wild coffee and the natural resources of their environment (e.g., forest, including food, burning/building materials, medicinal plants/spices, animal feed, honey). Over the centuries they have adapted their (land) use, traditions and customs to nature (NABU 2014). The most common livestock is cattle, followed by poultry, sheep and goats. Honey production (mainly using traditional techniques) and coffee cultivation are other important income sources (SNNPR 2013).

The region is characterised by Afromontane mountain cloud forests and rainforests, which contain wild *Coffea arabica*, bamboo forests, grasslands and shrublands (NABU 2014). Because of its relevance to national biodiversity and as catchment area, the Ethiopian government has put the area under partial national protection in the form of a Regional Forest Priority Area (RFPA). The area is particularly noteworthy for being the origin and centre of *Coffea arabica's* genetic diversity and therefore as a globally significant in situ gene bank (NABU 2014). The overall economic value of *Coffea Arabica* has been estimated at approximately 1.5 billion US$ (Hein & Gatzweiler 2006).

An outstanding event was the publication of photographic evidence of the African lion in 2012, documented in a rainforest for the first time (NABU 2014). Varied topography and high precipitation rates (2,000 mm annually) in an area of 26832 ha have led to a high diversity of wetlands. According to the Kafa Wetland Strategy (EthioWetland 2008), these include river margins, peatlands, riparian zones, extensive floodplains and alluvial plains, marshes/swamps as well as forest wetlands. They function as moisture and carbon reservoirs, and represent an important part of supraregional river basins (the rivers Gojeb/Omo, Baro-Akobo and others). Furthermore, they offer rare bird species (e.g., the Wattled Crane, Rouget's Rail) and large mammals (e.g., lions, Cape buffalos) the possibility to breed, retreat and feed. Species recordings have documented approximately 126 species of plants (e.g., *Cyperus latifolius*, *Anagallis serpens*), 106 species of birds and 21 species of mammals. Along with the forests, the aquatic habitats are the main suppliers of ecosystem services, and are used by the local population to produce water, food, animal feed, building materials and to generate income (e.g., medicinal plants, basketwork).

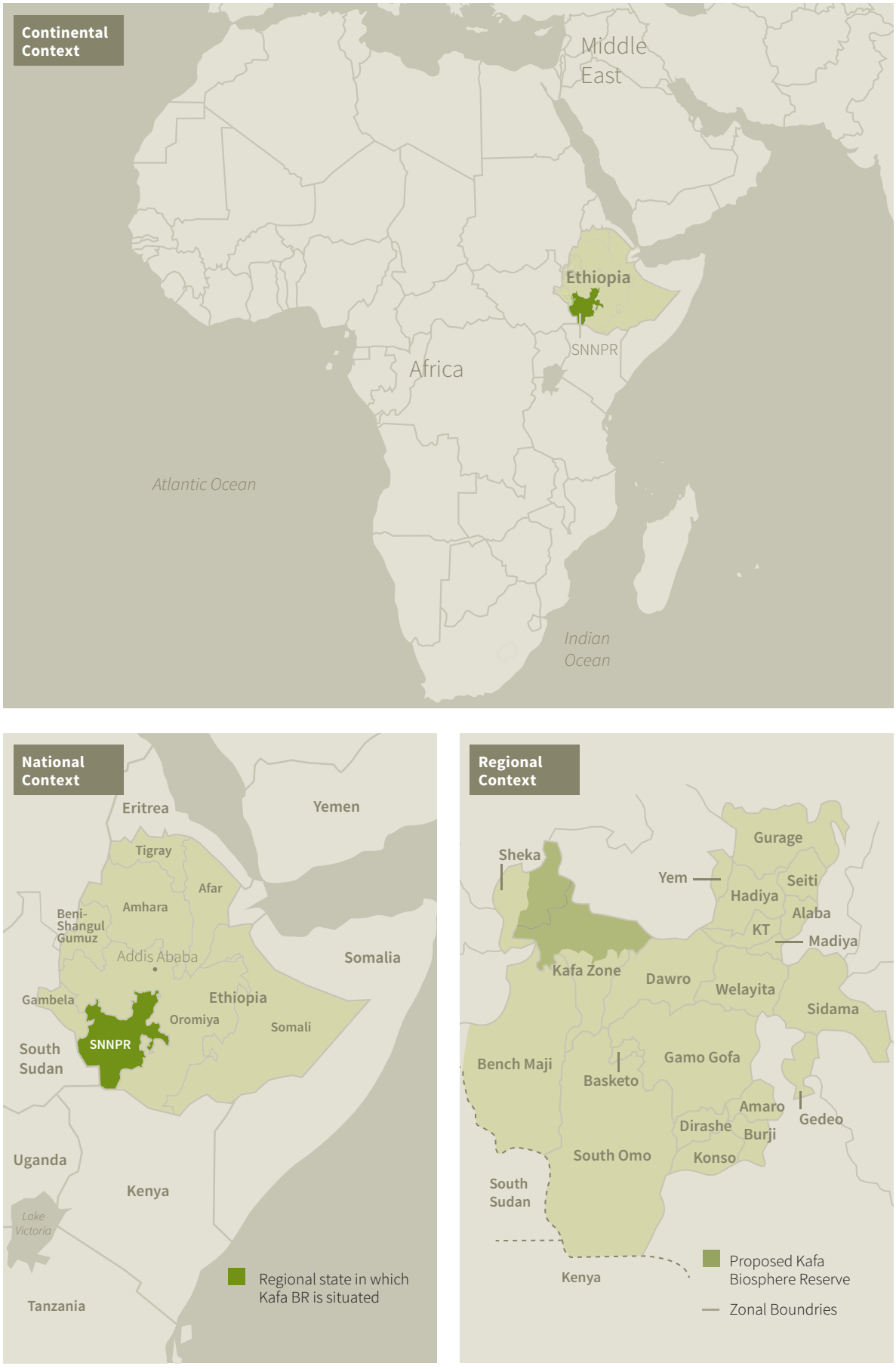

Figure 2: Location of the Kafa BR at a national and continental scale

Different political and demographic factors have driven changes in land use and land cover in the Kafa Zone. In the 1970s, major land redistribution occurred, followed by large-scale resettlement in the 1980s. The 1990s were shaped by the agricultural investment policy and the promotion of cereal production, along with the Ethiopian Forestry Action Plan. Finally, the 2000s were influenced by large-scale agricultural expansion, the establishment of National Forest Priority Areas, Participatory Forest Management (PFM) sites and ultimately the UNESCO biosphere reserve (Tadesse et al. 2014).

The Kafa BR covers an area of more than 7500 km², of which 47% is covered with forests. The average population density of the Kafa BR is 130.14 p/km². Administratively, the Kafa BR consists of ten woredas and 250 rural kebeles and 25 urban towns (SNNRP 2013).

Table 1 shows the distribution of the urban and rural population within the different kebeles and woredas in the Kafa BR. The data is based on one head counted per household, with males being the majority in most kebeles. The only exception is the woreda of Decha, in which females are the majority. This may be explained by the culture of the Kaffecho ethnic group who are mostly present in this woreda. A significant majority (>90%) of kebeles are in rural areas, while Gimbo woreda includes the most urban settlements.

Table 1: Distribution of rural and urban population in the woredas and kebeles of the Kafa BR (SNNPR 2013)

Woreda		Number of kebeles			One head per household		
		Rural	Urban	Total	Male	Female	Total
1	Adiyo	27	1	28	13,205	1,294	14,499
2	Bita	24	1	25	11,599	877	12,476
3	Chena	42	2	44	18,360	3,302	21,662
4	Cheta	16	0	16	3,150	1,676	4,826
5	Decha	57	1	58	6,582	12,637	19,219
6	Gesha	24	1	25	11,675	2,457	14,132
7	Gewata	30	1	31	9,320	758	10,078
8	Gimbo	31	3	34	12,311	1,779	14,090
9	Saylem	21	1	22	6,375	866	7,241
10	Tello	24	1	25	6,024	5,412	11,436
11	Bonga	0	3	3	-	-	-
Total		**296**	**15**	**311**	**94,791**	**31,222**	**126,013**

Chena is the most densely populated woreda, with 210 habitants per km². This is followed by Tello, Gesha, Gimbo and Adiyo (159, 143, 129, and 121 habitants per km², respectively). Most of the core zones in the Kafa BR are located in these woredas, along with most of its characteristic habitats such as bamboo forests and wetlands.

Nevertheless, steady population growth, poverty, illegal immigration and agro-investment (e.g., tea, coffee) have led to an increasing pressure on the region's natural resources (NABU 2014). The transformation of forests and wetlands into agricultural land as well as selective clearing for timber and fire wood are leading to fragmentation, degradation and reduction of natural habitats. The illegal extraction of construction materials such as sand, stone and soil disturb ecosystems, and unsettled land use rights encourage overuse (overgrazing, clearing) and illegal land grabbing. At the same time, the effects of climate change are noticeable in form of irregular rainfalls, extreme weather events such as heavy rains or droughts, as well as the proliferation of pests. Especially Wild *Coffea arabica* is proven to be sensitive (Davis et al. 2012).

UNESCO biosphere reserves have the explicit purpose of reconciling people's needs with nature conservation. Thus, the aim is to bring ecological, social and economic factors together to create sustainable ways of living (Bridgewater 2002). In the Kafa BR, there are long traditions of using wild plants and animals for various purposes. However, traditional management techniques may no longer be sustainable due to pressures from population growth and resettlement programmes. New technologies and the economic interests of external actors have produced significant changes in land use management, with detrimental effects on biodiversity and ecosystem services. Preserving biodiversity requires new land management approaches and techniques. In this sense, it is essential to consider socio-cultural factors when developing feasible conservation strategies and management plans.

Successfully managing a biosphere reserve involves considering different interests and needs. This usually requires a high level of participation from local communities. However, others argue that as long as local people's needs are met, participation through consultation (no active participation) is sufficient (Wallner et al. 2007). In developing countries, external stakeholders with different cultural backgrounds are often involved in setting up biosphere reserves. Common ground must be identified in order to communicate and successfully collaborate with local stakeholders. Different socio-cultural backgrounds and their perceptions of conservation and livelihood strategies must be considered to gain a mutual understanding of key issues. In the case of the Kafa BR, local residents are mostly smallholders, and their perception of the landscape values can vary significantly (Gaston & Spicer 2013). A study by Wallner et al. (2007) shows that the main argument in favour of biosphere reserves is the potential economic benefits to locals. Local ecological knowledge is increasingly valued in wildlife conservation (Berkes et al. 2000).

As a biosphere reserve, the Kafa BR needs to adhere to the objectives of the UNESCO Man and Biosphere (MAB) programme. This is supported by the Seville Strategy for biosphere reserves, which includes the following as one of its principles: "Reinforce scientific research, monitoring, training and education in biosphere reserves, since conservation and rational use of resources in these areas require a sound base in the natural and social sciences as well as the humanities".[1]

More specifically, the Seville Strategy (1996a) recommends that individual biosphere reserves make inventories of fauna and flora […] as the basis for sound site management and to develop a functional system of data management for rational use of research and monitoring. For the Kafa BR to maintain its UNESCO status, regular monitoring and assessment must be conducted. The Statutory Framework of the World Network of Biosphere Reserves (1996b) makes provision under Article 9 that "the status of each biosphere reserve should be subject to a periodic review every ten years, […]. In order to meet the review criteria, regular research and monitoring intervals need to be carried out to gain a sufficient data base and to identify possible constraints early enough to adjust management and protection practice.

To this end, the biodiversity assessment is a centrepiece for achieving regional, national and international objectives in biodiversity conservation and management, and to adhere to the UNESCO standards for biosphere reserves.

The application document to UNESCO provides information on key functions, sizes and spatial configuration of the reserve, which is essential for management and projections (Table 3).

[1] See: http://www.unesco.org/mab/doc/brs/Strategy.pdf

Table 2: Zonation of Kafa BR showing main spatial features and functions (adapted from Dresen 2011)

BR Zones	Size (ha) and percentage	Forest area (ha)	Key functions	Priority for the biodiversity assessment
Core zone	28,172 (4%)	28,110	Serves as a refuge for various endemic and/or endangered species and provides opportunities for long- and short-term research and monitoring programmes, as well as non-consumptive use.	High
Candidate core zone	219,130 (28%)	174,482	Contains highly endangered habitats. Candidate core zones should be included into the core zones after feasibility assessment.	Medium to high
Buffer zone	161,351 (22%)	87,487	Connects conservation areas that have been isolated by human activities. Buffer zones should encourage a symbiotic relationship between conservation and nature-related economic activities.	Medium
Transition zone	336,069 (46%)	61,560	Enhances environmental integrity or rehabilitation of unused farmland and plantations. Used to restore and preserve sites and/or features of historical and cultural significance.	Low
Total	**744,919 (100%)**	**35,639**		

2.4 Main types of habitat and vegetation in the Kafa Biosphere Reserve

The Kafa BR is home to the last surviving moist evergreen montane forests in the eastern Afromontane biodiversity hotspot (Mittermeier et al. 2004). The area is also recognised as a key biodiversity area. The wild coffee tree, *Coffea arabica*, is indigenous to the understorey of Kafa's natural Afromontane forest. In some areas it is harvested without standardised management. In other areas, designated as PFM sites, the wild coffee is harvested in forest fragments, where farmers cut and thin out parts of the upper canopy and annually slash the forest understorey. This form of forest use is known to be structurally sustainable for the natural forest vegetation. However, it must still be evaluated to what extent PFM sites are also degrading, as the understorey slashing can hamper regeneration.

According to the IBC (2005), there are five main habitat types in the Kafa Zone:

1) **Evergreen montane forest and grassland complex**: This complex habitat occurs between altitudes of 1900 and 3300 m a.s.l. and covers 52% of the BR. It includes much of the highlands located within the proposed buffer area of the BR. This habitat occurs in areas which are often densely populated, leading to pressures from expansion of arable land.

2) **Moist evergreen montane forest**: This habitat occurs between 1500 and 2600 m a.s.l. and covers 26% of the BR. This type of forest is of global conservation significance due to the occurrence of wild *Coffea arabica*. In addition to deforestation for arable land, timber extraction is a major threat to this habitat (Figure 6).

3) **Wetlands**: A complex system of wetland habitats occurs between 900 and 2600 m a.s.l. covering 6.6% of the BR. These sensitive ecosystems are of utmost importance for the local communities, for example in providing materials for building shelter, for grazing and freshwater supply. At the same time wetlands are also increasingly under pressure due to intense grazing and other land uses.

4) **Combretum-Terminalia woodland**: IBC (2005) has classified some areas of the Kafa BR as Combretum-Terminalia woodland, which were later corrected to bamboo forests by Dresen (2014). Figure 3 shows the older classification (light green), while Figure 4 displays the habitat types distinguished in a land use/land cover map in 2014.

5) **Sub-Afroalpine habitat**: This habitat occurs at altitudes higher than 3200 m a.s.l. and covers only 0.3% of the total BR. This vegetation type is under severe threat due to agricultural expansion. Indigenous tree species such as *Hagenia abyssinica* are under high pressure.

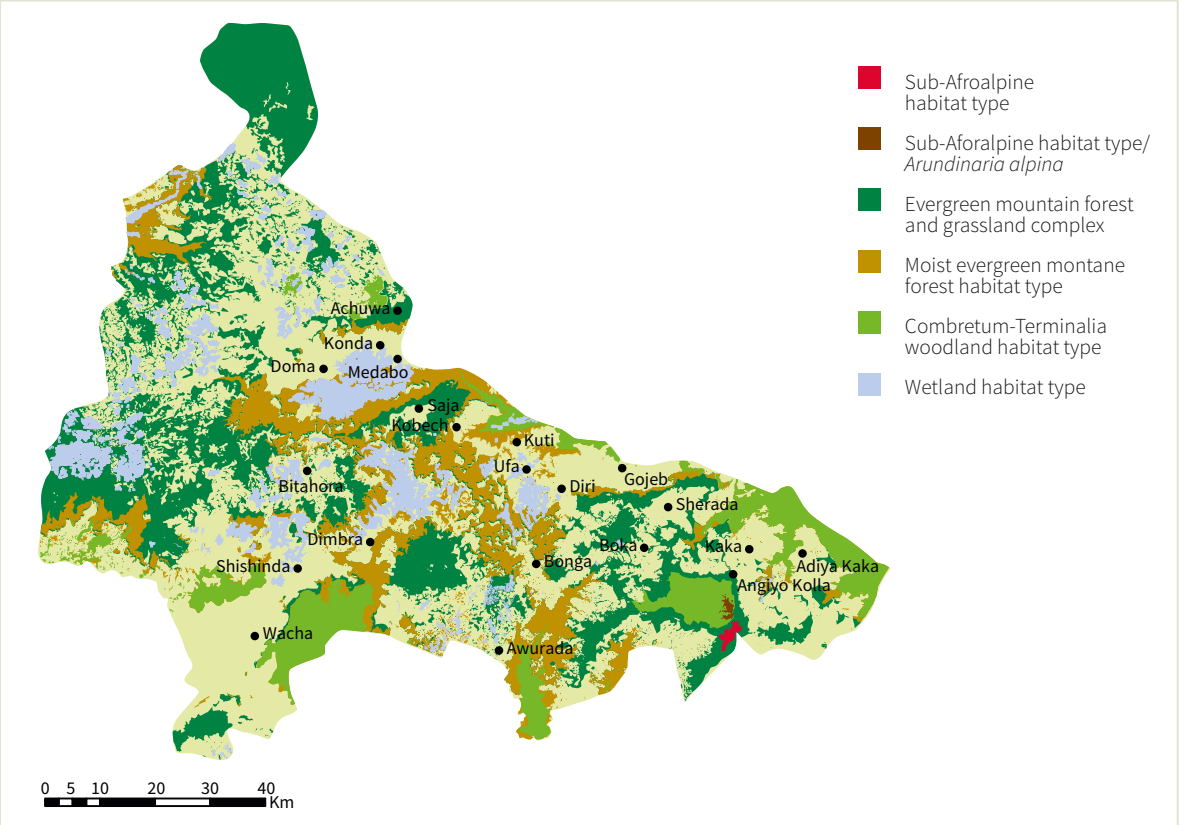

Figure 3: Habitat types in the Kafa BR as classified by the Institute of Biodiversity Conservation (IBC 2005), adapted by Dresen (2014)

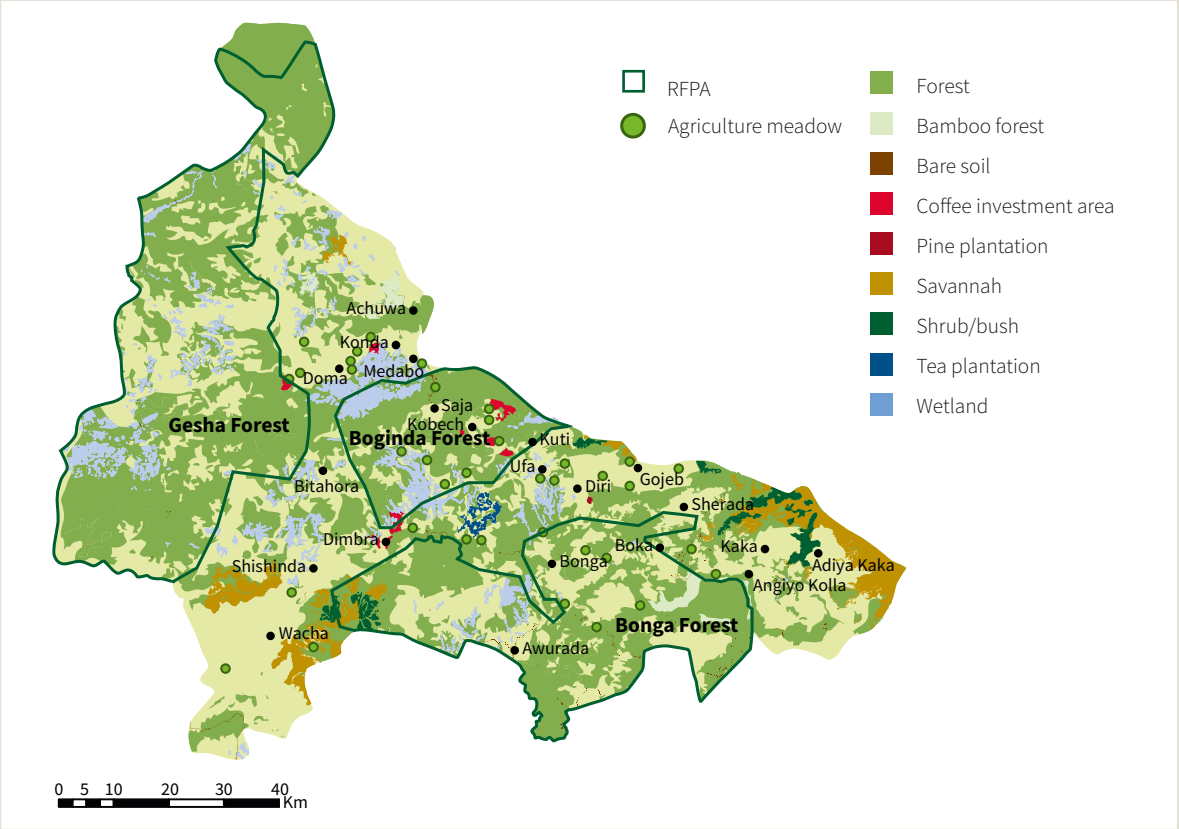

Figure 4: Regional Forest Priority Areas according to Million & Leykun (2001) (red lines) projected on land use and land cover at the Kafa BR, adapted by Dresen (2014)

The few existing vegetation studies conducted in the Kafa BR mainly concentrate on the PFM sites with *Coffea arabica*, analysing the undergrowth in disturbed habitats (Aerts et al. 2011; Denich & Schmitt 2006; Gobeze et al. 2009; Schmitt et al. 2009; Tadesse et al. 2014a, 2014b). These studies conclude that anthropogenic effects often lead to homogenisation of natural vegetation. In the biodiversity assessment, we therefore compared species composition between disturbed habitats (PFM sites) and undisturbed habitats (such as primary forests in the BR core zones).

A rapid biodiversity assessment in the Kafa Zone in 2007 recorded a total of 244 plants species in the three forest sites, representing 77 families. Of the 244 species recorded, 26.6% were trees, 27.9% were shrubs, 27.5% were herbs, 8.6% were climbers, 2.9% were epiphytes and 1.2% were grasses. The most abundant species in the Saja forest are *Oxanthus speciosus*, *Dracaena fragrans* and *Macaranga capensis*. The most abundant species in the Mankira forest are *Dracaena fragrans*, *Coffea arabica* and *Chionanthus mildbraedii*. In the Boka forest, bamboo (*Arundinaria alpina*) and *Schefflera volkensii* are dominant, with some understorey shrubs and herbs (EWNHS 2008).

A survey of three areas in Kafa BR (EWNHS 2008) classified 7 major land uses. The floristic inventories mainly focused on forested areas. Using transects and quadrates as sampling methods, the assessment recorded about 92 tree/shrub/liana species with a diameter of more than 10 cm at breast height across the three study sites. The Bonga area was the richest site with 70 species, followed by Boginda with 54 species and Mankira with 46 species. Bonga forest has the highest density of trees with a diameter of more than 10 cm followed by Boginda forest and Mankira forest (Nune 2008). The floristic composition of three sampled sites shows high heterogeneity of habitats. This is revealed by the lack of species shared by all three forest sites, indicating that each forest has a heterogeneous species composition. The most prevalent species are *Croton macrostachyus* in Mankira and *Millettia ferruginea* in Bonga and Boginda Forest. No single tree or shrub species was found in every sample plot across all three study sites, despite being separated by only a few kilometres (Nune 2008). These results highlight the high diversity of habitats in the Kafa BR. This study also found heavy exploitation of *Cordia africana*, *Pouteria adolfi-friederici* and *Prunus africana*, which are reported as endangered species.

Figure 5: Major habitat types in the Kafa BR: bamboo forest (photo: Juan Carlos Montero)

Figure 6: Major habitat types in the Kafa BR: bamboo forests (photo: Juan Carlos Montero)

Figure 7: Major habitat types in the Kafa BR: dense montane rain forests (photo: Anna Leßmeister)

Figure 8: Major habitat types in the Kafa BR montane rain forests (photo: Bruno D'Amicis)

Figure 9: Major habitat types in the Kafa BR: large wetlands and flood plains at Alemgono (photo: Juan Carlos Montero)

Figure 10: Major habitat types in the Kafa BR: large wetlands and flood plains at Alemgono (photo: Juan Carlos Montero)

Figure 11: Riverine vegetation at Gojeb River (photo: Juan Carlos Montero)

Figure 12: Riverine vegetation at Gummi River (photo: Juan Carlos Montero)

3. Methodological Approach

A great deal of complex administration was required prior to conducting the fieldwork to ensure compliance with Ethiopian law. The biodiversity assessment was conducted in close cooperation with the relevant Ethiopian authorities and research institutions, with agreements to use and share the information gained from the assessment.

In total, 18 international experts (17 Germans, 1 Dutch) and 12 Ethiopian experts were involved in the assessment. Among the Ethiopian experts, two were delegates of the Ethiopian Biodiversity Institute (EBI). The experts were assembled into seven different teams based on different taxa:

- Vascular plants (four Ethiopian, one German, one EBI delegate),
- Birds (four Germans, one Ethiopian),
- Insects (three Germans, three Ethiopian),
- Mammals (six Germans, one Dutch, one Ethiopian, one EBI delegate),
- Fungi (one German),
- Molluscs (one German), and
- Amphibian/reptiles (one German).

The names, contact information and current affiliations of each expert are provided in the participants section at the beginning of this report. The experts were supported by 23 local field guides and translators. Sampling sites were selected based on invaluable input from NABU staff like the Kafa BR rangers. Logistics and organisational support was provided by staff from NABU Headquarters Germany and NABU Ethiopia, along with 16 pick-ups and their drivers. In total, 80 people were involved in the assessment. The headquarters of the operation was at the KDA Guesthouse in Bonga.

3.1 Sampling site selection

Sampling sites were selected based on ecological parameters and the core objectives of the assessment. Thus, the most important criteria were:

(a) the presence and location of core and candidate core zones,
(b) access to the sites (e.g., distance from Bonga, road condition) and
(c) the presence of variable habitat types.

Areas were selected based on the regional forest priority areas in the Kafa BR proposed by Million & Leykun (2001), which consist of Bonga, Boginda and Gesha Forests (Figure 13). While Bonga and Boginda met the three selection criteria, Gesha Forest was too far from the operation headquarters.

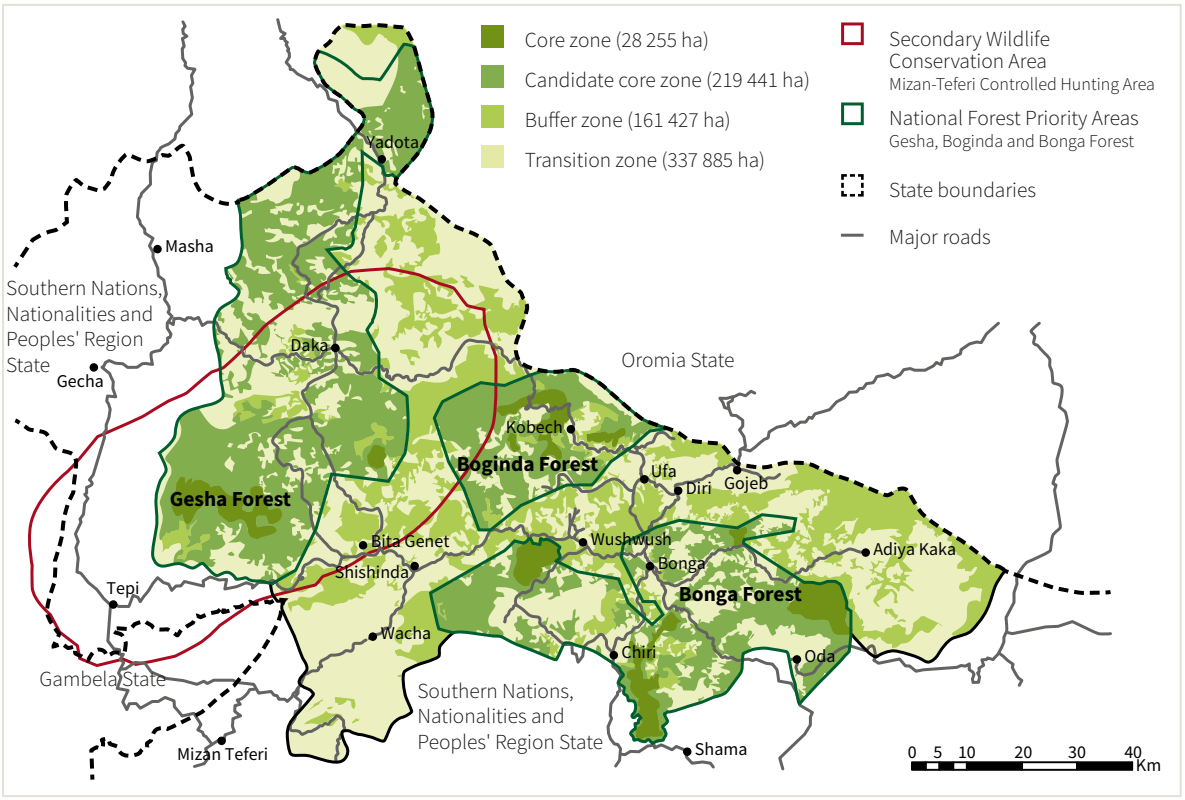

Figure 13: Regional forest priority areas within Kafa BR, showing the Bonga, Boginda and Gesha Forests (NABU 2016)

Table 3: Study areas priorities

Area	Total area (ha)	BR zones	Altitudinal range (m a.s.l.)	Priority
Afromontane forests	107393	Core/candidate core	1500-2600	High
Wetlands				
Floodplain forests	26832	Candidate and buffer	900-2600	High
Bamboo forests	ca. 10000	Core	2400-3050	High
Participatory Forest Management (PFM) sites	10000-15000	Candidate core	1500-2600	Medium to low

The chosen study sites can be further divided into those which are of particular ecological importance due to having near-to-intact forest ecosystems and those which are regularly used by humans, most importantly the PFM sites. These two types of area include different habitats, which are further specified below:

3.1.1 Areas of particular ecological importance

1.1 Bamboo forests: This extensive and unique vegetation in the Kafa BR occurs at altitudes between 2400-3050 m a.s.l. and is characterised by bamboo undergrowth either in pure stands or mixed with trees, including *Hagenia abyssinica*, *Myrsine melanophloeos* and *Hypericum revolutum* (Bekele 2003). A huge and unique patch is located in Adiyo woreda at the Eastern part of the Kafa BR.

1.2 Afromontane forests: These are characterised by dense vegetation, a complex understorey and distinctive tree layers where the emergent trees reach heights of around 25 m. They occur in hilly areas, shaped by depressions, streams and creeks. Along their altitudinal gradient, these forest areas are divided into two types:

a) Evergreen montane forest. This type of vegetation occurs between altitudes of 1900 to 3300 m a.s.l. and covers 52.1% of the Kafa BR

b) Moist evergreen montane forest: This habitat occurs between 1500 and 2600 m a.s.l. and covers 26% of the Kafa BR. This type of forest is of global conservation importance due to the presence of wild *Coffea arabica*.

Most previous inventories were conducted in the moist evergreen montane forests. For this assessment, the following woredas were selected:
- Decha, Tello, Gimbo and Chena in the Bonga Forest.
- Gawata in the Boginda Forest.

1.3 Wetlands: Based on NABU project activities on wetland restoration and community-based management, Alemgono and Gojeb Wetlands were selected for the assessment, along with the Shoriri Wetland. These habitats are complex systems mostly composed of flooded savannahs, forested islands and border zones which are inundated by an average water level of 30-60 cm for about three months of the year.

1.4 Floodplain forests-riverine areas: The study sites also included two areas which are periodically flooded by the Gummi and Gojeb Rivers. These floodplains are temporarily inundated during the rainy season from June to September, but flash floods also occur in the montane rainforest areas. In both cases the inundation period is comparably short (less than a month) and the water level oscillates between 30 cm and 1 m.

3.1.2 PFM sites

PFM sites were first established in Kafa in 2002. While PFM involves state forest departments to a certain extent, it ascribes particular relevance to local communities, their knowledge and their key role as forest managers. To date, Kafa has approximately 15000 ha of PFM sites with about 12000 members. The sites are mainly distributed across the montane forests (see above) of the Gawata, Decha and Gimbo woredas (Dresen 2011). These areas are spread throughout the Kafa BR.

Three areas were chosen for the assessment:
1. The Ufa PFM site, which covers around 1,200 ha and has 602 members. It is located in Decha woreda and forms a transition to the floodplain area formed by the Gummi River.

2. The Keja-Araba PFM site, which covers around 1,470 ha and has 620 members.

3. The Beta Chega PFM sites, for which no specific information is available.

11 sampling sites were selected among the different habitats outlined above. The sites are listed in Table 4. Each area was assigned a code for standardisation and data interpretation purposes. From these 11 sites, each working team chose the most suitable and effective sites for their sampling methods and assessments (further details can be found in the individual taxa reports).

Table 4: Sampling areas of NABU's biodiversity assessment at Kafa BR

Area	Site	Code	Habitat	Altitude (m a.s.l.)	Lat.	Long.
Bonga	Bamboo forests	BA	Bamboo forests dominated by *Arundinaria alpina*	2700	07°14'10.8" N	36°28'03.8" E
Bonga	Komba Forests	KO	Afromontane forests	1900	07°18'10" N	36°03'50" E
Bonga	Boka Forests	BK	Afromontane forests	2500	07°17'51.6" N	36°22'28.1" E
Bonga	Awurada Valley (Gummi River, PFM sites)	AW	Afromontane Forests/ riverine vegetation	1550	07°05'18.0" N	36°13'05.9" E
Bonga	Alemgono Wetland	AG	Wetland	1700	07°21'27.2" N	36°14'18.1" E
Bonga	Shoriri Wetlands	SHO	Wetland	1630	07°21'34.2" N	36°12'24.4" E
Boginda	Gojeb Wetland	GO-wet	Wetland	1600	07°33'13.6" N	36°02'99.4" E
Boginda	Gojeb River	GO-riv	River/floodplain forests	1550	07°37'04.5" N	36°03'10.5" E
Boginda	Boginda Forests	BO	Afromontane forests	2100	07°30'01.1" N	36°05'29.8" E
Bonga	Keja Araba (PFM sites)	KE-AB	Montane forests	1850	07°16'39.8" N	36°10'10.2" E
Bonga	Beta Chega (PFM sites)	BE-CH	Afromontane forests	2100	07°17'54.7" N	36°05'46.9" E
Bonga	KDA Guesthouse	KDA-GH	Urban settlement	1756	07°25'01.5" N	36°25'46.1" E

In a few cases, some teams also assessed areas outside the selected sampling sites. For example, the team assessing large mammals chose the Wushwush tea plantation and the bats team identified God's Bridge near Bonga as a suitable area. In addition, the area surrounding the KDA Guesthouse was used as a sample site, particularly by the insect and bat teams. Figure 14 shows the spatial distribution of each evaluated habitat in the Kafa BR used for sampling sites in the assessment.

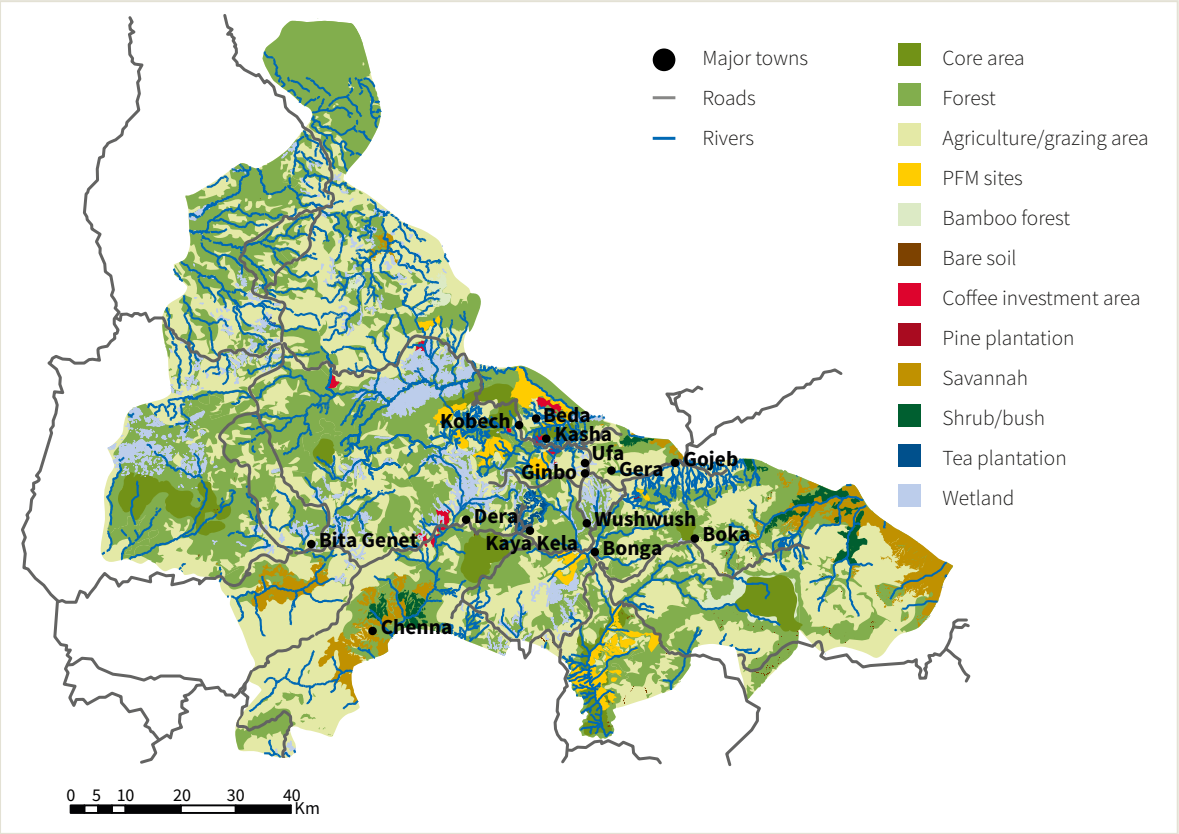

Figure 14: Sampling areas based on the coding system provided in Table 4 (Dresen 2011)

3.2 Data collection and information management

Due to the lack of baseline information and quantitative data on the studied taxa, data collection and management were largely based on expert experience and opinions. This was partially complemented with the limited literature available on Kafa and similar neighbouring habitats. To standardise approaches and understand NABU's objectives for the assessment, all experts were gathered for a meeting in Addis Ababa by Svane Bender-Kaphengst, NABU's Head of Africa Programme. During this meeting, the approaches to selecting indicator and flagship species and identifying threats were explained and discussed with the team leader Dr Juan Carlos Montero.

The data collection methods applied in the fieldwork follow standard protocols commonly used for these kinds of biodiversity assessments. They combine interviews, observations, transect/plot walking with modern tools and devices such as camera traps, call recordings and high-resolution microscopes, etc. Most teams worked during the day, apart from the mammal and bat teams, which conducted nocturnal observations and trapping. Due to the lack of suitable laboratories in Ethiopia, most samples were pre-processed and exported to Germany for specific identification. Each researcher signed a material transfer agreement (MTA), which obligates compliance with a number of criteria for exporting species to another country. Although the data collection and analysis processes differ between each taxon, the content and structure of the individual reports have been standardised for better comparison between the results and comprehensive presentation of the information acquired. Thus, a basic format for reporting was provided to the authors of each individual taxon. Further information on the sampling methods for each taxon can be found in the individual reports.

Immediately after completion of fieldwork, a workshop was held in Bonga, Kafa BR, to reflect on the methods applied, the preliminary results and suggestions for potential indicator and flagship species. In addition to

the experts, rangers, field assistants and NABU staff participated in the workshop. The participants shared and validated the knowledge gained during the field-work about each taxon and major habitat that was assessed.

During this systematisation and analysis of the field data, the preliminary species determinations were confirmed, rejected or corrected based on literature and (additional) expert knowledge. The analysis behind the choice of indicator and flagship species is presented in 3.3.

Figure 15: (photo: Juan Carlos Montero)

Figure 16: (photo: Juan Carlos Montero)

Figure 17: (photo: Juan Carlos Montero)

Figure 18: (photo: Juan Carlos Montero)

Figure 15-18: Regular briefings, supply, logistics and catering took place at the assessment's headquarters, the KDA Guesthouse compound

Figure 19: The plant team selecting the plot site (photo: Juan Carlos Montero)

Figure 20: The plant team selecting the herborization of the material collected (photo: Juan Carlos Montero)

Figure 21: The insect teams using different catching methods in open areas (photo: Viola Clausnitzer)

Figure 22: The insect teams using different catching methods in open areas (photo: Tom Kirschey)

Figure 23: The insect teams using different catching methods in close dense forests (photo: Svane Bender-Kaphengst)

Figure 24: The insect teams using different catching methods in close dense forests (photo: Matthias Schöller)

Figure 19-24: Collection of field data and samples by the teams (1)

Figure 25: The birds team making observation on an open area (photo: Torsten Ryslavy)

Figure 26: The birds team making observation on an open area (photo: Torsten Ryslavy)

Figure 27: Recording instruments used by the Bats team (photo: Ingrid Kaipf)

Figure 28: Recording instruments used by the Bats team (photo: Ingrid Kaipf)

Figure 29: Fungi expert identifying in the headquarters the material collected in the field (photo: Ingrid Kaipf)

Figure 30: Fungi collected at the Afromontane forest sites (photo: Andreas Gminder)

Figure 25-30: Collection of field data and samples by the teams (2)

Figure 31: The dragonfly team (photo: Thies Geertz)

Figure 32: The mollusc and amphibian teams collecting on areas influenced by water bodies (photo: Tom Kirschey)

Figure 33: (photo: Viola Clausnitzer)

Figure 34: The mollusc and amphibian teams taking samples (photo: Viola Clausnitzer)

Figure 35: A record of an antelope "Dik Dik" (*Moloqua kirkii*) registered by the camera trap (photo: Hans Bauer)

Figure 36: Footprint of the Dafassa Waterbuck (*Kobus defassa*) registered in the Gojeb Wettland (photo: Hans Bauer)

Figure 31-36: Collection of field data and samples by the teams (3)

3.3 Identification of indicator and flagship species

Given the complexity and lack of information on local biodiversity, it is often difficult to measure and monitor the potential impact of conservation practices on all species in the area. This problem is particularly relevant at the Kafa BR. Selecting indicator species is a cost and time efficient tool to characterise the state of an ecosystem and monitor changes in observable biodiversity parameters such as species richness or composition (Urban et al. 2012). Focusing on a limited set of species can be very helpful as an alternative to comprehensive fauna and flora surveys (Urban et al. 2012).

Flagship species are symbols of major conservation projects. They are usually large, charismatic and well-known species that are used to gain public attention and support (Kafa BR, for example, wild coffee and lions). Although, they are commonly used for conservation purposes, they often have limited scientific value for achieving conservation targets. A lack of flagship species in an area does not automatically imply low conservation value. At the same time, focussing conservation efforts on a single (flagship) species is rarely successful. However, flagship species can be an effective tool for public relations and for conserving particular sites or areas (Groves 2003).

In the Kafa BR, identifying and monitoring indicator and flagship species should concretise conservation targets and measures. Identifying appropriate targets and measures requires interpreting the planning region within a broader biogeographic context. Examples of unique or distinct biological include the presence of threatened and endangered species or a high degree of endemism (Groves 2003).

Choosing species or guilds as indicators in the Kafa BR is hampered by the lack of biological information at specific taxa level (e.g., distribution, ecology, inventories). The concept of indicator species needs to be employed cautiously, as it can lead to unwarranted generalisations and misleading interpretation of monitoring results, with negative implications for conservation management. For example, frogs are widely regarded as sensitive to habitat change, and declines in their populations are often interpreted as an indicator of climate change. However, in most cases, their decline is a result of multiple temporal and spatial factors with different levels of relevance. These driving forces may be accelerated by anthropogenic interventions such as deforestation, and are not limited to climate change. Using indicator species in conservation management often assumes that the maintenance and conservation of a suitable habitat (e.g., a particular forest type) for a single indicator species would also benefit other taxa with similar requirements. However, this relationship does not always hold (Landres et al. 1988). In the Bolivian Andes, for example, the Andean bear (*Tremarctos ornatus*) was chosen to be a good indicator species for the conservation status of the montane cloud forests. This was later contradicted by conservationists, who were able to show that the presence of the bear was not correlated with the presence and/or abundance of other taxa in the same habitat.

A key habitat requirement for bats is the presence of hollow trees, which are used for nesting and den sites. Because the abundance of hollow trees is a factor limiting bat populations over large forest areas, it would be more logical to preserve a certain amount of hollow trees than monitor indicator species. However, protecting hollow trees might not be relevant for other taxa (Lindenmayer et al. 2000).

When using indicator species to monitor pollution, the behaviour of selected indicator species can even prove the opposite to what it was dedicated to show. In the Australian river systems, the bivalve mollusc *Velesunio ambiguous* was chosen as an indicator for the presence of heavy metals; however, long term research on the same species and river systems have proven that the uptake of heavy metals by *V. ambiguous* does not reflect the extent of pollution in the surrounding riverine systems. Thus, this species was unreliable and unsuitable as an indicator species (summarised in Lindenmayer et al. 2000).

Some researchers suggest that the response to disturbances by one member of a guild might precisely predict the responses of other members. For example, Thiollay (1992) found that the populations of five sympatric, closely related and morphologically similar rainforest bird species varied unevenly under the influence of selective logging. Thus, different species within the same guild may not predictably respond to change, even though they are closely related morphologically and genetically. There are ecological reasons to believe that different members of a guild respond differently to the same factors, such as specific competition strategies and niche arrangements exhibited by different species (Lindenmayer et al. 2000).

Despite these criticisms and limitations, choosing indicator species for conservation and monitoring purposes in a poorly investigated habitat is a very important tool for understanding and conserving large habitats such as the forests and wetlands in the Kafa BR. But selecting indicator species and identifying their major threats is only the first step; monitoring and more quantitative research of each selected taxa are crucial to adjust the conservation plan, confirm the indicators or find more reliable and suitable species or guilds.

As shown above, selecting indicator species is far from trivial. Specific criteria must be followed, since selecting "wrong" or inappropriate species can lead to misleading conservation results. The biodiversity assessment applied the following principles when selecting indicator species following Landres et al. (1988):

(1) use indicators only when other assessment options are unavailable,
(2) clearly state assessment goals,
(3) major habitats require urgent attention and basic biological information,
(4) presence of a high heterogeneity of habitats separated by short distances,
(5) choose indicator species based on explicitly defined criteria in accord with assessment goals,
(6) include all species that fulfil stated selection criteria,
(7) know the biology of the indicator in detail, and treat the indicator as a formal estimator in conceptual and statistical models,
(8) identify and define sources of subjectivity when selecting, monitoring and interpreting indicator species,
(9) direct research at developing an overall strategy for monitoring wildlife that accounts for natural variability in population attributes and incorporates concepts from landscape ecology.

Based on these principles, we delineated a common definition of "appropriate" indicator species for the biodiversity assessment at Kafa BR:
Indicator species should be taxonomically well known, easy to identify and occur in a specific habitat. The absence of indicator species in a certain habitat may indicate human-created abiotic conditions and reflect the intensity of a disturbance regime.

Different kinds of species can serve as indicators of the biodiversity of a specific area. Lindenmayer et al. (2000) distinguish two broad groups of biodiversity indicators:

A) biological or taxon-based indicators, particularly species and guilds,
B) structure-based indicators, (spatial) landscape features such as structural complexity, connectivity and heterogeneity.

Nowadays, species are often chosen as indicators if they:
(a) reflect structural or functional changes in the ecosystem,
(b) are sensitive to a particular property of an ecosystem,
(c) influence other species or taxa, or
(d) are a representative member of a guild (Urban et al. 2012).

The biodiversity assessment made exclusive use of taxon-based indicators, taking different meanings and interpretations into account. According to Lindenmayer et al. (2000), taxon-based indicators can include:

(1) a species whose presence may indicate the presence of a set of other species and whose absence indicates the lack of that entire set of species,

(2) a keystone species (*sensu* Terborgh 1986), which is a species whose addition to or loss from an ecosystem leads to major changes in the abundance or occurrence of at least one other species,

(3) a species whose presence indicates human-created abiotic conditions such as air or water pollution,

(4) a dominant species that provides much of the biomass or number of individuals in an area,

(5) a species that indicates particular environmental conditions such as particular soil, microhabitats or type of rock,

(6) a species thought to be sensitive to and therefore to serve as an early warning indicator of environmental changes such as global warming or invasive species and

(7) a management indicator species, which is a species that reflects the effects of a disturbance regime or the efficacy of efforts to mitigate disturbance effects.

Types (1), (2), and (4) have been proposed as indicators of biological diversity (Lindenmayer et al. 2000). However, due to the lack of long-term information on the studied taxa, we focussed the assessment at Kafa BR on indicator species showing changes in abiotic conditions and/or changes in ecological processes (types (3), (5), (6) and (7)). As monitoring activities in Kafa increase, the first types of indicators can be properly assessed.

Flagship species were selected partly based on the chosen indicator species. These and other species which could serve as flagships were chosen after in-depth discussion among the experts involved in the assessment.

4. Summary of Results

This section presents the highlights of the taxon assessments and the selection of indicator and flagship species. A more detailed description of the results for each taxon can be found in the individual reports.

Overall, the biodiversity assessment detected high biological diversity within the Kafa BR, reflected in high diversity at both the habitat level and the species in each habitat. The identified habitats exhibit high heterogeneity, despite being only a short distance from each other. Another important finding is the extremely high rate of endemism. Despite the extremely short timeframe for the assessment, most of the assessed taxa consist of about 30% endemic species. This high degree of endemism can be explained by the isolated vast highlands surrounded by dry lowlands, along with the area's geological and tectonic history (see Section 2.1). Combined with the exceptionally high rate of endemism, the high diversity at the habitat level and the heterogeneity of landscapes makes the Kafa BR an exceptional area for biodiversity protection.

4.1 Results at taxa level

4.1.1 Vascular plants

Anna Leßmeister, Kifle Kidane, Terefe Woldegebriel, Kitessa Hundera, Debela Hunde and Juan Carlos Montero

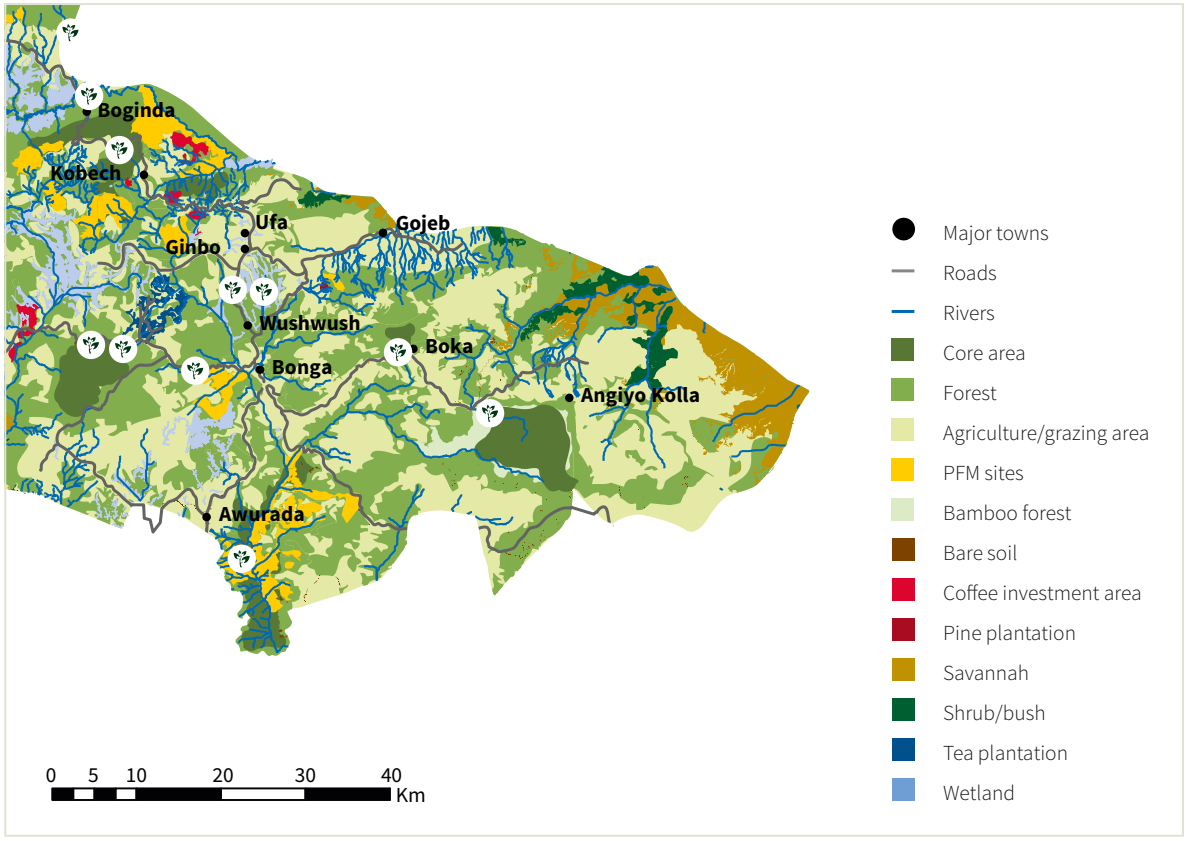

Figure 37: Sites sampled by the plant team at the Kafa Biosphere Reserve

Highlights

- Although there are data for a transitional bamboo-montane forest at Boka, this is the first quantitative study of the vegetation in the Kafa Biosphere Reserve's (BR) bamboo forests, along with the wetland and riverine forest patches.
- In total, 154 vascular plant species were recorded.
- Seven endemic species were recorded: *Aframomum corrorima*, *Bothriocline schimperi*, *Clematis longicaudata*, *Erythrina brucei*, *Millettia ferruginea*, *Tiliacora troupinii*, *Vepris dainellii*.
- 16 species are endangered or threatened: *Bothriocline schimperi* (LC), *Dracaena afromontana* (LC), *Erythrina brucei* (LC), *Ficus ovata* (LC), *Millettia ferruginea* (LC), *Pa-*

rochetus communis (LC), *Phaulopsis imbricata* (LC), *Vepris dainellii* (LC), *Canthium oligocarpum* (NT), *Coffea arabica* (VU), *Maytenus arbutifolia* (VU), *Ocotea kenyensis* (VU), *Pavetta abyssinica* (VU), *Prunus africana* (VU), *Tiliacora troupinii* (VU), *Cyathea manniana* (NT).

- The Afromontane forests are more species-diverse than the bamboo forest and wetlands. The latter, however, display high heterogeneity of habitats, thus increasing overall diversity.

- The floodplain forests and wetlands feature a higher diversity of plant species than Afromontane Participatory Forest Management (PFM) sites. Therefore, establishing core zones in the wetlands/floodplain forests would be advisable. More research is needed in this still poorly investigated habitat to extend species lists and investigate potential threats.

- The natural Afromontane forests show higher species diversity than the PFM Afromontane forests, as well as being home to considerably more species with high IVI values than the PFM sites. PFM techniques seem to decrease the natural regeneration of trees, resulting in a very low rate of species turnover.

- *Coffea arabica*, *Phoenix reclinata* and *Dracaena afromontana* are the flagship species.

- *Cyathea manniana*, *Dracaena afromontana* and *Hippocratea africana* are indicator species for primary montane forests susceptible to disturbances.

- *Pavetta abyssinica* and *Phoenix reclinata* are indicator species for floodplain forest and wetland forest patches.

- There is an urgent need for further investigation of other areas omitted from this assessment. For example, the western part of the reserve (Gesha and Bita areas) has complex patches of highland wetlands which certainly differ both structurally and compositionally from the investigated wetlands. The potential for discovering species new to science here is very high. Similarly, a huge, well-conserved patch of montane forest in the extreme northwest (Saylem) warrants detailed floristic study. At the other extreme, there is a lack of quantitative studies of the alpine vegetation northeast from Bonga (Adiyo), so more efforts are required in this area.

- Given the extreme importance of wetlands in Kafa, it is vital to typify their functions, processes, biochemistry and composition to aid further investigation. Some wetlands could be even nominated as Ramsar sites once sufficient information is available.

- Our results show that montane PFM sites exhibit lower diversity than the surrounding natural montane forests; therefore, there is an urgent need to investigate the vegetation (composition, diversity and ecology) at a spatial scale over time at both sites.

4.1.2 Fungi

Andreas Gminder

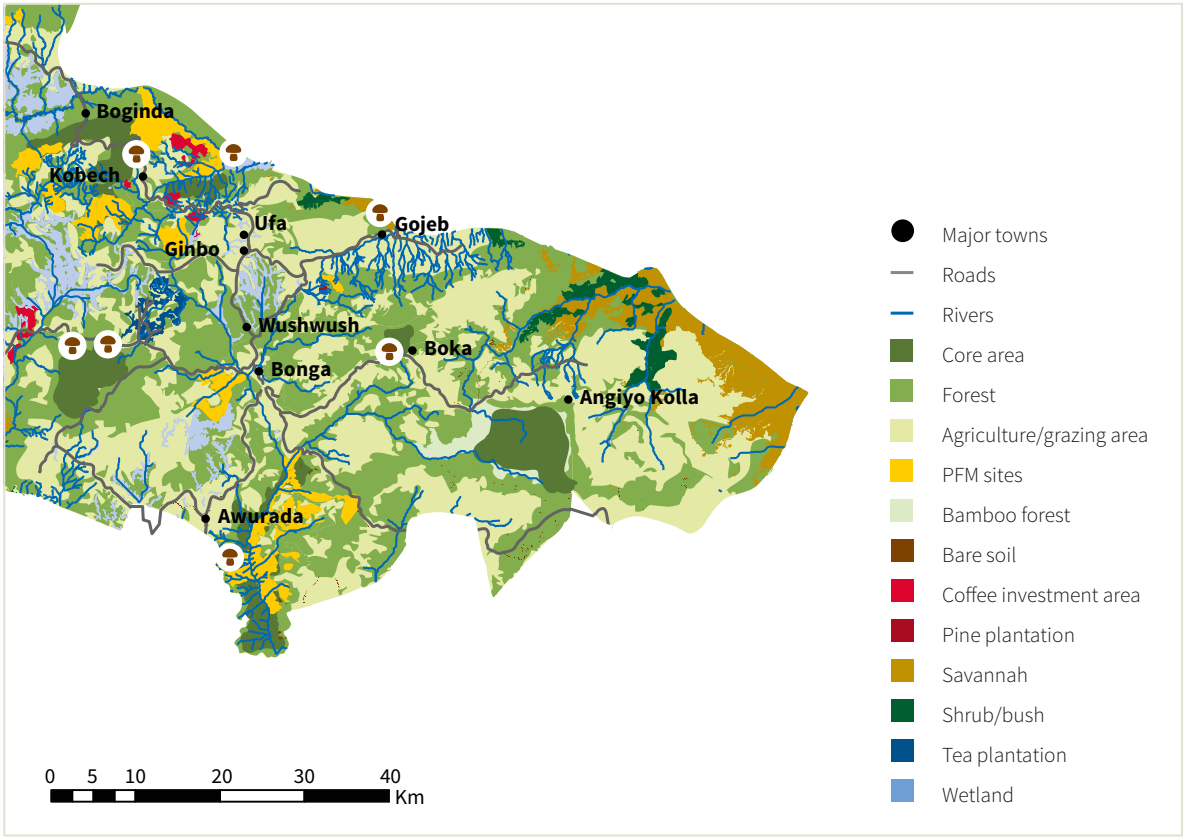

Figure 38: Sites sampled by the fungi team at the Kafa Biosphere Reserve

Highlights

- This is the first time a mycological survey has been conducted in the Kafa area.
- Nearly 350 species of fungi were recorded, but most were identified as morphospecies or could only be determined at the genus level.
- At least 30 species are new to Ethiopia, but this number may increase to more than 100 after all collections have been analysed.
- At least three species are already known to be new to science (*Ascocoryne kafai* ined., *Cerinomyces bambusicola* ined., *Coniolepiota kombaensis* ined.), but this number will most likely increase, at least in some genera of the Agaricales (*Cystolepiota*, *Entoloma*, *Psathyrella*) and Xylariales (*Hypoxylon* s. l.) orders.
- Two species are probably endemic to Ethiopia (*Cerinomyces bambusicola* ined., *Sarcoscypha* spec. nov. ined.).
- Many of the species are endangered by biotope loss, as they are believed to be confined to natural montane rain forests. The exact number cannot be estimated due to lack of comparative data.
- The bamboo forest seems to be home to several endemic species, but more studies are needed to confirm this.
- Compared to the wetlands and bamboo forests, the montane forests (coffee forests) at 1700 to 2000 m a.s.l. seem to be the most species-diverse biotope.
- *Sarcoscypha javanensis* and *Coniolepiota kombaensis* ined. could be a good indicator species for the status of natural montane cloud forests. *Cerinomyces bambusicola* ined. could serve as an indicator species for habitat quality in the bamboo forests. Finally, *Dentipellis fragilis* is an indicator for undisturbed forests in general.

4.1.3 Molluscs

Thies Geertz

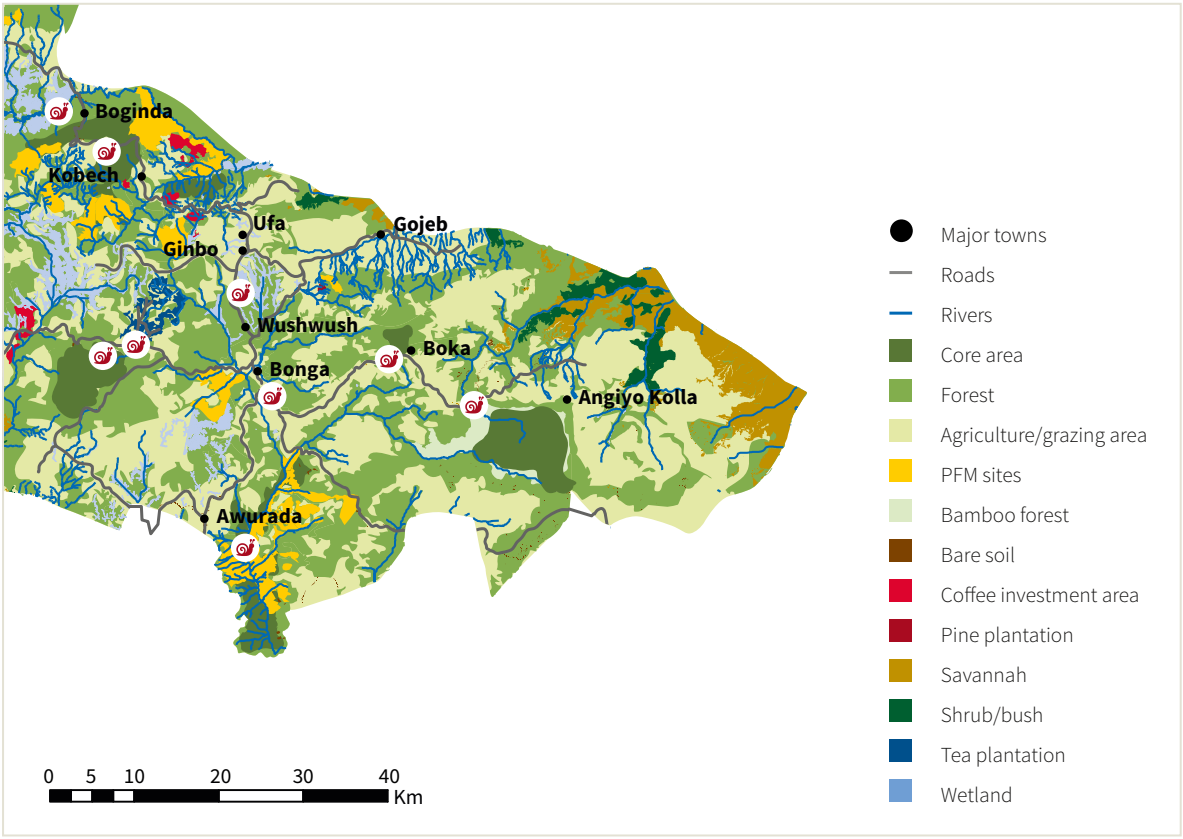

Figure 39: Sites sampled by the molluscs team at the Kafa Biosphere Reserve

Highlights

- As far as the author is aware, this is the first systematic assessment of terrestrial molluscs in an Ethiopian rainforest, if not the whole of Ethiopia.
- A total of 32 species of terrestrial molluscs were recorded.
- Knowledge of the ecology and conservation status of Ethiopian land snails is very poor at present. Further research is required to complete the checklist of land snails in the Kafa BR.
- None of the recorded species has been assessed by the IUCN Red List.
- Boginda Forest in the core zone was the most species-rich forest, with 16 recorded snail species.
- Freshwater molluscan diversity is very poor in the Kafa BR, with only nine species recorded in rivers, streams and ponds.
- One pea clam (*Pisidium* sp.) was discovered that is most probably new to science. Freshwater gastropods are absent from almost all investigated ponds and streams, despite seemingly good habitat conditions. This could be due to biogeographic factors or chemical water parameters and requires further research.
- Freshwater mussels (Unionoida) would be a good indicator group for the ecosystem health of streams and rivers.
- The carnivorous Streptaxidae are a potential indicator group for the ecological integrity of rainforests, although further research is required.
- Molluscs face an unprecedented rate of extinction, with 83% of East African land snails restricted to the endangered rainforests. Further research and conservation measures to curb deforestation are urgently required if these species are to survive.
- Future research should focus on identifying forest endemics in the Kafa BR, as these are potentially good indicator species and especially prone to extirpation.

4.1.4 Beetles with notes on other insects

Matthias Schöller, contribution on butterflies by Daniel Wiersborski

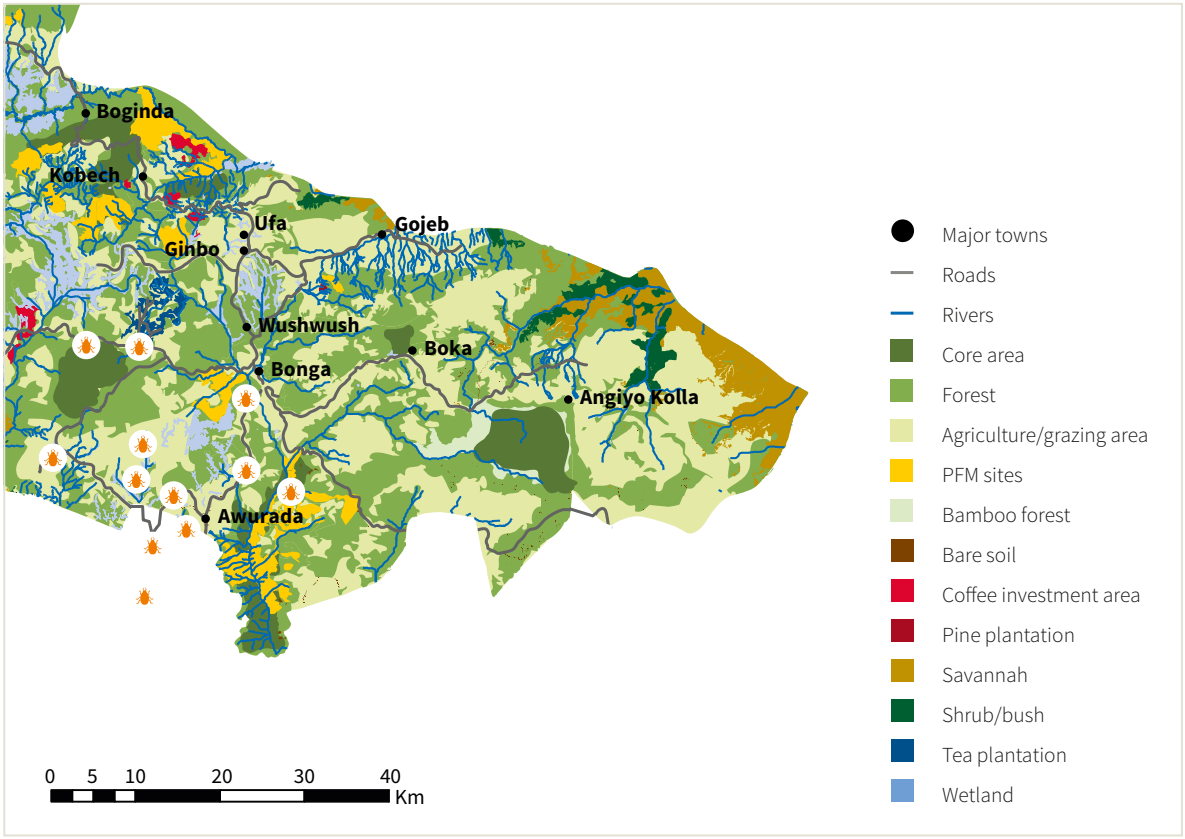

Figure 40: Sites sampled by the molluscs team at the Kafa Biosphere Reserve

Highlights

- This is the first time a comprehensive assessment of beetles has been conducted and reported at Kafa BR, covering a wide range of habitats and altitudinal gradients.
- The various sampling and trapping methods applied proved to be effective.
- 400 beetle species belonging to 79 families/subfamilies were recorded. Almost every major beetle family occurred at the sampled sites.
- Despite collecting during an unfavourable season, 164 Staphilinidae species were recorded within just 10 sampling days, out of approximately 530 known for Ethiopia (30%).
- Several species are new to science, e.g., a water beetle *Pachysternum* sp. nov., and the new species *Tachinoplesius schoelleri* Schülke 2016 was described. To date, determinations indicate 40 species are new to science; however, this number could increase as more determinations are completed. This process proved difficult due to a lack of specialists for many beetle groups.
- In the bamboo forests, phytotelmata were discovered, hidden in freshwater habitats. These are previously unknown for Ethiopia.
- Wetland habitats like the Shoriri Wetlands are in good condition. More research is needed in these areas.
- Species diversity in PFM forest sites benefits when the moisture in the ground layer is maintained by, e.g., the presence of large trees or microstructures such as climbing plants, tree holes or shrub and herb diversity.
- Leaf beetles in the genus *Altica* could be good indicators of wetland conservation status.

4.1.5 Flower-visiting insects

Hans-Joachim Flügel

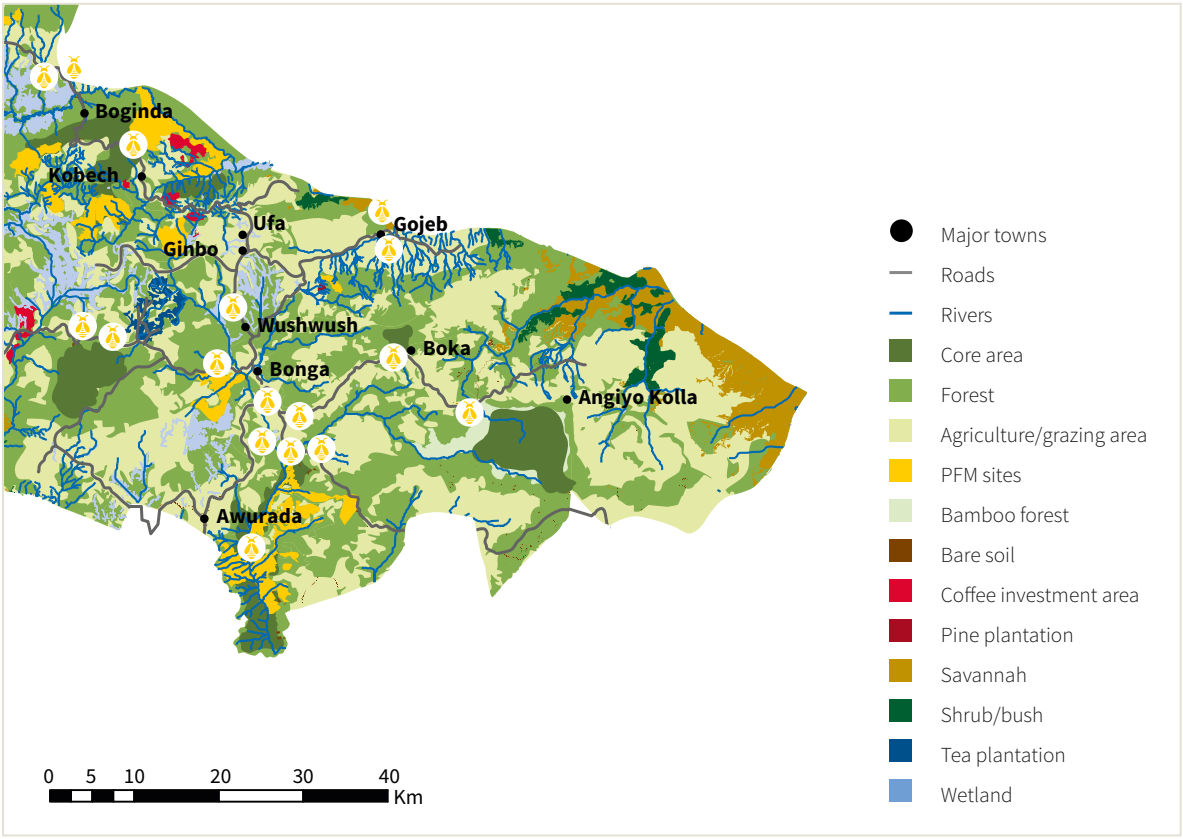

Figure 41: Sites sampled by the insect (flower-visiting insects) team at Kafa Biosphere Reserve

Highlights

- For the first time in the Kafa BR, an insect assessment was conducted with the focus on flower ecology.
- Approximately 300 insect specimens were recorded, of which approximately 50% could be determined to the species level.
- Identification to the species level was hampered by the absence of identification literature and reference collections for Ethiopian insects. Therefore, a more detailed statement on species composition and possible biodiversity highlights is currently not possible.
- The results of the assessment suggest that the Kafa BR is home to several endemic species, but more studies are needed to substantiate this finding. Most of the endemic species found seem to occur in the Afromontane rainforest.
- Ten species of the fly family Diopsidae were found, four of which are new to science.
- It is still unknown which insect species are the original pollinators of the coffee tree. This should be investigated by comparing wild *Coffea arabica* stands to cultivated stands, such as those found at Participatory Forest Management (PFM) sites.
- It is reasonable to assume that coffee production in plantations and PFM sites could be increased by introducing original pollinator species. Identifying the original coffee pollinators could thus considerably enhance coffee plant productivity at managed sites.

4.1.6 Dragonflies and damselflies (Odonata)

Viola Clausnitzer

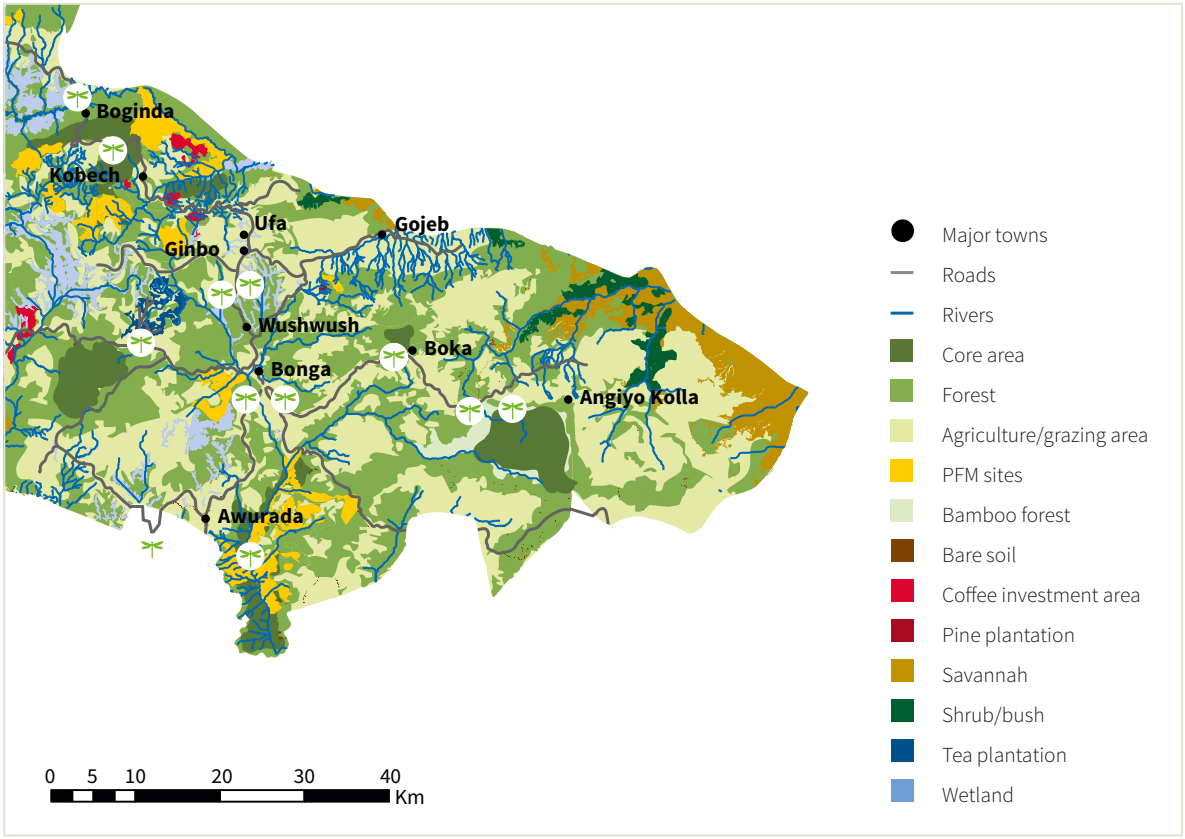

Figure 42: Sites sampled by the insect team (Odonata) at the Kafa Biosphere Reserve

Highlights

- A total of 33 Odonata (=dragonflies and damselflies, hereafter referred to as "dragonflies") species from seven families were recorded (31.1% of Ethiopia's dragonfly fauna and 65% of dragonfly fauna ever recorded in the Kafa BR).
- A total of 51 dragonfly species from nine families has ever been recorded in the Kafa BR.
- Three species are new to Ethiopia (*Aciagrion gracile*, *Tetrathemis polleni*, *Phyllomacromia* spec.).
- Twelve species were recorded the first time for the Kafa BR, including the endemic and endangered *Notogomphus ruppeli*.
- Eight of the recorded species are endemic to the Ethiopian highlands (*Pseudagrion guichardi*, *P. kaffinum*, *Notogomphus cottarellii*, *N. ruppeli*, *Atoconeura aethiopica*, *Orthetrum kristenseni*, *Palpopleura jucunda radiata*, *Trithemis ellenbeckii*).
- Five species are threatened according to the global IUCN Red List of Threatened Species (three 'vulnerable', two 'endangered'), all of them endemic to Ethiopia.
- Endemic species were only found in montane and submontane forest streams.
- The lower areas (wetlands) exhibit higher diversity, but no endemic species.
- The Ethiopian Highlander (*Atoconeura aethiopica*), the Ethiopian Sprite (*Pseudagrion guichardi*) and the Kaffa sprite (*Pseudagrion kaffinum*) are flagship species.

4.1.7 Herpetofauna (Amphibia, Reptilia)

Tom Kirschey

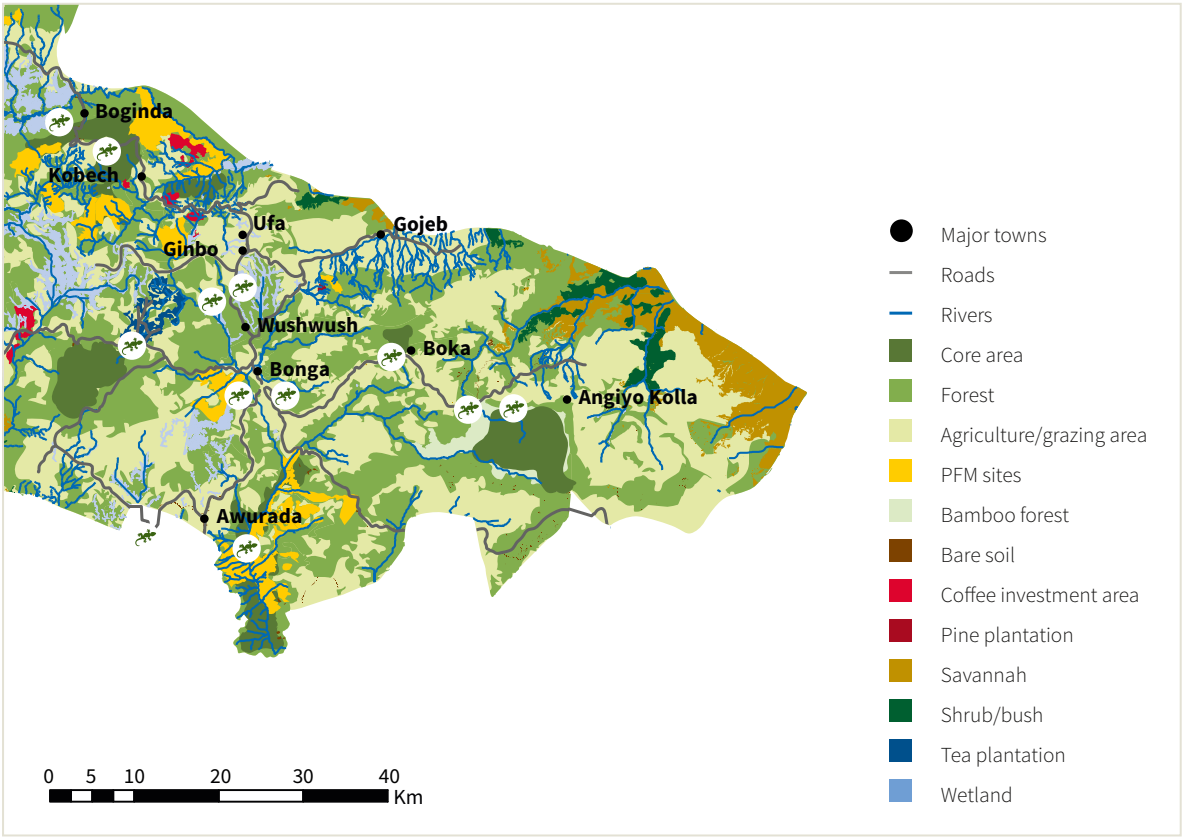

Figure 43: Sites sampled by the herpetofauna team at the Kafa Biosphere Reserve

Highlights

- A total of 17 amphibian species from four families were recorded (Table 2).
- A total of five squamate reptile species (two Sauria, three Serpentes) from four families were recorded (Table 3).
- One species of Hyperoliidae (genus *Leptopelis*) is probably new to science.
- Eight species of amphibians and two species of reptiles were recorded the first time for the Kafa BR (Amphibia: *Leptopelis ragazzii*, *Leptopelis* sp., *Hyperolius kivuensis*, *Phrynobatrachus inexpectatus*, *Ptychadena schillukorum*, *P. erlangeri*, *P. mascareniensis*, *Xenopus clivii*, Reptilia: *Trachylepis wingatii*, *Megatyphlops brevis*).
- Six (perhaps seven) of the recorded amphibian species are endemic to the Ethiopian Highlands (*Leptopelis ragazzii*, *L. vannutellii*, *L.* spec., *Afrixalus clarkeorum*, *A. enseticola*, *Phrynobatrachus inexpectatus*, *Ptychadena erlangeri*).
- One of the recorded reptile species is endemic to the southwestern Ethiopian Highlands (*Pseudoboodon boehmei*).
- Three species are threatened according to the updated global IUCN Red List of Threatened Species (two 'vulnerable', one 'endangered': *Leptopelis ragazzii*, *Afrixalus clarkeorum*, A. *enseticola*). All three are endemic to Ethiopia. Another species (*Leptopelis vannutellii*) was previously listed as 'vulnerable', but has been redesignated as 'least concern'.
- Beccari's giant frog (*Conraua beccarii*), Largen's dwarf puddle frog (*Phrynobatrachus inexpectatus*) and Clarke's banana frog (*Afrixalus clarkeorum*) are flagship species for amphibians.
- This report includes the first picture of the tadpole mouthpart of the previously undescribed and highly rheophile Beccari's giant frog (*Conraua beccarii*).
- Wetland sites, particularly inside or near the natural forest, show the highest level of diversity. The lowest diversity is found in the bamboo forest.
- Arboreal and running water habitats require more research.
- Endemic species are exclusively bound to forest habitats (canopy).

4.1.8 Bats and fruit bats

Ingrid Kaipf, Hartmut Rudolphi and Holger Meinig

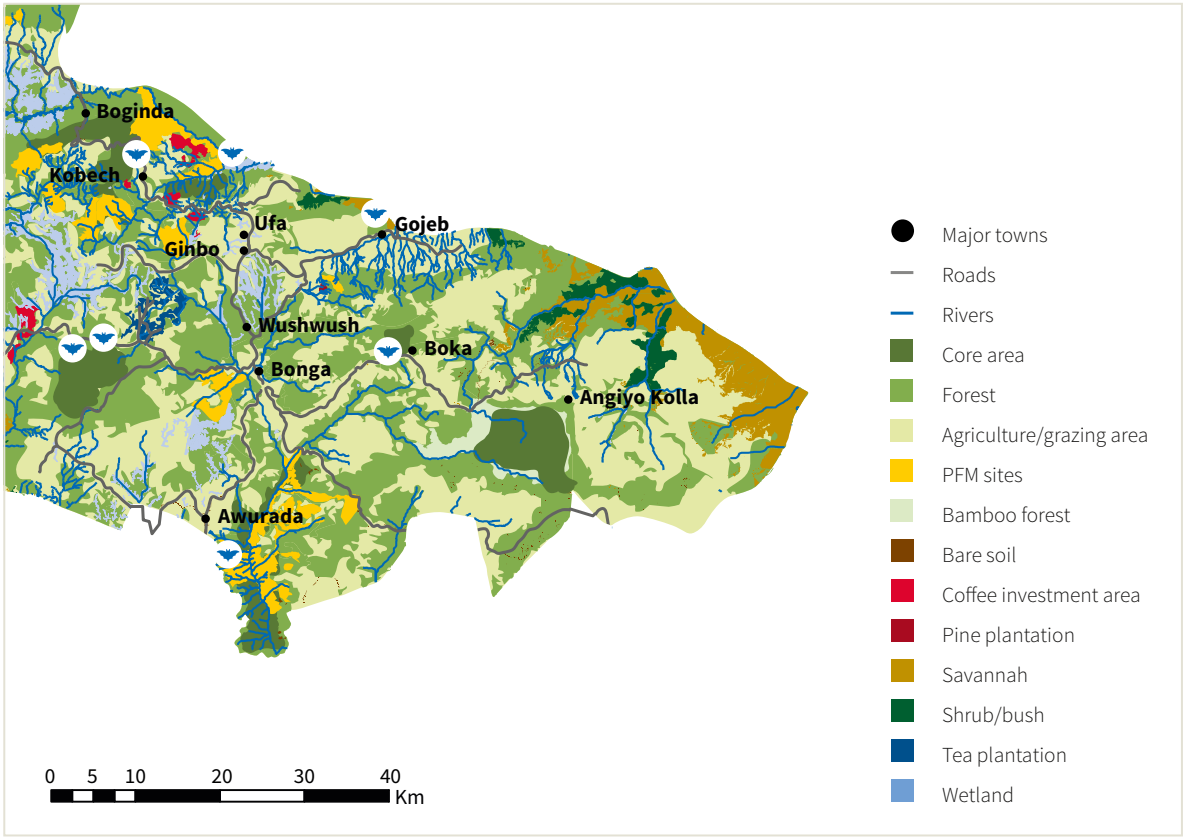

Figure 44: Sites sampled by the bat team at Kafa Biosphere Reserve

Highlights

- This is the first time a systematic bat assessment has been conducted in the Kafa BR.
- We recorded four fruit bat species, one of which is new for the Kafa BR but not for Ethiopia.
- We recorded 29 bat species by capture or sound recording. Four bat species are new for the Kafa BR but occur in other parts of Ethiopia.
- We recorded calls of a new species in the horseshoe bat family for Ethiopia via echolocation. This data needs to be confirmed by capture, because there is a chance it could be a species of *Rhinolophus* new to science.
- We suggest two flagship species: the long-haired rousette for the bamboo forest and the hammer-headed fruit bat for the Alemgono Wetland and Gummi River.
- The bamboo forests had the most bat activity at night, but the Gojeb Wetland had the highest species richness due to its highly diverse habitats.
- All caves throughout the entire Kafa BR should be protected as bat roosts.
- It will be necessary to develop an old tree management concept for the biosphere reserve to protect and increase tree roosts for bats.

4.1.9 Birds

Wolfgang Beisenherz, Bernhard Walter, Torsten Ryslavy and Yillma Dellelegn Abebe

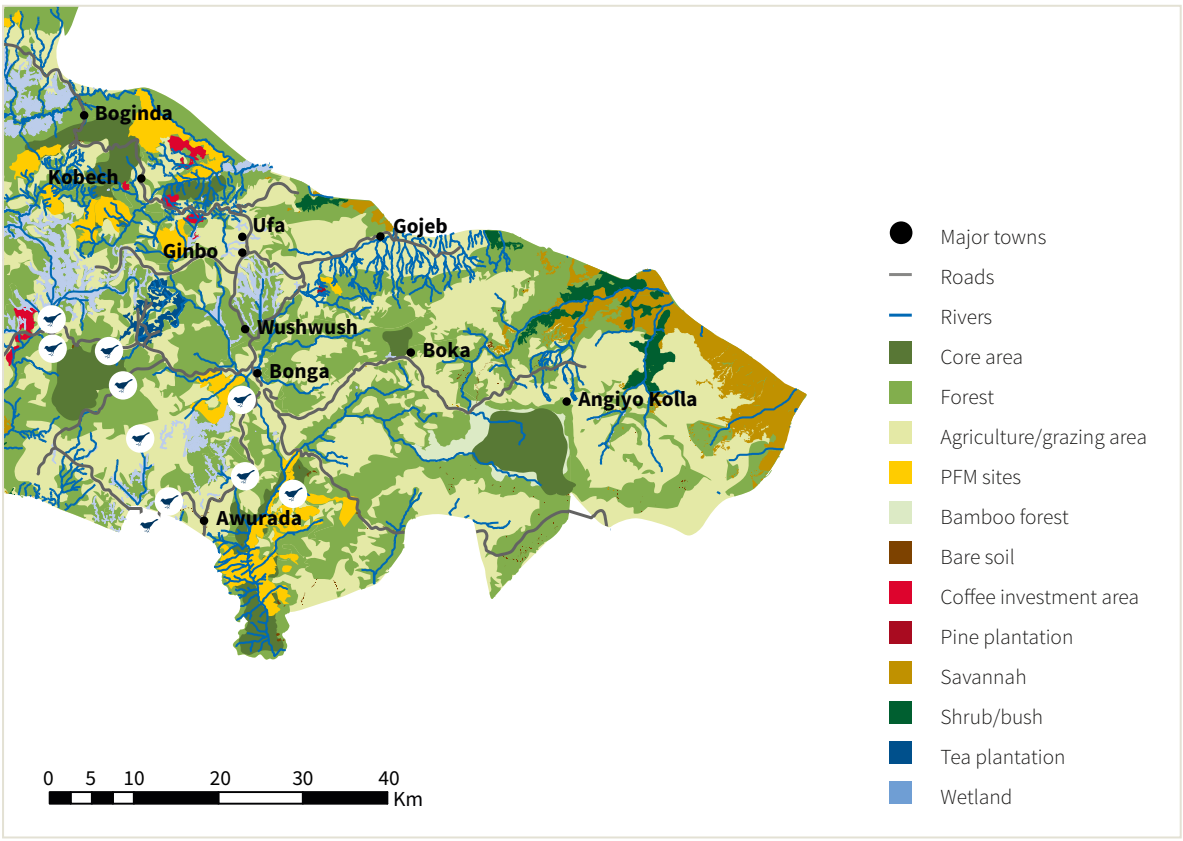

Figure 45: Sites sampled by the bird team at the Kafa Biosphere Reserve

Highlights

- 178 bird species were recorded.
- 25 species are restricted to the Afrotropical Highland biome.
- Two species are restricted to the Somali-Masai biome.
- Three species are endemic (Abyssinian Longclaw (*Macronyx flavicollis*), Abyssinian Catbird (*Parophasma galinieri*) and Yellow-fronted Parrot (*Poicephalus flavifrons*)).
- Seven species are near-endemic (Wattled Ibis (*Bostrychia carunculata*), Rouget's Rail (*Rougetius rougetii*), Black-winged Lovebird (*Agapornis taranta*), White-cheeked Turaco (*Tauraco leucotis*), Banded Barbet (*Lybius undatus*), Abyssinian Slaty Flycatcher (*Melaenornis chocolatinus*) and Thick-billed Raven (*Corvus crassirostris*). Thus, the Kafa BR is characterized by a high avian endemism.
- Eight species are endangered or threatened.
- A successful brood of the endangered Wattled Crane was found in Alemgono Wetland.
- Different broadleaf forests seem to exhibit similar diversity of bird species.
- The bamboo forests seem to be home to few bird species. There are no bird species specifically adapted to this habitat.
- The African Crowned Eagle (*Stephanoaetus coronatus*), Wattled Crane (*Bugeranus carunculatus*) and Black Crowned Crane (*Balearica pavonina*) can be considered flagship species.
- The African Crowned Eagle, White-cheeked Turaco and Sharpe's Starling (*Pholia sharpii*) could be good indicators of forest conservation status. The Black Crowned Crane, Abyssinian Longclaw and Rouget's Rail could prove good indicator species for wetland conservation status. Finally, the Finfoot (*Podica senegalensis*) and Half-collared Kingfisher (*Alcedo semitorquata*) could prove good indicator species for river conservation status. These species should be monitored regularly.

4.1.10 Primates

Andrea Schell & Karina Schell

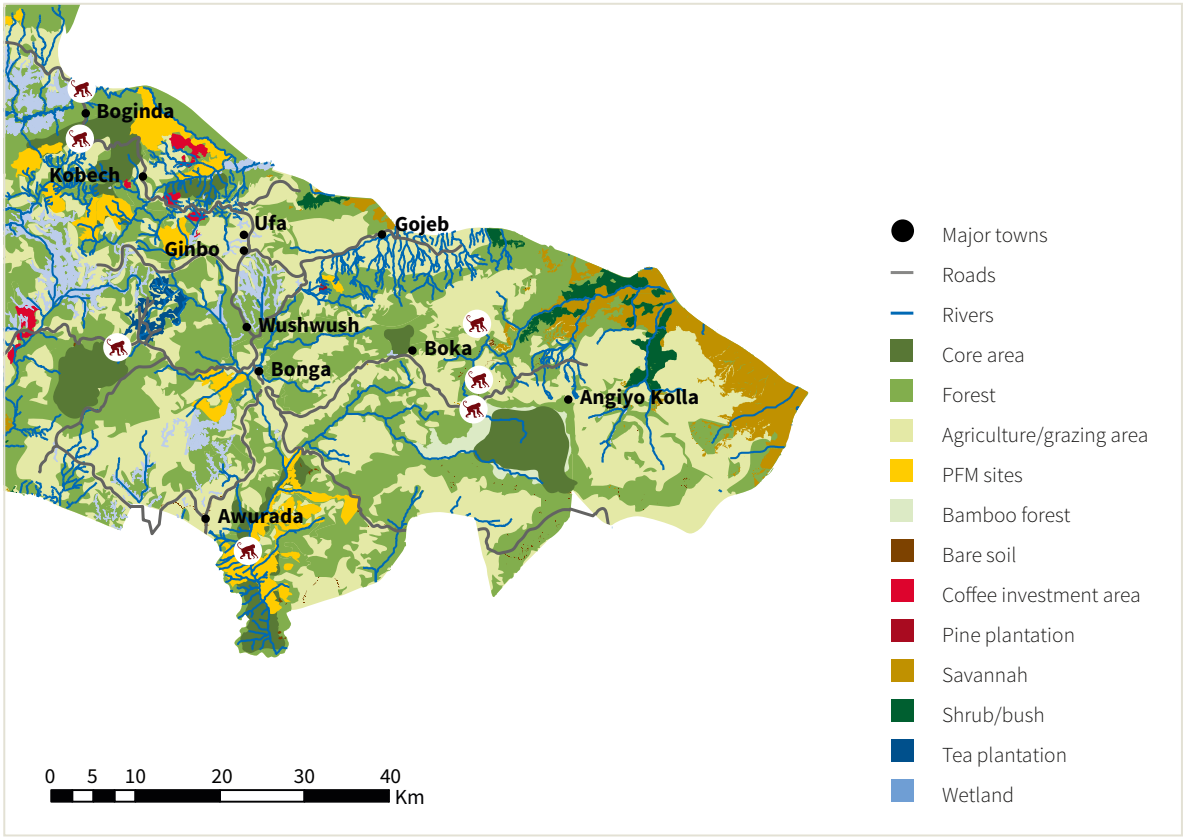

Figure 46: Sites sampled by the primates team at the Kafa Biosphere Reserve

Highlights

- This is the first broad assessment to determine the primate species composition of the Kafa Biosphere Reserve (BR). It was conducted in a diverse set of habitats such as bamboo and montane forests or wetlands covering an altitudinal gradient from 1400 to 2700 m a.s.l.

- The Kafa BR is possibly home to six primate species of five different genera. We recorded all of them:
  - Olive baboon (*Papio anubis*),
  - *Guereza* (*Colobus guereza* ssp. *guereza*),
  - Grivet (*Chlorocebus aethiops* ssp. *aethiops*),
  - Ethiopia lesser galago (*Galago senegalensis* ssp. *dunni*),
  - De Brazza's monkey (*Cercopithecus neglectus*),
  - Boutourlini's blue monkey (*Cercopithecus mitis* ssp. *boutourlinii*).

- We can confirm the presence of one vulnerable primate species endemic to the western side of the Ethiopian Rift Valley: Boutourlini's blue monkey (*Cercopithecus mitis boutourlinii*).

- Boutourlini's blue monkey, just like De Brazza's monkey, is a forest-dwelling monkey that avoids colonising disturbed forest patches. These two primate species will profit hugely from the BR and the permanent establishment of extended core areas and buffer zones.

- We present the first proof of the presence of the Ethiopia lesser galago (*Galago senegalensis* ssp. *dunni*) at the Kafa BR. We also provide the first loud-call recording of this species, crucial for subspecies determination.

- We support the current choice of the *guereza* as the flagship species for the Kafa BR, as it is very common, easy to recognize and widely appreciated.

- All primate species mentioned in this report are known to be strongly affected by habitat integrity and even moderate agriculture and/or forestry. We therefore strongly recommend using the following primate species as indicators for the intactness and diversity of a habitat, and to ensure environmentally sound agricultural and/or forest management:

  - Intact and diverse forest ecosystem: Boutourlini's blue monkey, De Brazza's monkey, Ethiopian lesser galago,

  - Environmentally sound (forest) farming: *guereza*, Ethiopian lesser galago.

- Olive baboons and grivets are usually seen as crop raiders, often causing conflicts with small-scale farmers. This bad reputation is confirmed by a variety of locals of the Kafa BR, thus showing the potential for participatory learning and action (PLA)-based workshops on human-wildlife conflict management. Activities should be directed towards farmers who rely on plant cultivation.
- We found olive baboons, *guerezas* and grivets across a broader altitudinal range than Boutourlini's blue monkeys, Ethiopia lesser galagos and De Brazza's monkeys.

4.1.11 Small- and medium-sized mammals (Soricomorpha, Lagomorpha, Rodentia, Procavidae)

Holger Meinig, Meheretu Yonas and Nicole Hermes

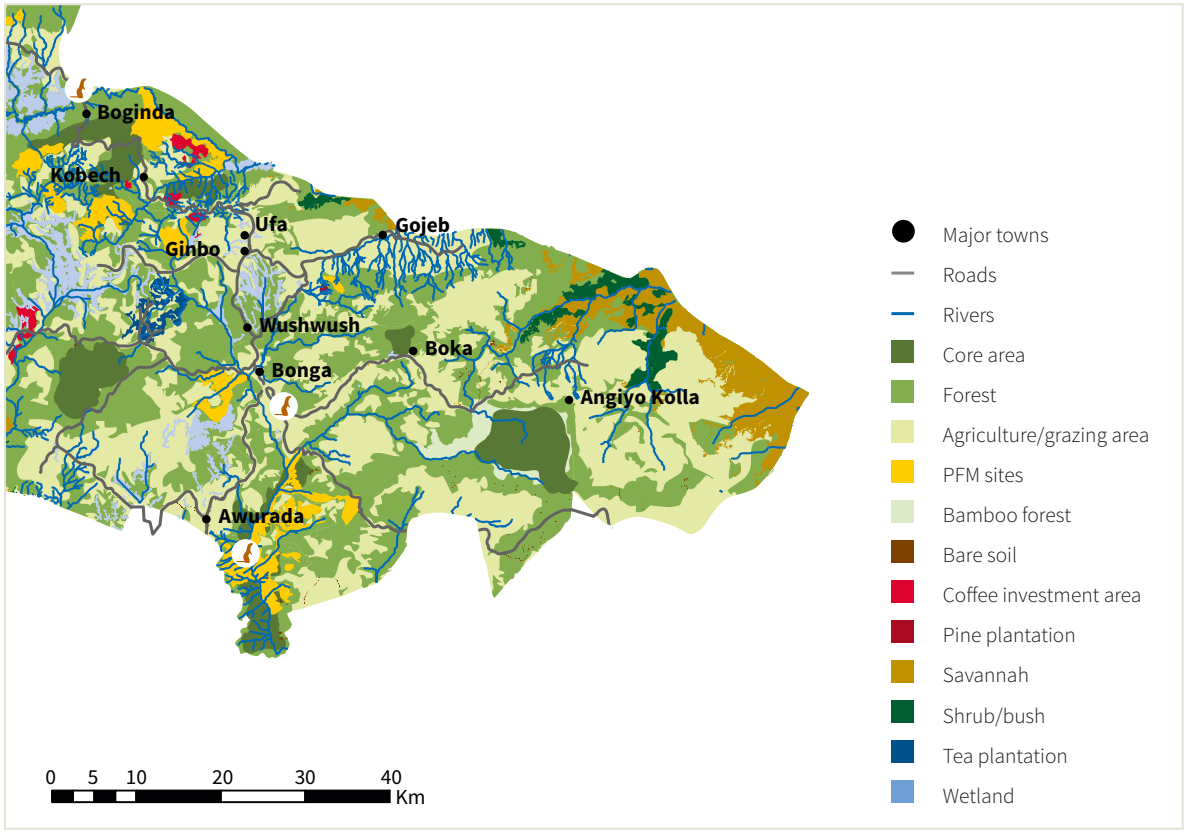

Figure 47: Sites sampled by the mammal (small- and medium-sized mammals) team at the Kafa Biosphere Reserve

Highlights

- The African pigmy mouse (Mus (*Nannomys*) mahomet), the Ethiopian hare (*Lepus* cf. *fagani*) and the Ethiopian meadow rat (*Stenocephalemys albipes*) are endemic to Ethiopia (the latter also occurs in neighbouring Eritrea).
- The forms of the East African mole-rat (*Tachyoryctes splendens* s.l.), brush-furred mouse (*Lophuromys flavopunctatus* s.l.), African marsh rat (*Dasymys* cf. *incomtus*) and Ethiopian vlei rat (*Otomys* cf. *typus*) encountered in this study could be endemic to Ethiopia, but this needs to be corroborated by genetic studies.
- The observed form of the Gambian sun squirrel (*Heliosciurus gambianus* ssp. (cf. *kaffensis*)) could also be an endemic subspecies or even entire species.
- The current study does not provide sufficient data to determine whether certain species are threatened or not.
- The wetlands surrounding the Gojeb River and adjacent habitats seem to be more species diverse than the other plots studied.
- The African clawless otter (*Aonyx capensis*) should be considered a flagship species. The species could be a good indicator for the status of river conservation and other natural/semi-natural waterbodies.
- Small mammals are sensitive to overgrazing and pollution from insecticides and herbicides as well

as to intensification of agriculture in general. Regulations concerning future human land use should be implemented and controlled in order to protect their natural environment.

- Sewers should be constructed and maintained, particularly for villages in the wetlands and near streams, to prevent habitats from pollution from different sources.

4.1.12 Medium (esp. Carnivora and Artiodactyla) and large mammals

Hans Bauer

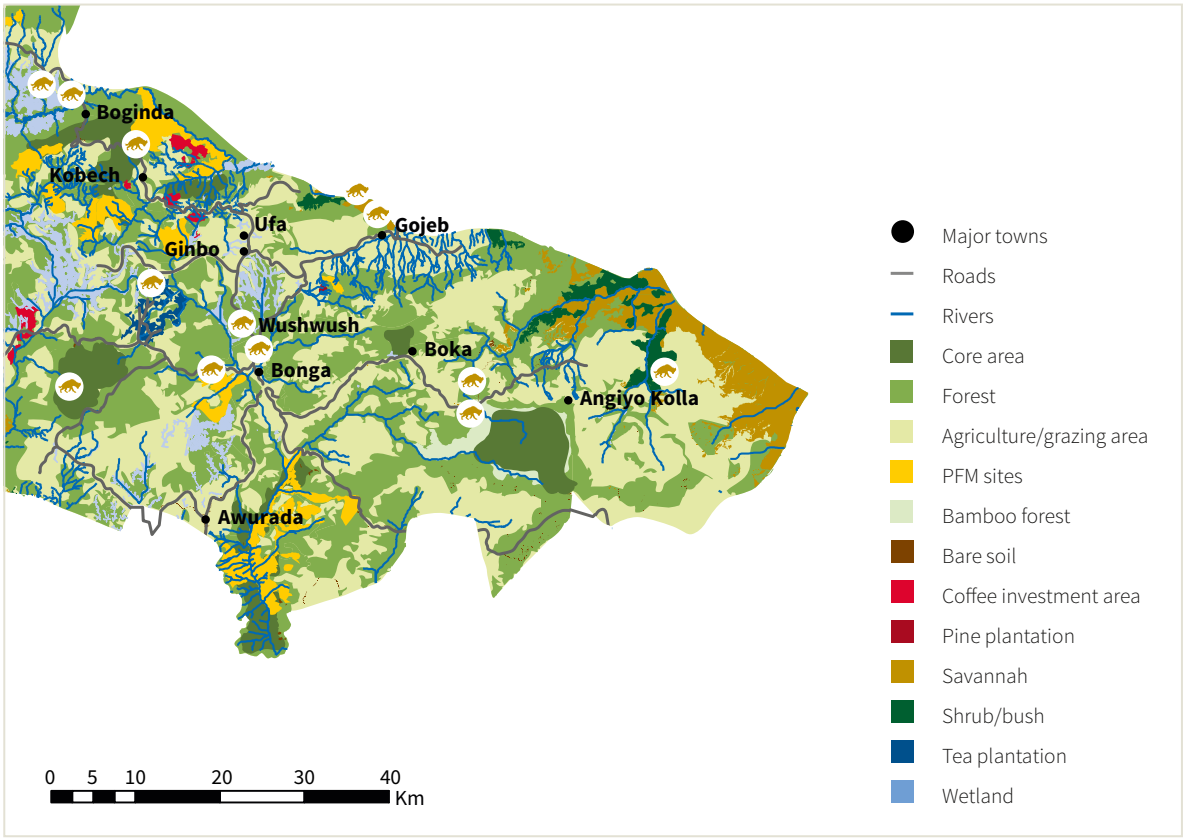

Figure 48: Sites sampled by the mammal (medium and large mammals) team at the Kafa Biosphere Reserve

Highlights

- 25 species were recorded.
- The presence of the endangered wild dog (*Lycaon pictus*) could not be confirmed; it is possible the species is locally extinct.
- The presence of lion (*Panthera leo*) was confirmed; this is the flagship species.
- Larger mammals are not useful as indicators of forest conservation status due to their very low densities.
- Camera trapping returned very low capture rates, indicating abnormally low mammal density. This should be confirmed and investigated.
- An additional survey six months later and on behalf of NABU revealed additional mammal species i.e. the leopard (*Panthera pardus*).

4.2 Results for indicator and flagship species

This section summarises the main results for indicator and flagship species and the threat analysis conducted for each species. In total, 29 indicator species and 18 flagship species have been identified and had their primary threats assessed based on expert knowledge. To facilitate a spatial interpretation of the results, the indicator species have been separated into three major habitat types: forest, wetlands and river areas. Many indicator species occur in more than one habitat type. 13 indicator species are also proposed as flagship species (see Tables 5 and 6).

4.2.1 Selection of indicator species

16 species have been selected for forested areas of the Kafa BR (montane, bamboo and floodplain forests): five tree species, four insect species, three bird species, two bat species and two fungus species.

The tree fern (*Cyathea manniana*), a giant fern forming very conspicuous patches in the dense forests, exclusively occurs in the montane forests, which qualifies it as an indicator species for this habitat. Similarly, the wild date palm (*Phoenix reclinata*) and the dragon tree (*Dracaena afromontana*) occur in the depressions (mostly) bordering waterbodies in dense montane and hilly dense forests, respectively. The endemic species *Pavetta abyssinica* is characteristic to the floodplain forests.

The four selected insect species belong to the Odonata group (dragonflies). All of them are endemic to the Ethiopian highlands. They are mostly present along freshwater bodies such as streams and small creeks in the montane forests. Ethiopia's endemic dragonflies are relatively tolerant to habitat disturbances, but they will nonetheless disappear if the damage to their habitats due to water pollution, water extraction and large-scale reforestation with eucalyptus continues. Thus, the montane forest gomphids Cottarelli's Longlegs (*Notogomphus cottarellii*) and Rüppell's longlegs (*Notogomphus ruppeli*) are particularly mentioned to be good indicators for the conservation status of the forests.

Of the nine selected bird species, three have been selected as indicators for the forest areas: the African crowned eagle (*Stephanoaetus coronatus*), which occurs along floodplains and in the montane forests, the white-cheeked turaco (*Tauraco leucotis*) and Sharpe's starling (*Pholia sharpii*). At present, these species are common and not threatened in Ethiopia, but they strongly depend on the existence of intact (montane) forests. The white-cheeked turaco is near endemic, Sharpe's starling is restricted to the canopy of high montane forests and thus not common throughout Africa. A decline in these currently common species would indicate a threat to their habitat.

Two bat and fungi species have been selected as indicators for forest areas. Of particular interest is the fruit bat *Rousettus lanosus* (long-haired rousette), which mostly occurs in the bamboo montane forests and in border zones. This species is very rare in lowlands and is restricted to East Africa, with only few records and observations in Ethiopia's neighbouring countries. The hammer-headed fruit bat (*Hypsignathus monstrosus*) is the largest African fruit bat, common in Central and West Africa, but rare in Ethiopia. It occurs along riversides or floodplain forests and is less present in montane forests.

Table 5: List of indicator species

Habitat type	Taxon	Scientific name	English name	Order
Wetland	Insect	*Altica* sp.	Not known	Coleoptera
River	Insect	*Pseudagrion guichardi*	Ethiopian sprite	Odonata
Wetland/river	Insect	*Orthetrum kristenseni*	Ethiopian skimmer	Odonata
River	Insect	*Notogomphus ruppeli*	Rüppel's longlegs	Odonata
River	Insect	*Atoconeura aethiopica*	Ethiopian Highlander	Odonata
River	Insect	*Notogomphus cottarellii*	Cottarelli's longlegs	Odonata
Montane forest	Fungi	*Sarcoscypha* spec. nov.	Red cup fungus	No Known
Bamboo				
forest	Fungi	*Cerinomyces bambusicola* spec. nov. ined.	Not known	Dacrymycetales
Wetland/flood-plain forests	Bat	*Hypsignathus monstrosus*	Hammer-headed fruit bat	Hypsignathus

Habitat type	Taxon	Scientific name	English name	Order
Bamboo forests and border zones	Bat	*Rousettus lanosus*	Long-haired rousette	Rousettus
Wetland	Bird	*Bugeranus carunculatus*	Wattled crane	Gruiformes
Wetland	Bird	*Balearica pavonia*	Black crowned crane	Gruiformes
Wetland	Bird	*Rougetius rougetii*	Rouget's rail	Gruiformes
Wetland	Bird	*Macronyx flavicollis*	Abyssinian longclaw	Passeriformes
River	Bird	*Alcedo torquata*	Half-collared kingfisher	Coraciiformes
River	Bird	*Podica senegalensis*	African finfoot	Gruiformes
Montane forest	Bird	*Stephanoaetus coronatus*	African crowned eagle	Falconiformes
Montane forest	Bird	*Tauraco leucotis*	White-cheeked turaco	Cuculiformes
Montane forest	Bird	*Pholia sharpii*	Sharpe's starling	Passeriformes
River	Molluscs	*Mutela rostrata*	Not known	Unionoida
Montane forest	Plant	*Cyathea manniana*	Giant tree fern	Cyatheales
Floodplain forest	Plant	*Pavetta abyssinica*	Not known	Gentianales
Montane forest	Plant	*Phoenix reclinata*	Wild date palm	Arecales
Montane forest	Plant	*Dracaena afromontana*	Dragon tree	Liliales
Forest	Plant	*Hippocratea africana*	Giant liana	Celastrales
Wetland/river/ forest	Amphibia	*Afrixalus clarkeorum*	Clarke's banana frog	Anura
River/forest	Amphibia	*Leptopelis vannutellii*	Dime forest tree frog	Anura
Wetland/river/ forest	Amphibia	*Leptopelis ragazzii*	Shoa forest tree frog	Anura
Montane forest	Primates	*Colobus guereza* ssp. *guereza*	Mantled guereza	Primates

The proposed fungi species are new records to science. *Cerinomyces bambusicola* spec. nov. ined is a saprophytic resupinate phleboid fungus which attaches to wood and grows in clumps. This fungus species is restricted to East African montane forests. According to available information, it only occurs in bamboo forests. The chosen species is *Sarcoscypha* spec. nov., which is a conspicuous red cup fungus which grows saprotrophically, mostly on fallen twigs of broad-leaved trees. It mostly occurs in montane forests and/or adjacent close forest habitats such as the PFM sites.

For the wetlands and river areas, six bird species were proposed as indicators. For the wetlands, the team selected the wattled crane (*Bugeranus carunculatus*), the black crowned crane (*Balearica pavonia*), Rouget's rail (*Rougetius rougetii*) and the Abyssinian longclaw (*Macronyx flavicollis*). For river areas, the team selected the half-collared kingfisher (*Alcedo torquata*) and the African finfoot (*Podica senegalensis*). All six species exclusively occur along wetlands, floodplains and riverine areas, and most are large and easy to recognise in the field.

Three frog species were chosen as indicators for wetlands, river and forests areas. The Shoa forest tree frog (*Leptopelis ragazzii*) is a relatively large tree frog endemic to montane areas of Ethiopia and lives in wetlands, river and forested areas influenced by waterbodies. The Dime forest tree frog (*Leptopelis vannutellii*) mostly occurs on trees along floodplain forests and/or forested areas near waterbodies. This large tree frog is endemic to the Ethiopian Highlands. It needs clear forest streams, but is less sensitive than *L. ragazzii* to slight habitat disturbances. Clarke's banana frog (*Afrixalus clarkeorum*) lives in different habitats, including floodplain forests, river areas and wetlands, but it is also present in human induced habitats such as crop fields and PFM sites. The aquatic (larvae) and terrestrial (adult) lifeforms can be detected in the axillae of false banana trees. However, the species is restricted to the Ethiopian Highlands.

The mollusc *Mutela rostrata* has been selected as an indicator for river areas. This species is a pan-African, sediment-dwelling, filter-feeding freshwater mussel will a shell up to 100 mm in size. Its larvae (Glochidia) parasitises on the gills of freshwater fish (exact species unknown). In Ethiopia, it has only been recorded in the lower Omo river basin.

4.2.2 Selection of flagship species

In addition to the mantled *guereza* (*Colobus guereza* ssp. *guereza*) and the coffee tree (*Coffea arabica*), which are already used as flagship species, 15 additional flagship species were identified for the Kafa BR (Table 6). They include four insect species (Odonata group), four bird species, three frog species, two mammal species (including primates) and two tree species.

For the dragonflies (Odonata), the Ethiopian Highlander (*Atoconeura aethiopica*), Ethiopian sprite (*Pseudagrion guichardi*), the Kaffa sprite (*Pseudagrion kaffinum*) and the Ethiopian skimmer (*Orthetrum kristenseni*) were chosen as flagship species. All of them mostly occur along wetlands, riverine areas and floodplain forests and to a lesser extent in adjacent areas such as PFM sites or secondary forests.

The Wattled Crane (*Bugeranus carunculatus*) and the Black Crowned Crane (*Balearica pavonia*) are bird flagship species for the wetlands. Both are characteristic of wetlands, large, attractive and easy to recognise. Wattled cranes are particularly rare in Ethiopia, with no contact to other populations of the species in Southern Africa. The African Crowned Eagle (*Stephanoaetus coronatus*) is a conspicuous bird species mostly present in forested montane areas. It is not restricted to Ethiopia, but also occurs in other Afromontane areas. The species can easily be distinguished by its call and observed when flying over forests.

The three chosen frog species are the Shoa forest tree frog (*Leptopelis ragazzii*), the Dime forest tree frog (*Leptopelis vannutellii*) and Clarke's banana frog (*Afrixalus clarkeorum*). They occur in wetlands, along rivers and in forest areas and are endemic to the Ethiopian Highlands.

For mammals, the African clawless otter (*Aonyx capensis*) was chosen as a flagship species. Due to their attractive appearance, otters are very popular in Europe and the United States and serve as an attraction to visitors in wetland and river areas. Otters were regularly observed in the Gojeb River. They are sensitive to water pollution and the destruction of dense vegetation structures on the banks of rivers and ponds, so they could potentially be good indicators of environmental status.

Table 6: List of flagship species

Habitat type	Taxon	Scientific name	English name	Order
Wetland/river	Insect	*Pseudagrion kaffinum*	Kaffa sprite	Odonata
Wetland/river	Insect	*Orthetrum kristenseni*	Ethiopian skimmer	Odonata
River	Insect	*Pseudagrion guichardi*	Ethiopian sprite	Odonata
River	Insect	*Atoconeura aethiopica*	Ethiopian highlander	Odonata
Wetland	Bird	*Bugeranus carunculatus*	Wattled crane	Gruiformes
Wetland	Bird	*Balearica pavonina*	Black crowned crane	Gruiformes
Montane forests	Bird	*Stephanoaetus coronatus*	African crowned eagle	Falconiformes
Montane forests	Bird	*Tauraco leucotis*	White-cheeked turaco	Cuculiformes
Montane forests	Mammal	*Panthera leo*	Montane forest lion	Mammalia
River	Mammal	*Aonyx capensis*	African clawless otter	Mammalia
Montane forest	Plant	*Phoenix reclinata*	Wild date palm	Arecales
Montane forest	Plant	*Dracaena afromontana*	Dragon tree	Liliales
Montane forest	Plant	*Coffea arabica*	Wild coffee	Rubiaceae
Wetland/river/forest	Amphibia	*Afrixalus clarkeorum*	Clarke's banana frog	Anura
River/forest	Amphibia	*Leptopelis vannutellii*	Dime forest tree frog	Anura
Wetland/river/forest	Amphibia	*Leptopelis ragazzii*	Shoa forest tree frog	Anura
Montane forests	Primates	*Colobus guereza* ssp. *guereza*	Mantled guereza	Mammalia

The observations and recordings during the assessment confirmed the presence of lions (*Panthera leo*). The mammal experts recorded new evidence such as footprints in areas previously not known for lion appearances, thus helping to understand its distribution in the area. Future ecological and molecular studies may determine whether this lion is the same as the savannah lion. In any case, having the lion as a flagship species for dense montane forests is a particular highlight for Kafa, and deserves special attention.

The two tree species selected as flagships only occur in montane dense forests. The wild date palm (*Phoenix reclinata*) is an elegant and unique palm which forms several patches in dense forests. It is widely domesticated, but its growth behaviour and presence in nature exhibit a slightly different form, one which is very attractive to visitors. Due to its unique physiognomy and spectacular shape, the Afromontane dragon tree (*Dracaena afromontana*) is also an ideal flagship species which can be easily observed in the montane forests.

5. Conclusions on future Biodiversity Monitoring and Conservation Measures

The biodiversity assessment presented in this report lays the foundation for effective biodiversity monitoring in the Kafa BR. The selection of 29 indicator species and 17 flagship species will facilitate targeted analysis of major anthropogenic threats to species and their habitats. Once the key drivers of habitat destruction and species deterioration in the Kafa BR are known, conservation measures can be (re-)directed to protect the biodiversity of Kafa BR more efficiently. This chapter outlines preliminary recommendations for the design of the biodiversity monitoring and provides suggestions for practical conservation actions.

5.1 Monitoring indicator species

Monitoring should provide information on the abundance of each of the indicator species as listed in 4.2.2 within the Kafa BR. Different methods need to be applied to different groups of species.

For the plant species (mainly *Cyathea manniana*, *Pavetta abyssinica*, *Phoenix reclinata Dracaena afromontana*, *Hippocratea africana*), monitoring can rely on observations by local community members and rangers in the BR, since all species are well known and easy to identify (see e.g., Danielsen et al. 2000). We suggest developing monitoring questionnaires for regular interviews (e.g., twice a year). The questionnaires should be filled out by rangers and used for interviews with locals who regularly access the relevant areas. For each species, changes in their abundance and the presumed reasons for this change should be investigated. Similar methods could be applied to mammal and bird indicator species that are locally well known. Seasonal variations in species visibility need to be taken considered, e.g., for acoustic monitoring of bird species.
Insects, amphibians and fungi can probably only be monitored when relevant experts visit the BR for a general monitoring e.g., every two years. It will be challenging to obtain robust data on abundance over time by direct monitoring.

5.2 Site monitoring

Monitoring can also be carried out through regular site visits and assessments by the BR rangers, particularly at sites which were part of this biodiversity assessment. Rangers should use the same site reporting forms that were designed for this assessment to ensure comparability with earlier visits. Additional sites may be identified and involved in the comparative assessment over longer periods. Site monitoring focuses on a broader range of species and threats and may therefore deliver more integrated information, complementing the information collected in the assessment thus far.

5.3 Identifying and monitoring major threats

Participants in this assessment discussed the major threats facing the Kafa BR, especially to indicator species and their habitats. Combined with existing knowledge and information on threats, some preliminary indications on threats can now be presented here. For forest species, the most obvious threats are deforestation, habitat fragmentation and forest/habitat degradation. Deforestation and habitat fragmentation are often monitored via remote sensing techniques. Rough information on canopy changes may also be obtained from, e.g., Global Forest Watch (GFW); however, for accurate monitoring internal analyses based on satellite imagery might be necessary. Degradation is more difficult to monitor. Remote sensing is generally unable to deliver the required data accuracy for the canopy. It may, however, be helpful for detecting small paths that are established for hunting or selective logging. One alternative to remote sensing is to develop a system based on the causes of degradation, such as fire, use of timber/fuelwood or coffee planting in natural forests. At Kafa BR a motioning has been developed by NABU's subcontractor, the Wageningen University. In addition to assessing reference emissions levels and estimating project impact on CO2 emissions, this monitoring also featured innovative ground-based monitoring with smartphones, where activity data continuously collected by the BR rangers were fed into an integrated monitoring system with WebGIS .

For wetlands and river species, the main threats are drainage activities, agricultural run-off and fertiliser, along with domestic and urban waste. Direct monitoring of these threats could entail regular measuring of

water levels in wetlands/rivers and chemical analyses of water quality at critical sites. Such analyses may be part of the site monitoring (see above). Critical sites can be identified through interviews with locals conducted by rangers, asking about, e.g., patterns in fertiliser use. Other activities which potentially threaten specific species such as harvesting fuelwood or hunting should be included in regular monitoring efforts. A general analysis of the most pressing demands on natural resources such as timber extraction of slash and burn agriculture could also be useful. On behalf of NABU, geoSYS conducted the mapping and analysis of wetlands and rivers at Kafa BR. The pilot wetlands Gojeb and Alemgono were thoroughly studied according to their ecological status, threats and needs for conservation (see Dresen et al. 2015). Therefore, the results of this study should be taken into account for the future monitoring of the wetlands at Kafa BR.

5.4 Conservation measures

Basic protection of habitats is already established in the Kafa BR through the definition of zones with different restrictions and associated control mechanisms such as patrolling, etc. However, these measures are not necessarily effective, particularly outside the core zone. Conservation can therefore also be achieved by directly tackling critical threats and, more specifically, the uses of natural resources that are related to these threats. Deforestation and fragmentation may be reduced by restricting the expansion of agriculture in forested areas and, at the same time, increasing the sustainability of existing agricultural land use, for example by promoting agroforestry, with coffee as the primary product. Improving cultivation techniques for annual crops such as corn may also help reduce the need for further expansion.

Degradation is mainly caused by the extraction of fuelwood and timber. Efficient cooking stoves such as Mirt stoves which have been tested and introduced to selected households by NABU help reduce the demand for fuelwood. Further promotion of PFM sites and related capacity building provides a sustainable supply of both timber and fuelwood. Raising awareness about possible alternative tree species for fuelwood and timber could also reduce the pressure on primary forests. Water-related threats may be targeted by providing technical support for irrigation systems, wastewater treatment and fertiliser management.

To be successful, all these measures need to be planned and implemented by the local communities. Therefore, a common understanding and agreement about the major threats to biodiversity among the inhabitants is crucial. This can be achieved via participatory appraisals for joint planning of conservation and sustainable livelihoods as conducted by NABU for BR planning purpose, PFM planning or the community-based watershed management programme.

Moreover, awareness creation amongst the local community members on threatened fauna and flora is crucial for an effective monitoring. NABU has implemented a number of community awareness creation programmes in the past in Kafa BR which may be taken as a reference.

6. References

Aerts R, Hundera K, Berecha G, Gijbels P, Baeten M, Van Mechelen M, Hermy M, Muys B, Honnay O (2011). Semi-forest coffee cultivation and the conservation of Ethiopian Afromontane rainforest fragments. For. Ecol. Manage. 261, 1034–1041. doi:10.1016/j.foreco.2010.12.025.

Bekele T (2003). The potential of Bonga forest for certification: A Case Study. National Stakeholders Workshop on Forest Certification: Organized by Institute of Biodiversity Conservation and Research (IBCR), FARM Africa and SOS Sahel.

Bender-Kaphengst S (2011). Saving the Wild Coffee Forests: Joint Forces for Kafa Biosphere Reserve in Ethiopia. In: Austrian MAB Committee (eds.), 2011. Biosphere Reserves in the mountains of the world. Excellence in the clouds? Austrian Academy of Sciences Press, Vienna.

Berkes F, Colding J, Folke C (2000). Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications 10, 1251–1262.

Bridgewater PB (2002). Biosphere reserves: special places for people and nature. Environmental Science & Policy 5, 9–12.

Chernet T (2008). Land Resources and socio-economic report of Bonga, Boginda, Mankira and the surrounding areas in Kafa Zone, SNNPRS, Ethiopia. Report for PPP project on the establishment of a Coffee Biosphere Reserve in Bonga Region. Addis Ababa, Ethiopia.

Danielsen F, Balete DS, Poulsen MK, Enghoff M, Nozawa CM, Jensen AE (2000). A simple system for monitoring biodiversity in protected areas of a developing country. Biodiversity and Conservation 9: 1671–1705.

Davis AP, Gole TW, Baena S, Moat J (2012). The impact of climate change on indigenous Arabica coffee (Coffea arabica): predicting future trends and identifying priorities. PLOS ONE 7: e47981.

Denich M, Schmitt CB (2006). Ecology and Development Series No. 47, 2006. ZEF.

Dennis Moss Partnership (2009). Application for nomination of Kafa Biosphere Reserve. On behalf of PPP project.

Dresen E (2011). Forest and Community Analysis. Final report. On behalf of NABU's project „Climate Protection and Preservation of Primary Forests – A Management Model using the Wild Coffee Forests in Ethiopia as an Example".

Dresen E (2014). Map "Habitat Types in Kafa Biodiversity Reserve" produced on behalf of NABU for NABU's biodiversity assessment.

Dresen E, Tegetmeyer C, Mundt F, Dresen M (2015). Final Report – Mapping and analysis of wetlands and rivers at Kafa Biosphere Reserve. Submitted to NABU.

Ethiopian Wildlife and Natural History Society (2008). Status and Distribution of Faunal Diversity in Kaffa Afromontane Coffee Forest. Ethiopian Wildlife & Natural, Fauna Survey submitted to PPP Consortium.

EthioWetlands and Natural Resources Association (2008). A Wetlands Strategy for Kafa Zone. South Nations, Nationalities and Peoples Regional State. Prepared for FAO – Kafa Sustainable Land Management Project (SLM), Bonga.

EWNHS (Ethiopian Wildlife and Natural History Society) (2008). Rapid Biodiversity Assessment in Kafa Zone: The case of Mankira, Saja and Boka Forest. Prepared for FAO – Kafa Sustainable Land Management Project (SLM), Addis Ababa.

Gamachu D (1977). Aspects of Climate and Water Budget in Ethiopia. Addis Ababa University Press, Addis Ababa, 71 pp.

Gobeze T, Bekele M, Lemenih M, Kassa H (2009). Participatory forest management and its impacts on livelihoods and forest status: the case of Bonga forest in 11, 346–358.

Groves CR (2003). Drafting a Conservation Blueprint. A Practitioner's Guide To Planning For Biodiversity. Washington DC: Island Press.

Hein L, Gatzweiler F (2006). The economic value of coffee (Coffea arabica) genetic resources, Ecological Economics 60, 176-185.

IBC (Institute of Biodiversity Conservation) (2005). National Biodiversity Strategy and Action Plan. Government of the Federal Democratic Republic of Ethiopia.

Landres PB, Verner J, Thomas JW (1988). Ecological Uses of Vertebrate Indicator Species: A Critique. Conservation Biology, 2(4), 316–328.

Lindemayer DB, Margules CR, Botkin DB (2000). Indicators of biodiversity for ecologically sustainable forest management. Conservation Biology, 14 (4), 941–950.

Million B, Leykun B (2001). State of Forest Genetic Resources in Ethiopia. Forest Genetic Resources Working Papers, Co-publication of FAO, IPGRI/ SAFORGEN, DFSC, ICRAF, Working Paper FGR/21E.

Mittermeier RA, Robles Gil P, Hoffman M, Pilgrim J, Brooks T, Goettsch Mittermeier C, Lamoreux J, da Fonseca GAB (2004). Hotspots revisited. CEMEX, Mexico City.

NABU (2014). Biodiversity under Climate Change: Community-Based Conservation, Management and Development Concepts for the Wild Coffee Forests. Project Proposal submitted to the International Climate Initiative of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

Nune S (2008). Flora Biodiversity Assessment in Bonga, Boginda and Mankira Forest, Kafa, Ethiopia. Ethiopian Wildlife and Natural History Society on behalf of PPP project.

Reusing M (1998). Monitoring of forest resources in Ethiopia. Government of the Federal Democratic Republic of Ethiopia, Ministry of Agriculture, Natural Resources Management & Regulatory Department & German Agency for Technical Cooperation (GTZ), Addis Ababa.

Schmitt CB, Senbeta F, Denich M, Preisinger H, Boehmer HJ (2009). Wild coffee management and plant diversity in the montane rainforest of southwestern Ethiopia 78–86.

SNNPR (2013). Southern Nations Nationalities and Peoples Regional State. Kafa Zone Finance and Economic department 2005 e.c. (2012) zonal statistical abstract, May, 2006 e.c. (2013).

Tadesse G, Zavaleta E, Shennan C (2014a). Coffee landscapes as refugia for native woody biodiversity as forest loss continues in southwest Ethiopia. Biol. Conserv. 169, 384–391.

Tadesse G, Zavaleta E, Shennan C, FitzSimmons M (2014b). Policy and demographic factors shape deforestation patterns and socio-ecological processes in southwest Ethiopian coffee agroecosystems. Applied Geography 54, 149–159.

Terborgh J (1986). Keystone plant resources in the tropical forests. Pages 330-344 in M. Soulé, editor. Conservation biology: the science of scarcity and diversity. Sinauer, Sunderland, Massachusetts, USA.

Thiollay JM (1992). Influence of selective logging on bird species diversity in a Guianan rain forest. Conserv. Biol. 6: 47–63.

UNESCO (1996a). Biosphere reserves: The Seville Strategy and the Statutory Framework of the World Network. UNESCO, Paris.

UNESCO (1996b). Statutory framework of the world network of biosphere reserves. UNESCO, Paris.

Urban NA, Swihart RK, Malloy MC, Dunning JB (2012). Improving selection of indicator species when detection is imperfect. Ecological Indicators, 15(1), 188–197.

Vivero JL, Kelbessa E, Demissew S (2005). The Red List of Endemic Trees & Shrubs of Ethiopia and Eritrea. Fauna & Flora International, Cambridge.

Wallner A, Bauer N, Hunziker M (2007). Perceptions and evaluations of biosphere reserves by local residents in Switzerland and Ukraine. Landsc. Urban Plan. 83, 104–114.

WBISPP (2004). Forest Resources of Ethiopia, Woody Biomass Inventory and Strategic Planning Project, MoARD, Addis Ababa in: Bongers, F. & Tennigkeit, T. (editors), 2010. Degraded forests in Eastern Africa: management and restoration.

Detailed reports