FEEDING PATTERN, COMMUNITY EDUCATION AND REHABILITATION OF CONSERVATION FACILITIES FOR FOREST ELEPHANTS IN OMO FOREST RESERVE, SOUTHWESTERN NIGERIA

BEING A DETAILED FINAL REPORT

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EXECUTIVE SUMMARY

The project expanded the study and conservation of forest elephants in southwestern Nigeria. The focus was to help establish foraging patterns, promote public understanding of the precarious situation of forest elephants and rehabilitate conservation facilities in the project site (Omo forest reserve) in order to enhance the various conservation works on the elephants.

The project involved a number of community-based conservation education/outreach programmes, which were aimed at generating and promoting environmental awareness as well as creating capacity at local level for responsible behaviour towards elephants and other wildlife species in the area. The outreach programmes were also designed to increase understanding of elephant conservation issues, exchange opinions and experiences, and establish a dialogue among sectors of the community.

Apart from the community-based conservation education, field data collection on elephant foraging activities were also carried out including laboratory analysis of elephant dungs for the determination of micro-plant fragment in elephant's diets.

The Nigerian Conservation Foundation (NCF) carried out the rehabilitation of conservation facilities at the elephant sanctuary in order to enhance research and ecotourism activities bordering on the forest elephants. This involved laying of wooden bridge and renovation of chalets, including repair of roof, wall, doors, and floor panels as well as provision of bed, mattresses and cooking utensils.

Elephants in Omo forest reserve feed on 43 species of plants belonging to 32 taxonomic families. Of these number, only four species were cultivated while three species were found in both farmland and elephant sanctuary. The elephants showed a high preference index (PI) score for 17 out of the 43 utilized plant species. These include: *Alstonia boonei, Brachystegia nigerica, Ceiba pentandra, Celtis zenkeri, Cleistopholis patens, Cissus spp., Desplathia sp., Dracaena mannii, Elaeis guineensis, Ficus ingens, Ficus mucuso, Khaya ivorensis, Musanga smithii, Nauclea diderrichii, Rauvolfia vomitoria, Thaumatococcus danielli,* and *Zanthoxyllum zanthozyloides*.

The implications of the feeding patterns for crop-raiding activities by elephants in surrounding farmlands is minimal. However, the diversity of elephant food and their preferences in different seasons also show that the elephants in Omo forest reserve have a high tendency to increase their home range so as to satisfy their food demand.

Our work provides baseline information about different types of natural food available in Omo forest reserve, and their relative importance in the diets of elephants in the area. This information is important for the conservation of African forest elephants and improved seasonal management for the long-term protection of this endangered species and its shrinking habitat.

The community-based education/outreach have continued to contribute to the conservation of elephants and other endangered species in the project area. The receptions in all communities visited were homely and community members were generally enthusiastic. It helped greatly in changing some of the people's negative attitudes and behaviours towards biodiversity conservation to that of supporting our conservation initiatives.

The repair and refurbishment of facilities at the elephant sanctuary was very helpful in our research and has been attracting ecotourists in the project area.

1.0 INTRODUCTION

1.1 Background

Forest elephants (*Loxodonta cyclotis* Matschie, 1900) are facing severe threats in Nigeria. This is due largely to heavy pressure on the rainforest habitats where they live. In Omo forest reserve, there are about 28 elephants within the semi-evergreen rainforest (Amusa et al., 2017). However, anthropogenic activities including logging, farming, hunting and illegal settlement camps have led to habitat fragmentation and continuous threat on the survival of elephant population in the area.

Given that the population of elephants is small, knowledge of their foraging patterns is important for understanding their habitat requirements and assessing their habitat condition for effective management. It is believed that large herbivores such as elephants require extensive home ranges to satisfy their high food demand, and reduction in food availability due to loss of habitat may create challenges for elephant conservation (Sukumar, 1989).

Over the past few years, a number of conservation initiatives have been going on to protect elephants and other endangered species in Omo forest reserve. In furtherance of these efforts, therefore, this project was embarked upon to help establish foraging patterns, promote public understanding of the precarious situation of the remaining forest elephants and rehabilitate conservation facilities in the project site in order to enhance the various conservation works on the elephants.

1.2 Objectives

1. Establish patterns of utilization of both cultivated and non-cultivated plant species by elephants, taking into account seasonal variation in the project site.
2. Promote public understanding of the precarious situation of the remaining forest elephants in the project area and to seek community-level support for their protection.
3. Repair and refurbish conservation facilities in the project site in order to enhance the various works on the elephants and conserve their habitats within.

1.3. Justification

The project will contribute towards enhancing the protection of forest elephants in Nigeria. It will provide useful information on foraging patterns and other data for elephant habitat management in the project area. A full knowledge of elephant foraging patterns is important for understanding their habitat requirements and for assessing their habitat condition for effective management. This knowledge and understanding is presently lacking in the project area. Details regarding food choice and seasonal diet composition of elephant remain unknown. This information is important for elephant conservation in terms of habitat management. The data will be very useful to the project team, the Nigerian Conservation Foundation and other management authorities in the project area.

Furthermore, sustained engagement of local communities will raise tolerance for elephant encounters among community households. Community-based conservation education has a huge potential towards contributing to the conservation of endangered species. This is an investment for the future. If communities are knowledgeable and understand the importance of conservation, only then would they change their behaviour to support conservation initiatives.

The repair and refurbishment of elephant sanctuary within the project area will help advance research and ecotourism activities in the area.

2.0. MATERIALS AND METHODS

2.1 Description of Project Site

The project site is Omo forest reserve which was gazetted in 1925 as part of the old Shasha forest reserve of southwestern Nigeria. It is located between Latitudes 6° 35' - 7° 05'N and Longitudes 4^o19' - 4° 40'E in the Ijebu East and North Local Government Areas of Ogun State (Figure 1). It covers an area of about 1,305 km^2 forming common boundaries with Osun, Ago-owu and Shasha forest reserves in Osun State and Oluwa forest reserve in Ondo State, all of which also share some common natural endowments.

Omo forest reserve is mixed moist, semi-evergreen rainforest in the Congolian sub-unit of the Guinea-Congolian Centre of Endemism or Phytochorion (Ola-Adams, 2014). The Nigerian government in 1946 established a 460 ha Strict Nature Reserve (SNR) within the reserve. It was upgraded to a Biosphere Reserve (BR) in 1977 by UNESCO owing to its richness in biological diversity (Obioho, 2005; Amusa, 2014). It is an IUCN category IV reserve. It was, therefore, expected to be a managed nature reserve/wildlife sanctuary with several objectives that are aimed at protecting biodiversity but permitting human use where this is compatible with forest conservation. Nevertheless, the ecological integrity of the reserve is threatened by increasing migrant farmers and high rate of logging operations among other anthropogenic activities.

In spite of this, the forest still harbours one of the last remaining populations of elephant, chimpanzee and white throated monkeys in the southwestern part of Nigeria. Interventions from the government and various conservation agencies (Nigeria Conservation Foundation, Paingtozoo and Pro-natura Nigeria) in order to mitigate threats to the rich biodiversity of the reserve have become inevitable. Part of these interventions involved establishing a wildlife sanctuary covering an area of about 37,500ha ≈ 29% of the forest reserve. The wildlife sanctuary is made up of elephant (30,000ha ≈ 23%) and chimpanzee (7,500ha ≈ 6%) areas or camps. However, the management of the areas has been quite fortuitous owing to ineffective institutionalization and poor law enforcement to halt most of the anthropogenic activities affecting biodiversity conservation.
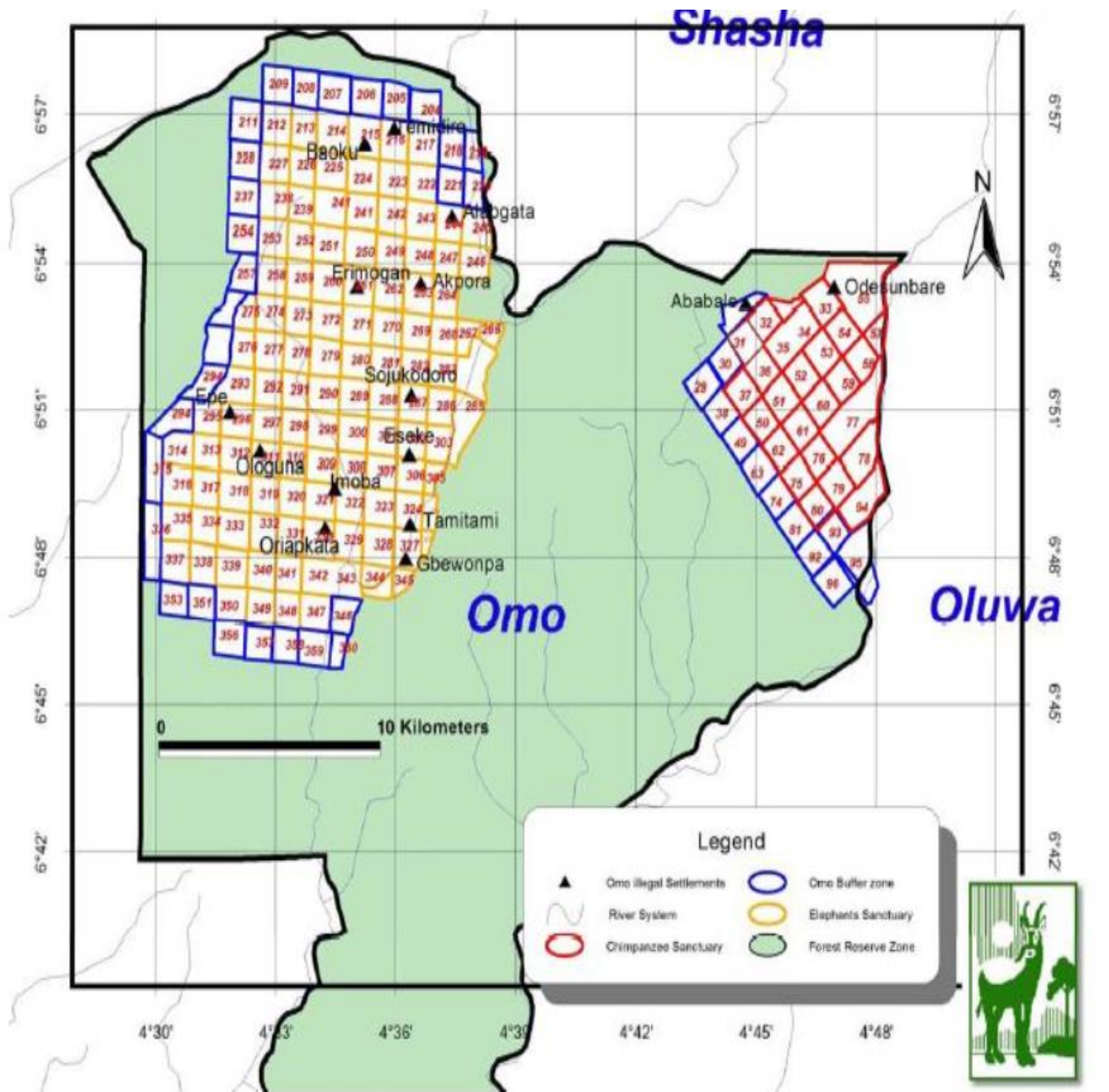
Figure 1: Map of Omo forest reserve showing the elephant sanctuary (Left-hand corner grid lines)

2.2 Project Activities

2.2.1 Review of objectives

The project activities began with a review of objectives, identification of possible challenges/constrains, and delimitations to successful project implementation. Thereafter, sensitization and planning meetings were held with community stakeholders in forest enclaves. We recognized the need for us to step up sensitivity and awareness on elephant conservation in communities within the project area. There were indications that a few people within some of the communities still have a negative attitude towards elephant conservation in the area. There is an emerging relationship in people's attitudes towards elephant conservation and land use for farming, especially in core elephant habitats. Against this backdrop, the need to step-up better understanding of the current condition of the forest elephants through community education and support in the project area was top on our programme. We believe people are

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part of the problem of species conservation and public education and outreach will be part of the solution.

2.2.2 Community-based conservation education/outreach programmes
We organized community-based conservation education/outreach programmes, which were aimed at generating and promoting environmental awareness as well as creating capacity at local level for responsible behaviour towards the elephants and other wildlife species in the area. The outreach programmes were also designed to increase understanding of elephant conservation issues, exchange opinions and experiences, and establish a dialogue among sectors of the community. It involved education and extension programmes. A total of six communities were covered.

There were two sessions of the programme held in each community visited. The first session involved a screen display of wildlife diversity of Omo forest reserve. Community members were asked to identify the animals in local language (Yoruba) with a reward for each correct answer. The reward was in form of gift items including T-shirts, key-holders, writing pens and bottle openers, all carrying important conservation messages. The animals displayed were (1) Porcupine- *Atherurus africanus* (Oore in Yoruba), (2) Bushbuck- *Tragelaphus scriptus* (Igala in Yoruba), (3) Duiker- *Cephalophus sp* (Etu in Yoruba), (4) Buffalo- *Syncerus caffer* (Efon in Yoruba), (5) Bush pig- *Potamochoerus porcus* (Elede igbo in Yoruba), (6) Mangabey- *Cercocebus torquatus* (Owe in Yoruba), (7) Mona monkey- *Cercopithecus mona* (Edun pupa in Yoruba), (8) Pangolin- *Smutsia gigantea* (Aika in Yoruba), (9) Civet cat- *Civettictis civetta* (Eta in Yoruba), and Elephant- *Loxodonta cyclotis* (Erin in Yoruba).

The second session was a documentary show entitled "The Queen" by the National Geographic Wild. The documentary revealed the challenges faced by a herd of elephants traversing the Kalahari Desert in Botswana. At the end of the show, community members were again asked a number of questions in relation to the documentary with reward of gift items. Thereafter, there were interactive sessions that afforded community members opportunities to ask different questions on the natural history of elephants while the project team proffered satisfactory answers. It was a revelation that allowed some myths and misconception about elephants and elephant conservation to be dispelled. It also helped increased the people's knowledge of the forest, its biodiversity, and issues in elephant's conservation.

2.2.3 Collection of data on elephant feeding pattern
Questionnaire administration
The project team administered questionnaire to farmers and hunters within the project site in order to elicit information on elephant food plants in the area. This was a form of rapid rural appraisal (RRA) technique for data gathering, since locals who share their landscape with the natural frontier of biodiversity often possess some knowledge about the subject of interest. Another aspect of the questionnaire contained questions relating to crop-raiding activities by elephants in the project area.

Field data collection
An indirect method which involved observation of elephant feeding signs on food trails was used to determine elephant food resources in both the elephant sanctuary and farmlands. The trails taken by elephants were followed and all the plants and their parts showing signs of being fed upon by the animals were recorded in transect surveys. The relative frequency of feeding sign was calculated to yield a feeding sign score. Feeding sign was also ranked according to the intensity of browsing.

In addition, samples of elephant dung encountered during the field survey were collected. Visual examinations of deposited elephant dung piles were performed to identify the presence of macro-plant fragments. Micro-plant fragments were identified through micro-histological analysis. Fragments of probable food species were collected for the preparation of reference slides. Random fragments isolated on each dung slide were used to compare with a reference slide for epidermal derivatives.

Food availability survey
Food preferences of elephants were determined through transects surveyed twice for each of rainy and dry season. Data on frequency, density and basal area of food plants were collected.

Data analysis
Total feeding score for each food plant was calculated by multiplying the frequency of each plant species showing feeding signs with total feeding sign score of that species. Total feeding score of each species was then multiplied by 100 and divided by the total feeding score of all species to calculate an index equivalent to utilisation percent. This was used to calculate preference index for each species. Furthermore, the importance value index (IVI) of a plant species in each habitat (elephant sanctuary and farmlands) was calculated by adding the relative frequency, density and basal area for trees. The preference index (PI) was also calculated following the method of Fritz et al. (1996). The Chi-square test was used to test for differences in feeding preferences between plant parts and seasons. Pearson correlation was used to determine the correlation between forage availability and preference.

## 2.2.4 Rehabilitating conservation facilities at elephant sanctuary
The Nigerian Conservation Foundation carried out the rehabilitation of conservation facilities at the elephant sanctuary in order to enhance research and ecotourism activities bordering on the forest elephants. This involved laying of wooden bridge and renovation of chalets, including repair of roof, wall, doors, and floor panels as well as provision of bed, mattresses and cooking utensils.

3.0 RESULTS AND DISCUSSION

3.1 Elephant food plant

Elephants in Omo forest reserve feed on 43 species of plants belonging to 32 taxonomic families (Figure 2). Eight of these plant species were encountered in farmland within the project area (Table 1). Of these number, only four species were cultivated while three species were found in both farmland and elephant sanctuary. Thirty-eight plant species that served as elephant food in the area were found exclusively in the elephant sanctuary (Table 2). Plant species in the families Apocynaceae, Aracaceae, Ebenaceae, Fabaceae, Meliaceae, Moraceae, Piperaceae, Sterculiaceae represent about 44.19% of total plants consumed by the elephants.
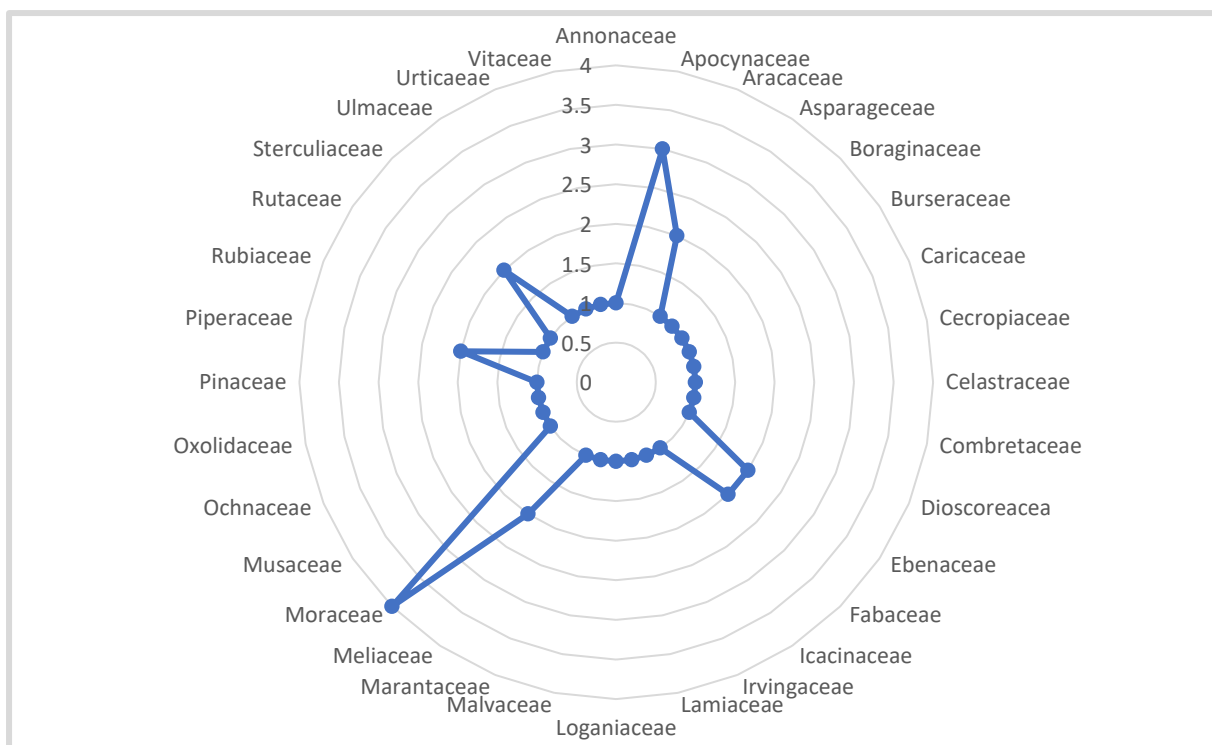
Figure 2: Distribution of elephant food plant by taxonomic family in the project area

Table 1: Plant species utilized as food by elephants in farmland within the project area

S/N	Family	Scientific name	Parts utilized	Status
1	Aracaceae	*Elaeis guineensis,* Jacq.	Fruit	Cultivated and Wild
2	Araceae	*Xanthosoma mafaffa*, Schott.	Corms	Wild
3	Asparageceae	*Dracaena mannii,* Baker.	Leaves	Wild
4	Caricaceae	*Carica papaya,* L.	Fruit	Cultivated
5	Moraceae	*Ficus exasperata,* Vahl.	Bark	Wild
6	Musaceae	*Musa paradisiaca*, L.	Fruit	Cultivated
7	Piperaceae	*Piper guineense,* Schumach.	Leaves	Wild
8	Sterculiaceae	*Theobroma cacao,* L.	Pod and seeds	Cultivated

Table 2: Plant species utilized as food by elephants in elephant sanctuary within the project area

S/N	Family	Scientific name	Parts utilized	Status
1	Annonaceae	*Cleistopholis patens* (Benth.) Engl. & Diels	Bark	Wild
2	Apocynaceae	*Alstonia boonei* De Wild.	Leaves	Wild
3	Apocynaceae	*Voacanga africana* Stapf.	Bark	Wild
4	Apocynaceae	*Rauvolfia vomitoria* Afzel.	Leaves	Wild
5	Aracaceae	*Elaeis guineensis,* Jacq	Fruit	Cultivated and Wild
6	Aracaceae	*Xanthosoma mafaffa*, Schott.	Corms	Wild
7	Asparageceae	*Dracaena mannii,* Baker	Leaves	Wild
8	Boraginaceae	*Cordia millenii* Bak.	Bark	Wild
9	Burseraceae	*Canarium schweinfurthii* Engl.	Bark	Wild
10	Cecropiaceae	*Musanga smithii* R.Br.	Leaves	Wild
11	Celastraceae	*Salacia madagascariensis* Lam. DC.	Bark	Wild
12	Combretaceae	*Terminalia ivorensis* A. Chev.	Fruits	Wild
13	Dioscoreacea	*Dioscorea spp.*	Tuber	Wild
14	Ebenaceae	*Diospyros dendo*Wew.ex Hiern.	Bark and Leaves	Wild

15	Ebenaceae	*Diospyros sp.*	Bark and Leaves	Wild
16	Fabaceae	*Baphia nitida* Lodd.	Fruits and Seeds	Wild
17	Fabaceae	*Brachystegia nigerica* Hoyle & A.P.D. Jones	Fruits and Seeds	Wild
18	Icacinaceae	*Icacina tricantha* Oliv.	Tuber	Wild
19	Irvingaceae	*Irvingia gabonensis* (Aubry-Lecomte ex O'Rarke) Baill.	Fruits and Seeds	Wild
20	Lamiaceae	*Gmelina arborea* Roxb.	Bark and Seeds	Wild
21	Loganiaceae	*Anthocleista vogeli* Planch.	Leaves	Wild
22	Malvaceae	*Ceiba pentandra* (L.) Gaertn.	Bark and Leaves	Wild
23	Marantaceae	*Thaumatococcus danielli* (Benn,) Benth.	Leaves	Wild
24	Meliaceae	*Khaya ivorensis* A. Chev.	Fruits	Wild
25	Meliaceae	*Entadrophragma utile* Sipo (Dawe & Sprague) Sprague	Bark	Wild
26	Moraceae	*Ficus exasperata* Vahl	Bark	Wild
27	Moraceae	*Ficus sp.*	Bark	Wild
28	Moraceae	*Ficus mucuso* Welw. ex Filcaho	Bark	Wild
29	Moraceae	*Ficus ingens* Miq.	Bark	Wild
30	Ochnaceae	*Lophira alata* Banks ex Gaertn.	Leaves	Wild
31	Olacaceae	*Strombosia pustulata* Oliv.	Leaves	Wild
32	Oxolidaceae	*Oxalis corniculata* L.	Fruit	Wild
33	Pinaceae	*Pinus spp.*	Bark	Wild
34	Piperaceae	*Piper guineense* Schumach.	Leaves	Wild
35	Rubiaceae	*Nauclea diderrichii* (De Wild.& T.Durand) Merrill	Bark and Seeds	Wild
36	Rutaceae	*Zanthoxylum zanthoxyloides* (Lam.) Zepern. &Timbler	Bark	Wild
37	Sterculiaceae	*Cola gigantea* A. Chev.	Bark	Wild
38	Tiliaceae	*Desplatsia sp.*		Wild
39	Ulmaceae	*Celtis zenkeri* Engl.	Leaves and Bark	Wild
40	Urticaeae	*Musanga smithii* R.Br.	Leaves	Wild
41	Vitaceae	*Cissus spp.*	Bark	Wild

3.2 Elephant foraging patterns

The utilisation pattern of food species by elephants in the project area suggests that 56.45% of all identified food species were consumed during the rainy season, while 43.55% were consumed during the dry season (Tables 3 and 4). There was no significant difference in the utilization of plant parts by elephants in both rainy and dry seasons (χ^2 = 11.09; df = 7; P > 0.05). The elephants were mainly browsers. The bark, foliage (leaves and twigs), fruit and seeds of browsed trees were selected for consumption (Figures 3 and 4). It was also noted that elephants occasionally fed in the farmland only during the dry season.

Table 3: Plant species utilized as food by elephants during dry season within the project area

S/N	Family	Scientific name	Parts utilized	Status
1	Apocynaceae	*Alstonia boonei* De Wild.	Leaves	Wild
2	Apocynaceae	*Voacanga africana* Stapf.	Bark	Wild
3	Apocynaceae	*Rauvolfia vomitoria* Afzel.	Leaves	Wild
4	Aracaceae	*Elaeis guineensis,* Jacq	Fruit	Cultivated and Wild
5	Aracaceae	*Xanthosoma mafaffa*, Schott.	Corms	Wild

| S/N	Family	Scientific name	Parts utilized	Status
6	Asparageceae	*Dracaena mannii,* Baker	Leaves	Wild
7	Caricaceae	*Carica papaya,* L.	Fruit	Cultivated
8	Celastraceae	*Salacia madagascariensis* Lam. DC.	Bark	Wild
9	Ebenaceae	*Diospyros dendo*Wew.ex Hiern.	Bark and Leaves	Wild
10	Lamiaceae	*Gmelina arborea* Roxb.	Bark and Seeds	Wild
11	Loganiaceae	*Anthocleista vogeli* Planch.	Leaves	Wild
12	Malvaceae	*Ceiba pentandra* (L.) Gaertn.	Bark and Leaves	Wild
13	Marantaceae	*Thaumatococcus danielli* (Benn,) Benth.	Leaves	Wild
14	Moraceae	*Ficus exasperata* Vahl	Bark	Wild
15	Moraceae	*Ficus sp.*	Bark	Wild
16	Moraceae	*Ficus mucuso* Welw. ex Filcaho	Bark	Wild
17	Moraceae	*Ficus ingens* Miq.	Bark	Wild
18	Musaceae	*Musa paradisiaca,* L.	Fruit	Cultivated
19	Olacaceae	*Strombosia pustulata* Oliv.	Leaves	Wild
20	Piperaceae	*Piper guineense* Schumach.	Leaves	Wild
21	Rubiaceae	*Nauclea diderrichii* (De Wild.& T.Durand) Merrill	Bark and Seeds	Wild
22	Rutaceae	*Zanthoxylum zanthoxyloides* (Lam.) Zepern. &Timbler	Bark	Wild
23	Sterculiaceae	*Theobroma cacao,* L.	Pod and seeds	Cultivated
24	Tiliaceae	*Desplatsia sp.*		Wild
25	Ulmaceae	*Celtis zenkeri* Engl.	Leaves and Bark	Wild
26	Urticaeae	*Musanga smithii* R.Br.	Leaves	Wild
27	Vitaceae	*Cissus spp.*	Bark	Wild

Table 4: Plant species utilized as food by elephants during rainy season within the project area

S/N	Family	Scientific name	Parts utilized	Status
1	Annonaceae	*Cleistopholis patens* (Benth.) Engl. & Diels	Bark	Wild
2	Apocynaceae	*Alstonia boonei* De Wild.	Leaves	Wild
3	Apocynaceae	*Voacanga africana* Stapf.	Bark	Wild
4	Apocynaceae	*Rauvolfia vomitoria* Afzel.	Leaves	Wild
5	Boraginaceae	*Cordia millenii* Bak.	Bark	Wild
6	Burseraceae	*Canarium schweinfurthii* Engl.	Bark	Wild
7	Celastraceae	*Salacia madagascariensis* Lam. DC.	Bark	Wild
8	Combretaceae	*Terminalia ivorensis* A. Chev.	Fruits	Wild
9	Ebenaceae	*Diospyros dendo*Wew.ex Hiern.	Bark and Leaves	Wild
10	Ebenaceae	*Diospyros sp.*	Bark and Leaves	Wild
11	Fabaceae	*Baphia nitida* Lodd.	Fruits and Seeds	Wild
12	Fabaceae	*Brachystegia nigerica* Hoyle & A.P.D. Jones	Fruits and Seeds	Wild
13	Icacinaceae	*Icacina tricantha* Oliv.	Tuber	Wild
14	Irvingaceae	*Irvingia gabonensis* (Aubry-Lecomte ex O'Rarke) Baill.	Fruits and Seeds	Wild
15	Lamiaceae	*Gmelina arborea* Roxb.	Bark and Seeds	Wild
16	Loganiaceae	*Anthocleista vogeli* Planch.	Leaves	Wild
17	Malvaceae	*Ceiba pentandra* (L.) Gaertn.	Bark and Leaves	Wild

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18	Marantaceae	*Thaumatococcus danielli* (Benn,) Benth.	Leaves	Wild
19	Meliaceae	*Khaya ivorensis* A. Chev.	Fruits	Wild
20	Meliaceae	*Entadrophragma utile* Sipo (Dawe & Sprague) Sprague	Bark	Wild
21	Moraceae	*Ficus exasperata* Vahl	Bark	Wild
22	Moraceae	*Ficus sp.*	Bark	Wild
23	Moraceae	*Ficus mucuso* Welw. ex Filcaho	Bark	Wild
24	Moraceae	*Ficus ingens* Miq.	Bark	Wild
25	Ochnaceae	*Lophira alata* Banks ex Gaertn.	Leaves	Wild
26	Olacaceae	*Strombosia pustulata* Oliv.	Leaves	Wild
27	Oxolidaceae	*Oxalis corniculata* L.	Fruit	Wild
28	Pinaceae	*Pinus spp.*	Bark	Wild
29	Rubiaceae	*Nauclea diderrichii* (De Wild.& T.Durand) Merrill	Bark and Seeds	Wild
30	Rutaceae	*Zanthoxylum zanthoxyloides* (Lam.) Zepern. &Timbler	Bark	Wild
31	Sterculiaceae	*Cola gigantea* A. Chev.	Bark	Wild
32	Tiliaceae	*Desplatsia sp.*		Wild
33	Ulmaceae	*Celtis zenkeri* Engl.	Leaves and Bark	Wild
34	Urticaeae	*Musanga smithii* R.Br.	Leaves	Wild
35	Vitaceae	*Cissus spp.*	Bark	Wild
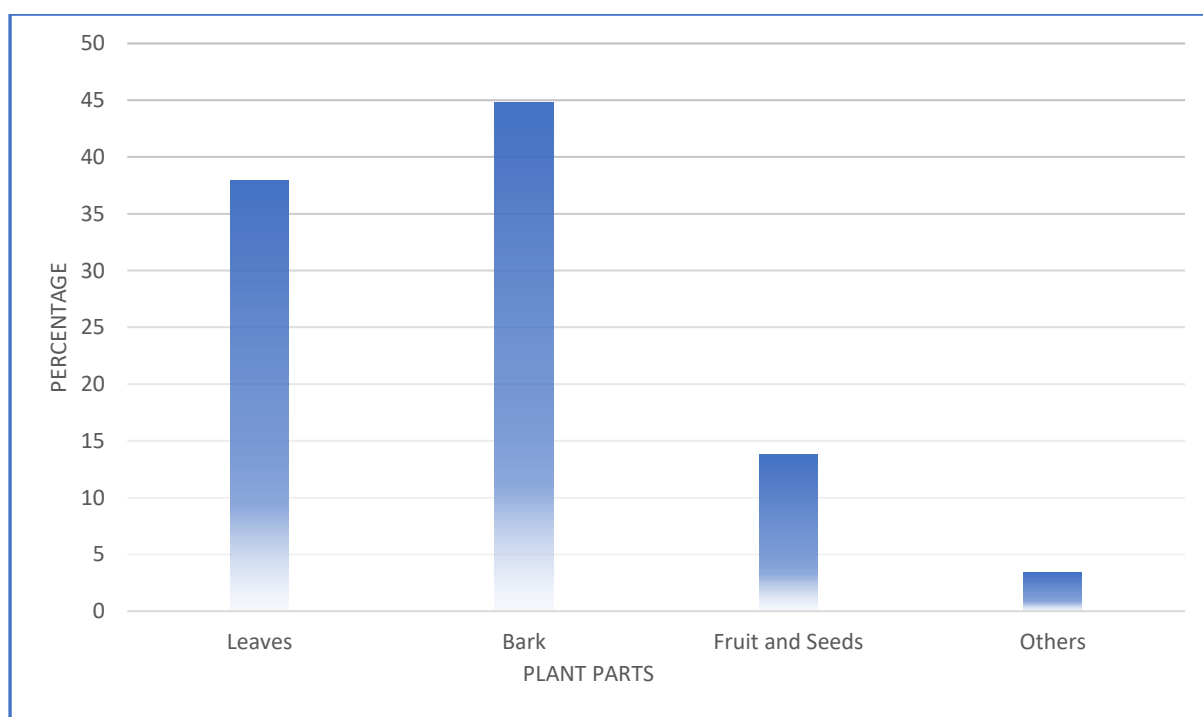
Figure 3: Frequency distribution of plant parts utilized by elephant in dry season
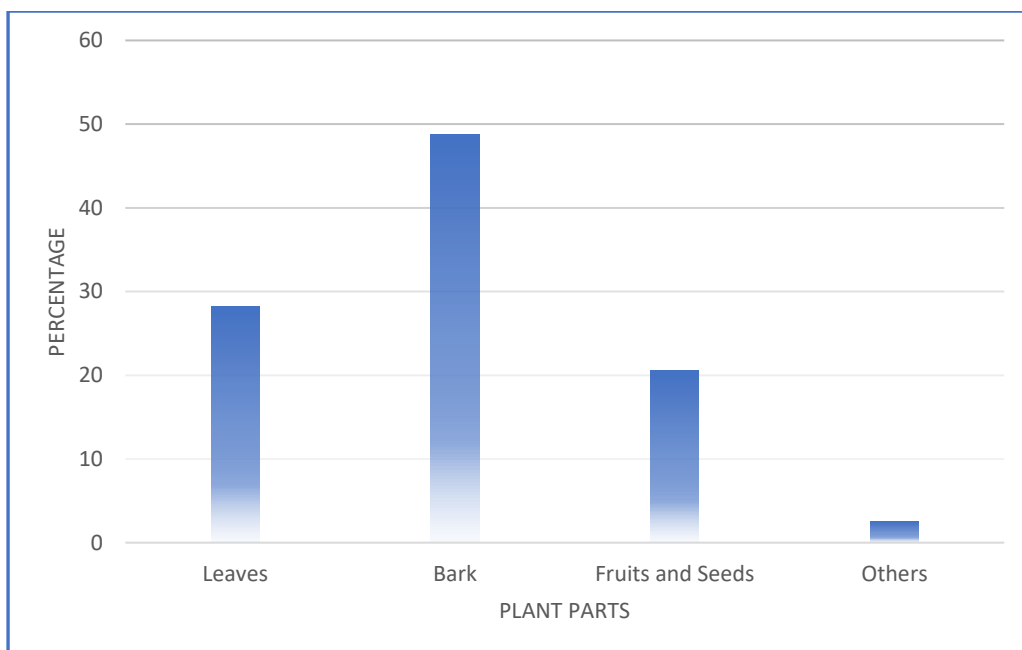
Figure 4: Frequency distribution of plant parts utilized by elephant in rainy season

3.3 Food availability and species preferences

Given that elephants only sometimes fed in the farmland during the dry season, it could be safely inferred that there was no significant difference in the types of food plants available to the elephants in both rainy and dry seasons. The elephants showed a high preference index (PI) score for 17 out of the 43 utilized plant species (Figure 5). These include: *Alstonia boonei, Brachystegia nigerica, Ceiba pentandra, Celtis zenkeri, Cleistopholis patens, Cissus spp., Desplathia sp., Dracaena mannii, Elaeis guineensis, Ficus ingens, Ficus mucuso, Khaya ivorensis, Musanga smithii, Nauclea diderrichii, Rauvolfia vomitoria, Thaumatococcus danielli,* and *Zanthoxyllum zanthozyloides* (Table 5). In addition to these species, the elephants also showed a strong preference for *Cacarica papaya, Theobroma cacao,* and *Musa paradisiaca* in the farmland. Overall, there is no correlation between abundance of plants and preference by elephants (Pearson correlation value = 0.238; P-Value = 0.107).
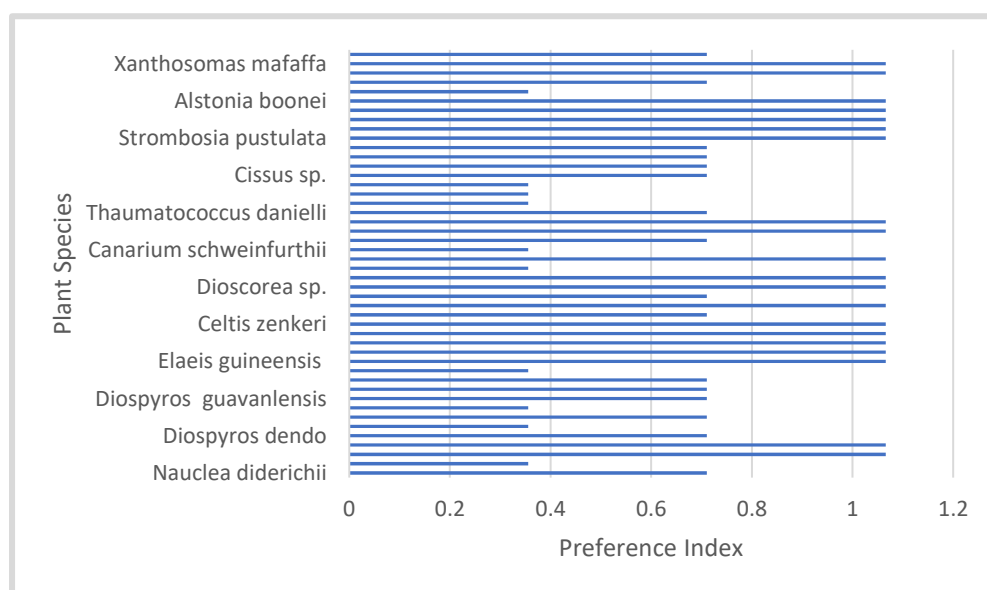
Figure 5: Preference indices (PI) for selected plant species in the project area

Table 5: Relative importance of different plant species in the diets of elephants in the project area

S/N	Plant species	Frequency	Utilization percentage	Importance value Index (IVI)	Preference Index (PI)
1	*Alstonia boonei* De Wild.	2	0.135043889	615.586045	1.066172
2	*Anthocleista vogeli* Planch.	9	0.405131668	1.0025	0.710781
3	*Baphia nitida* Lodd.	4	0.09002926	4.01	0.355391
4	*Brachystegia nigerica* Hoyle & A.P.D. Jones	11	0.742741391	21.0525	1.066172
5	*Canarium schweinfurthii* Engl.	1	0.022507315	2.005	0.355391
6	*Carica papaya,* L.	20	0.900292595	489.22	0.710781
7	*Ceiba pentandra* (L.) Gaertn.	23	1.553004727	25.218	1.066172
8	*Celtis zenkeri* Engl.	30	2.025658339	3.0075	1.066172
9	*Cissus spp.*	7	0.472653612	6.015	1.066172
10	*Cleistopholis patens* (Benth.) Engl. & Diels	1	0.067521945	7.0175	1.066172
11	*Cola gigantea* A. Chev.	10	0.450146298	30.0758038	0.710781
12	*Cordia millenii* Bak.	1	0.022507315	7.0175	0.355391
13	*Desplatsia sp.*	3	0.202565834	10.025	1.066172
14	*Dioscorea spp.*	5	0.225073149	2.005	0.710781
15	*Diospyros sp.*	105	4.726536124	105.688	0.710781
16	*Diospyros dendo*Wew.ex Hiern.	42	1.89061445	9.0225	0.710781
17	*Dracaena mannii,* Baker	21	1.417960837	1.0025	1.066172
18	*Elaeis guineensis,* Jacq	2	0.135043889	46.1567072	1.066172
19	*Entadrophragma utile* Sipo (Dawe & Sprague) Sprague	1	0.022507315	1.0025	0.355391
20	*Ficus exasperata* Vahl	9	0.405131668	5.0125	0.710781
21	*Ficus ingens* Miq.	1	0.067521945	2.005	1.066172
22	*Ficus mucuso* Welw. ex Filcaho	2	0.135043889	1.0025	1.066172
23	*Ficus sp.*	3	0.135043889	3.0075	0.710781
24	*Gmelina arborea* Roxb.	7	0.315102408	1.0025	0.710781
25	*Icacina tricantha* Oliv.	4	0.180058519	9.0225	0.710781

26	*Irvingia gabonensis* (Aubry-Lecomte ex O'Rarke) Baill.	1	0.022507315	1.0025	0.355391
27	*Khaya ivorensis* A. Chev.	3	0.202565834	11.0507234	1.066172
28	*Lophira alata* Banks ex Gaertn.	7	0.315102408	1.0025	0.710781
29	*Musa paradisiaca*, L.	28	1.260409633	28.07	0.710781
30	*Musanga smithii* R.Br.	2	0.135043889	1.0025	1.066172
31	*Nauclea diderrichii* (De Wild.& T.Durand) Merrill	11	0.742741391	11.0275	1.066172
32	*Oxalis corniculata* L.	1	0.04501463	1.0025	0.710781
33	*Pinus spp.*	2	0.04501463	7.0175	0.355391
34	*Piper guineense* Schumach.	1	0.022507315	1.0025	0.355391
35	*Rauvolfia vomitoria* Afzel.	21	1.417960837	1.00818529	1.066172
36	*Salacia madagascariensis* Lam. DC.	1	0.04501463	7.0175	0.710781
37	*Strombosia pustulata* Oliv.	7	0.315102408	1.0025	0.710781
38	*Terminalia ivorensis* A. Chev.	1	0.022507315	4.01	0.355391
39	*Thaumatococcus danielli* (Benn,) Benth.	46	3.106009453	42.105	1.066172
40	*Theobroma cacao*, L.	105	4.726536124	105.688	0.710781
41	*Voacanga africana* Stapf.	1	0.022507315	6.015	0.355391
42	*Xanthosoma mafaffa*, Schott.	6	0.270087779	21.0525	0.710781
43	*Zanthoxylum zanthoxyloides* (Lam.) Zepern. &Timbler	614	41.458474	1.04153727	1.066172

Implications of findings

Available diet and nutritional preference are part of the most important factors that drive elephant movements, and that generate conflict with humans, especially when available elephant habitat is shrinking (Rode et al., 2006). The present work recorded 43 plant species within 32 families that were foraged by the African forest elephants in Omo forest reserve. In a similar study, Koirala et al (2016) reported 57 species of plants in the Asian elephant's diet in Nepal. Sukumar (1990) recorded 112 species of plants in the elephant's diet in southern India, and Chen et al. (2006) reported 106 plant species in the diets of elephants in Shangyong National Natural Reserve in Xishuangbanna, the People's Republic of China. According to Koirala et al (2016), the wide range of results between studies may be due to differences in the number and diversity of plant species available in each of the study areas.

Despite the well-known fact that elephants are mixed feeders, and there is seasonal variation in their food selection (Sukumar, 1989), the present work has shown that browse flora were predominant in elephant's diet for both rainy and dry season. There is also scarcity of grass species in the study area. Thus, our finding is in tune with the submission of Campos-Arceiz and Blake (2011) that the African forest elephant is mostly a browser and frugivore rather than the grazing and browsing habit exhibit by the savanna elephant. The lack of correlation between availability of plants and preference by elephants also suggest a strong food selection by elephants which relate to specific preferences (Raubenheimer, 2011).

The implications of the feeding patterns for crop-raiding activities by elephants in surrounding farmlands is minimal. However, the diversity of elephant food and their preferences in different seasons also show that the elephants in Omo forest reserve have a high tendency to increase their home range so as to satisfy their food demand. Further studies are needed to understand the feeding selectivity of the elephants and its implications for their conservation.

Our current work provides baseline information about different types of natural food available in Omo forest reserve, and their relative importance in the diets of elephants in the area. This information is important for realising successful outcomes for the conservation of African forest elephants and improved seasonal management for the long-term protection of this endangered species and its shrinking habitat.

Project Achievements

1. The community-based education/outreach have continued to contribute to the conservation of elephants and other endangered species in the project area. The receptions in all communities visited were homely and community members were generally enthusiastic. It helped greatly in changing some of the people's negative attitudes and behaviours towards biodiversity conservation to that of supporting our conservation initiatives.

2. The project helped to reveal the diversity of elephant food and their preferences in different seasons within the project area.

3. It also helped to show the relative importance of the different plant species in the diets of elephants in the area. This will help improve seasonal management of these plants for the long-term protection of the elephant. It will also go a long way in mitigating crop-raiding activities by elephants in surrounding farmlands.

4. The repair and refurbishment of facilities at the elephant sanctuary was very helpful in our research and has been attracting ecotourists in the project area.

5. The project also afforded us a better understanding of the elephant ranging pattern which is important for their effective management in the area.

6. We recorded no case of human–elephant conflict throughout the project duration owing to increased environmental sensitivity towards the animal and cooperation of local communities.

7. As an upshot from the above, logging operations within the elephant sanctuary is near absent owing to some level of protection and our conservation initiative.

Acknowledgements

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Satellite imagery and Map of Omo forest reserve showing the elephant sanctuary (grid lines- E)
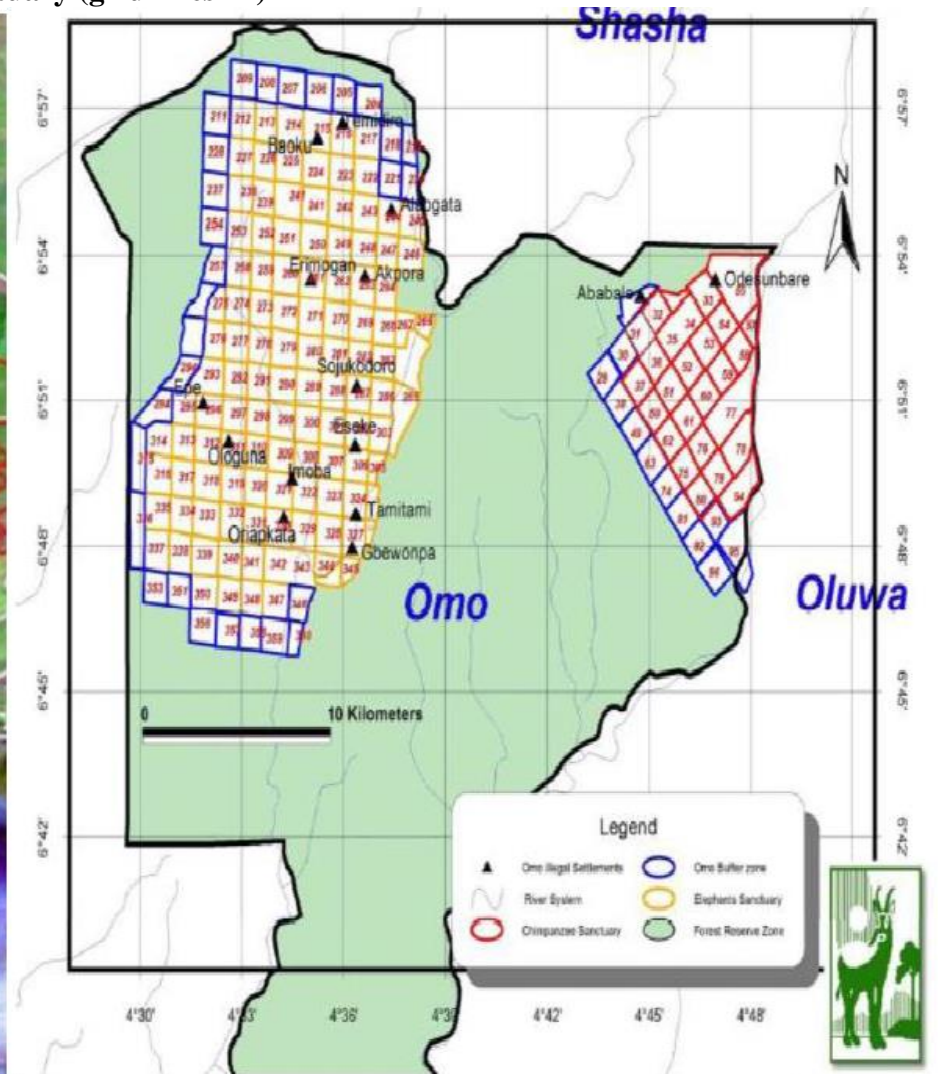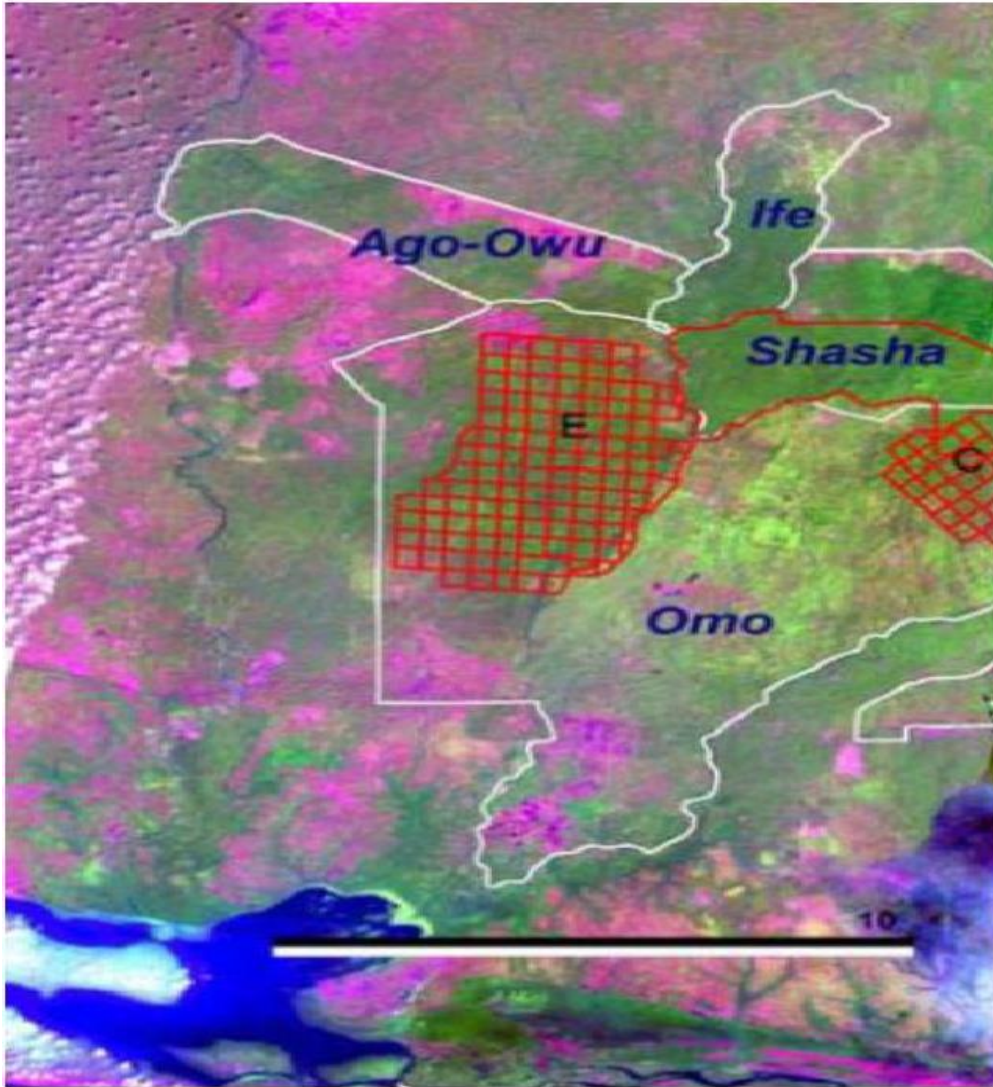
Meeting to review project objectives by team members

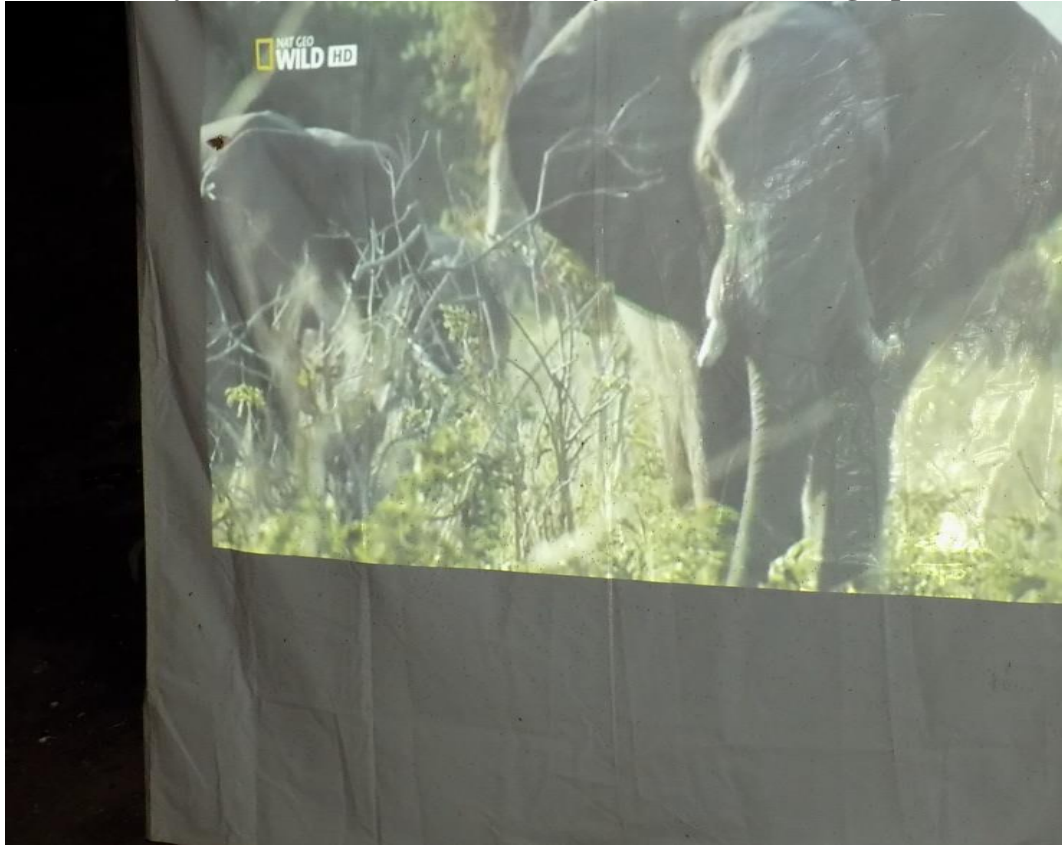**Sensitization and planning meetings with community stakeholders**

Display of wildlife diversity of Omo forest reserve

Identifying animals in local language (Yoruba)

Documentary show entitled "The Queen" by the National Geographic Wild

Interactive sessions on programme contents

Administration of questionnaire on farmers

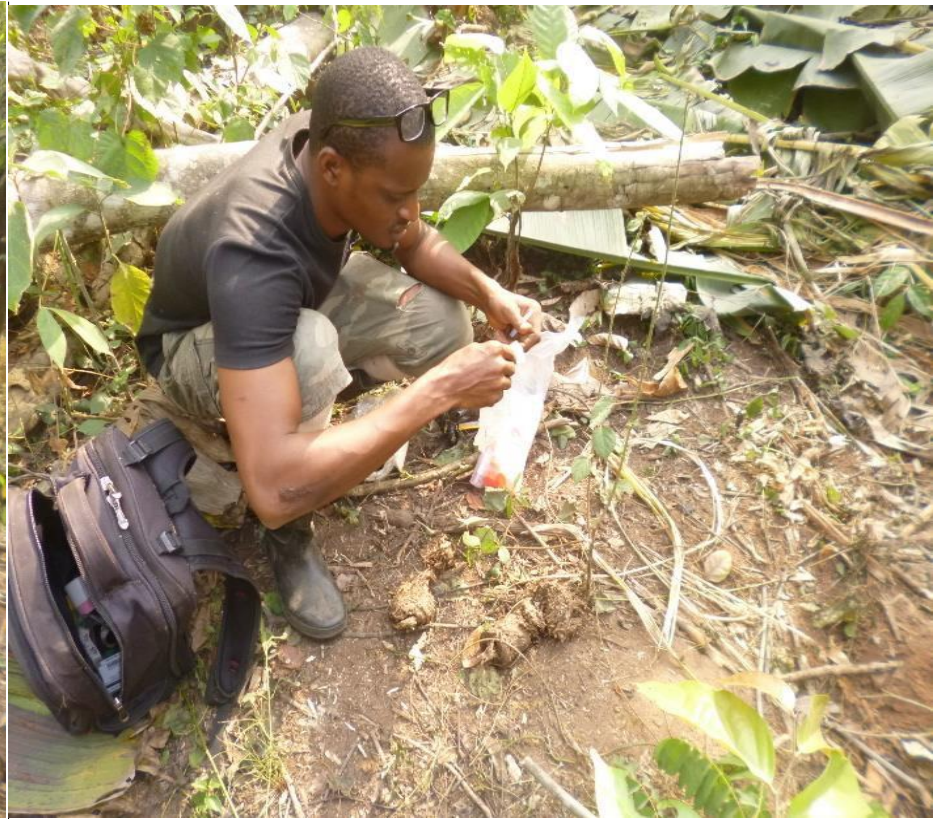**Field data collection on elephant food plants**

Conservation facilities at elephant sanctuary by Nigeria Conservation Foundation

Processing of elephant faecal samples in the laboratory for micro-histological analysis

Some photomicrographs used to characterize and identify plant species found in elephant faecal material in the project area