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Species-Diversity Utilization of Salt Lick Sites at Borgu Sector of Kainji Lake National Park, Nigeria

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Additional information is available at the end of the chapter

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1. Introduction

Mineral elements occur in the living tissues or soil in either large or small quantities. Those that occur in large quantities are called macro/major elements while those that occur in small quantities are called micro/minor/trace elements. These macro elements are required in large amount and the micro are required in small amount (Underwood, 1977, Alloway, 1990,) They occur in the tissues of plants and animals in varied concentrations. The magnitude of this concentration varies greatly among different living organisms and part of the organisms (W.B.E, 1995).

Although most of the naturally occurring mineral elements are found in the animal tissues, many are present merely because they are constituents of the animal's food and may not have essential function in the metabolism of the animals. Hence essential mineral elements refer to as mineral elements are those which had been proven to have a metabolic role in the body (McDonald, 1987). The essential minerals elements are necessary to life for work such as enzyme and hormone metabolisms (W.B.E, 1995). Enzymes are activated by trace elements known as metallo enzymes (Mertz, 1996). Ingestion or uptake of minerals that are deficient, imbalanced, or excessively high in a particular mineral element induces changes in the functions, activities, or concentration of that element in the body tissue or fluids. Biochemical defects develop, physiological functions are affected and structural disorder may arise and death may occur under the circumstances (Pethes, 1980).

The influence of wildlife management with the goal of maintaining wildlife population and the entire biodiversity at maximum level and maximum ecosystem utilization depend heavily on the knowledge of mineral elements in the nutrients requirement of animals (Mertz, 1976).

2. Salt lick/mineral lick

Salt licks are deposit of mineral salts used by animals to supplement their nutrition, ensuring enough minerals in their diets. A wide assortment of animals, primarily herbivores use salt licks to get essential nutrients like calcium magnesium, sodium and zinc. Salt licks are natural mineral which are mineral outcrops in the soil which are visited by herbivores for soil eating (biting and chewing) or licking (with tongue). They also supplement mineral that are deficient in animal vegetable diets (Ayeni, 1972).

Animals regularly visit licks in the ecosystem which are composed of primarily common salt (sodium chloride). It provides sodium, calcium, iron, phosphorus etc (Ayeni, 1972). Salt licks occur naturally in certain locations in the forest where mineral salt are found on the ground surface.

Shortage of sodium in the plants which are eaten by wildlife could motivate the game to eat a lot of soil at the lick (Ayeni, 1972). The shortage is as a result of water soluble sodium salts being leached out during heavy rain following long period of desiccation. Some plants even substitute potassium ions for sodium ions uptake from soil without showing mineral deficiency symptom (Buckman and Brandy 1960). Many plants are also rich in sodium and potassium, example are; *Acacia elatior* (Brenan), *Achyranthes aspera* (L), *Calyptrotheca premna resinosa* (Hochst) and *Salvadora persica* (L) and *Echolium amplexicaule* (Moore).

Functions of licks change during rainy seasons to those of natural water holes from which wildlife drank and wallowed. Some animals prefer using the drinking holes example are Buffalo and water-buck, but some still eat the soil lick mineral as well as drinking the lick example, warthog and hartebeest.

When salt lick appears, animals may travel to reach it, the lick become a sort of rally points where lots of wildlife can be observed. The concentration of animals in the area becomes visible, game viewing and photographing for tourist are improved in the area, animal studies and census conduction are also improved.

In an ecosystem, salt lick provides sodium calcium, iron, phosphorus and zinc required in the spring time for bones, muscles and growth for the wildlife. All trace elements like copper, magnesium and cobalt are retain in the salt lick for the metabolism of most mammals. Salt licks are used for hunting purposes by the animals.

Salt lick with a wide range of animals illustrate the ways in which wildlife naturally seek out nutrition which is essential to their survival. It provides nutrition for predators in the form of conveniently located prey who may be distracted by the salt lick long enough to become a snack.

3. Species utilization of salt lick

The following species of wildlife usually utilized salt licks in Nigeria; Elephant (*Loxodonta africana*), Buffalo (*Syncerus caffer*), Western hartebeest (*Alcelaphus buselaphus*), Roan antelope

(*Hippotragus equimus*), water buck (*kobus defessa*), Kob (*kobus kob*), Bushbuck (*Traquellaphus scriptus*), Oribi (*Ourebi ourebi*), Red flanked duiker (*Cephalophus rufilatus*), Grimm's duikers (*Sylvicapra grimmia*), Warthog (*Phacochoerus aethiopicus*) and Baboon (*Papio Anubis*). The following game species were also observed in east Africa to use salt licks: rhino (*Diceros bicornis*) Zebra (*Equus burchelli*) Impala (*Aepycenus melampus*), Water buck (*Kobns ellipsiprymus*), Eland (*Taurotragus oryx*).

4. Activities of animals using salt lick

Salt licks are used predominantly in the day. Different species used salt licks at different period of the day. Buffalo and Warthog used lick mainly in the morning and afternoon. The shapes of the animal mouths determine the method by which salt licks material is obtained and ingested. Elephant and Warthog dig up the licks content using their tusks and lift up large licks materials with the trunk, whereas baboon used their hands to pick up and throw small pieces into the mouth. Hartbeest cut fresh lick materials by biting deeper into the craters with the incisors while water-buck, buffalo, roan, duiker, oribi and bush buck lick up the powdered lick material with the tongue.

Salt lick is found in abundance in the game reserves that are situated in the drier habitats in Northern Nigeria. Henshaw and Ayeni (1971) postulated that abundance and use of salt licks by wildlife indicates nutritional deficiencies caused by degrading environment or overpopulation or both. Examples are in the case of Yankari where ten licks are located within 11km along the Gaji River and the frequency of occurrence and intensity of use is very high.

5. Problems of salt licks in game reserved

Three problems have been noticed by the presence of salt lick in the game reserves; soil removal, vegetation destruction and spread of disease (Woodley, personal communication). Over 5000 tons of soils are removed annually. The soil is lost through wallowing, eating or licking and trampling. The areas around the salt lick are always trampled by hoof action, overgrazing and devoid of vegetation cover. Since many or so much drinking, urination, defecation, wallowing and feeding occur at the licks, diseases spread rapidly (Ayeni, 1979, Ogunsanmi, 1997). The use of artificial licks may prevent this.

6. Types of salt lick

Salt licks can be natural or artificial. Artificial salt licks are used by farmers for their cattle, horses and other herbivores to encourage health growth and development. Typically a salt lick in form of block is used in these circumstances. The block may be mounted on a platform so that domesticated animals do not consume dirt from the ground with necessary salt. There is need to medicate shy animals or a large group of animals.

Some people used artificial salt licks to attract wildlife such as deer and moose along with smaller creatures like squirrels. Animals may be attracted purely for pressure of humans

who install the salt lick with the goal of watching or photography. Also salt licks are used by hunters to encourage potential prey to frequent an area. Wildlife biologists also used salt lick to assist them in tracking populations and can be a serve as medication in that it is used as birth control to keep animals from proliferating in the area where they are few natural predators, example is the deer.

Artificial salt lick comes in two forms; blocked and bagged. Bagged salt licks are designed to be buried in pits to create a more realistic form of salt lick with the salt and mineral leaching out in wet weather to form a salt deposit which will attract animals. While blocked licks are installed directly or mounted on platforms depending on personal taste. It can also be hanged on a tree in the middle of the farm or ranch house.

The universal popularity of salt licks with wide range of animals illustrates the way in which wildlife naturally seek out nutrition which is essential to their survival and provide nutrition for predators. Salt lick is a natural gathering place for grazing animals, which also attracts the carnivores. Animals ingest it as part of food they eat or they eat it directly

7. Significance of natural salt lick

Natural salt licks are utilized by wildlife to supplement their mineral requirements (Ayeni, 1979). Wild game especially the herbivores can always identify the spots in their habitat where the essential minerals could be found. The African elephant have been noted to travel great distances to visit areas of saline earth which they swallow in considerable quantities as a purgative (Wari, 1993). Lick utilization is related to the spatial distribution and abundance of environmental minerals. A positive correlation between the spatial distribution of elephants in Wakie National Park, central Africa and the abundance of environmental sodium has been reported (Weir, 1972).

Water holes which usually serve as salt licks for animals during dry season may become heavily contaminated with infectious pathogens which can survive to the dry season (Woodford, 1979, Ogunsanmi, 1997). Droplet of respiratory disease is also made possible when animals crowd together in salt lick spots. Salt lick can be infected with anthrax spores and can act as focal point for the spread of the disease (Woodford, 1979). There is also a high increase in predation illustrated by the frequency of carcasses near licks which often lead to high mortalities (Lasan, 1999).

8. Resources availability and utilization by wildlife

The pattern of utilisation is determined by the growth of different plants and the physiological need of the animals, Benjamin, (2007). The abundant of mineral ions Na^+ , K^+ , Ca^+ and Mg^+ in salt lick, (Ayeni,1971), cause the concentration of big games along the river during the dry season due to the availability of salt lick, cover, water, and cover and fresh flush of the grasses and browse able materials.

Afolayan (1977), Milligant and Ajayi, (1978), observed that the utilization of salt lick by large mammals in Kainji Lake National park reduced with increased distance from water point

particularly streams and rivers. Vertebrates have complex nutritional requirement in the form of chemical elements. Just as water and food supply, salt lick constitute one of the requirements expected in an ecological unit. Ayeni, (1971) observed that not all animals come regularly to salt lick but big games pay much visit e.g. elephants, antelopes, baboons etc. Phosphorus and sodium are believed to be principal trace elements causing animals to use salt lick (Cowan, 1949). Habitat degradation through over grazing and over browsing and soil compaction result from heavy lick use (Ayeni, 1972).

9. Factors influencing wildlife population

The increase in animal population is a function of animal chance to survive and multiply, and that chance to multiply and survive is a function of the environment. Environment is the sum total of all factors that influences the animals' speed of development and expectation of life and fecundity. The component which are claimed to be homogeneous with respect to the way it influences the animals chance of survival, Andrewartha and Birch, (1954) are;

- The resources e.g food, water and cover
- Mate
- Predators, pathogens and aggressors
- Weather condition
- Pollution.

10. Salt lick and trace minerals

Mineral elements play an important role in the nutrition of wild games. Hence a brief discussion on wildlife nutrition is important. Salt is unique in that animals have a much greater appetite for the sodium and chloride in the salt than for other minerals. Because most plants provide insufficient sodium for animals feeding and may lack adequate chloride content, salt supplementation is a critical part of a nutritionally balanced diet for animals. In addition, because animals have definite appetite for salt, it can be used as a delivery mechanism to ensure adequate intake of less palatable nutrient and as a feed limiter.

Sodium plays major roles in nerves and impulse transmission and the rhythmic of heart action. Efficient absorption of amino acids and monosaccharide from the small intestine requires adequate sodium. The other nutrient in salt, chloride, are essential for life. Chloride is a primary anion in blood and the movement of chloride in and out of the red blood cells, is essential in maintaining the acidic-base balance of the blood. Chloride is also a necessary part of the hydrochloric acid produced in the stomach which is required to digest most food. Animals have more defined appetite for sodium chloride than any other compound in nature except water. Ruminants have such a strong appetite for sodium that the exact location of salt source is permanently imprinted in their memory which they can then return to when they become deficient. Horses have been shown to have specific appetite for salt if the diet is deficient in sodium.

Trace elements

There are seven trace minerals that have been shown to be needed in supplementing animal diets. They are iron, copper, zinc, manganese, cobalt, iodine and selenium. They are needed in small amounts, or traces, in the diets and hence their names traces minerals".

Currently trace minerals deficiency is a bigger problem than the acute mineral deficiencies. They are several examples where an area was not recognise to have trace mineral deficient in the past but now has been shown to require supplementation. For example selenium deficiency was not considered to be a problem in the United States until recently.

Salt as a carrier of trace minerals

Salt is known to be a carrier of trace minerals, since all herbivores has natural appetite for salt this could serve as a source of trace minerals for them. Moreover when horses, cattle, sheep and other animals are on pasture with little, or no varying amounts of concentrate feeding, farmer can supply trace mineral salt in the form of a mineral block or loose trace mineral salt in a box.

11. Wildlife nutrition

Nutrition is the study of process by which organic and inorganic substances ingested by living organisms are converted to various needs for life processes such as promoting growth, replacing worn-out and injured tissues and perpetuate life. Wildlife nutrition is concerned with the supply of quality food in an animal environment. The basic requirements of all wildlife are food, water and cover. In general animal with adequate food supply grows larger, produced more young, are more vigorous and healthy, and are more resistant to many form of diseases than those affected by malnutrition (Nancy and Martha, 1995). When wild animals are shipped, moved, migrated, translocated or restocked to destinations where plant food that are typically consumed by freely grazing animals e.g reindeer are not found in sufficient quantities to provide adequate nourishment. Nutritional and digestive disorder set in which could be fatal (Luick, 1968). According to Luick, 1979, more than 60% of reindeer may die in two weeks of departure from their native tundra ranges.

Digestive and nutritional disorders are factors contributing to high mortality rate others include; the stresses of capture and handling, hyperthermia, regurgitation and inhalation of rumen contents, injury and diseases and overdoses of immobilizing agents and tranquilizers, (Luick, 1968, 1976). Nutritional disorders are primarily a result of failure in adjustment of the balance between nutrient input and requirements. These disorders are distinct and specific to a particular nutrient, (Sauvant, 1991)

An increasing amount of information is accumulating to show that many nutrients are needed at higher levels to improve the ability of the animal immune system to cope with infection. Sodium chloride, copper, zinc, Selenium, phosphorus and magnesium already

have been shown to be helpful in this regard. Nutrients requirement for growth, gestation and lactation do not necessary mean that the level will be adequate for normal immunity and high resistance to diseases. But nutrient levels higher than those recommended may be needed for maximum productivity and health of the animals.

12. Essential mineral elements in wildlife nutrition

Mineral elements are restricted to mineral elements which have metabolic role in the animal body, (McDonald, 1979). Bowen, (1999), an essential mineral element is necessary to proof that diet lacking the element can cause deficiency symptom in animals. These depend on three basic factors. These are;

1. The organism can neither grow nor complete its life cycle without an adequate supply of the element.
2. The element cannot be replaced by any elements and
3. The element has direct influence on the organism and is involved in its metabolism.

13. Major mineral elements at salt-lick site

- a. **CALCIUM (Ca):** Calcium is the most abundant element in the animal body. It is an important constituent of the bone and feet where about 99% of the body total calcium is found. Calcium is also an essential constituent of living cells and tissue fluids. It is essential in the activities of a number of enzymes including those necessary for the transmission of nerve impulses and for contractile properties of muscles. It is also necessary in the coagulation of blood and the normal function of cell membrane, (Clegg and Clegg, 1978; McDonald, 1998).
- b. **PHOSPHORUS (P):** It occurs in the bone and is vital for bone formation. It also occurs in protein called phosphor-proteins, nucleic acids and phospholipids. The element plays a vital role in energy metabolism in the formation of sugar phosphate and adenosine di and tri-phosphates. It forms an essential constituent of milk and is necessary for the function of the neuromuscular system (McDonald, 1987).
- c. **POTASSIUM (K):** Potassium plays an important role in osmoregulation of the body fluids and in acid-base balance in the animals. It functions principally as the cation of the cell. It plays an important part in muscle and nerve excitability, carbohydrate metabolism and is important blood and interstitial fluid, (McDonald et. al., 1981).
- d. **CHLORINE (Cl):** Chlorine is associated with sodium and potassium in acid base balance and osmoregulation. It plays an important role in the gastric secretion where it occurs as hydrochloric acid as well as chloride salts. Chlorine deficiency can lead to an abnormal increase of the alkali reserve of the blood.
- e. **SULPHUR (S):** It is an important constituent of protein in animals such as protein containing amino acids cystine, methionine, biotine and thiamine, the hormone, insuline and important metabolite, coenzyme A also contain sulphur.
- f. **MAGNESIUM (Mg):** Magnesium is closely associated with calcium and phosphorus in the formation of bones and about 70% is found in the skeleton, the remains distributed

in the soft tissue and fluids. It is the commonest enzyme activator, particularly in the activation of phosphate transferases, decarboxylases and acyl transferases (McDonald *et. al.*, 1987).

14. Trace elements

- a. **IRON (Fe):** Iron plays an important role in the synthesis of haemoglobin and enzymes in the foetus. It also occurs in the blood serum in a protein called transferrin which is concerned with the transport of iron from one part of the body to another. Iron is also a component of many enzymes including the cytochrome C reductase, succinic dehydrogenase and fumaric dehydrogenase. Hence, it is vitally important in the oxidative mechanism of all living cells. (Clegg and Clegg, 1978; Pethes, 1980; McDonald, 1987). Symptoms of deficient of iron include paleness of the skin, hypochromic microcytic anaemia and conjunctiva.
- b. **COPPER (Cu):** Copper is found in blood plasma and occurs in various complex forms loosely bound to albumin and amino acids. It is necessary for haemoglobin synthesis and has been found in over 35 enzymes and proteins. These include; red blood cell, ceruloplasmin, and mitochondrial ceruloplasmin, (Underwood, 1977; Pethes, 1980).
- c. **IODINE (I):** Iodine is required by animals for the synthesis of the thyroid hormones, thyroxine and triiodothyroxine produced in the thyroid gland (Pethes, 1980). Deficiency results in endemic goitre.
- d. **ZINC (Z):** Zinc is found in every tissue in the animal's body. It plays an important role in enzyme activation and in wound healing. It is important in the fundamental process of RNA, protein synthesis and metabolism. Deficiency results in growth retardation, loss of appetite, alopecia, bone deformation, impaired fertility in both male and female animals and increase occurrence of tetragenicity and behavioural anomalies.
- e. **FLUORINE (F):** It is one of the constituents of bone, teeth, soft tissues and body fluids. It activates adrenal cytochrome P-450 enzyme which is the primary mediator of hormone action (Pethes, 1980). Its function is in the prevention of dental caries. Deficiency symptoms include; pain on movement, lameness, arthritis, of the hip, erosion of the tooth enamel and decrease in milk yield, (Pethes, 1980).

15. Study area

The study was conducted in Kainji Lake National Park (KLNP). In Nigeria the role of game reserve in conserving wildlife for various purposes is widely recognised. The flora (plants) constitute only one element of the complex ecosystem which they belong and are not in stable state. The effective management of land as game reserve is the general principle. There is a management plan to be drawn. Such plan has been prepared for Kainji Lake National Park (KLNP) (Ayayi and Hall, 1975). The principle purpose of the plan is to provide all available information relevant to the management of the reserve. It also makes provisions for its regular revision and updating and incorporate timetable for these purposes.

16. Location

Kainji Lake National Park extends 80km in an east-west direction and about 60km north-south. It consists of two sectors, the Borgu sector and Zuguruma sector. It lies between $9^{\circ} 4'$ to $10^{\circ} 30'$ N and $3^{\circ} 30'$ to $5^{\circ} 50'$ E, covering a total area of 5,340.82km (Tuna, 1983). The Borgu sectors cover an area of 3,970.02km S.E in Borgu Local Government Area of Niger State. Ero, (1985), put the location of Borgu between $10^{\circ} 50'$ N latitude and $4^{\circ} 19'$ E longitude. The Borgu has the Kainji Lake on the east while the west is by the republic of Benin (Figure 1).

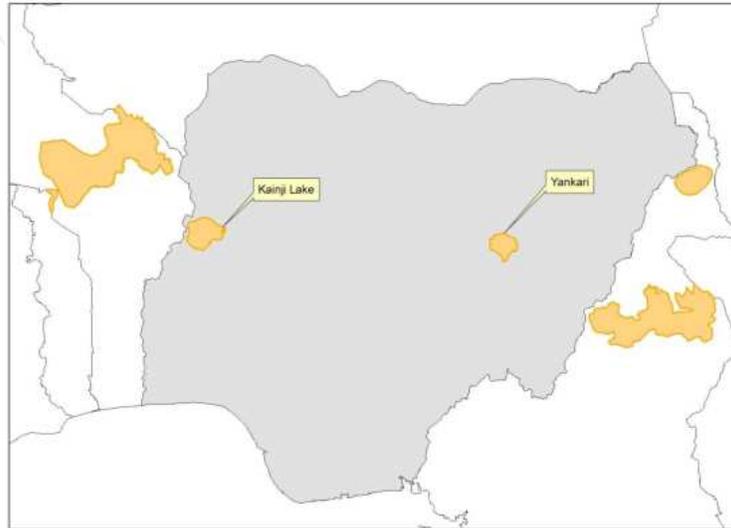


Figure 1. Map of Nigeria showing the location of Kainji Lake National park

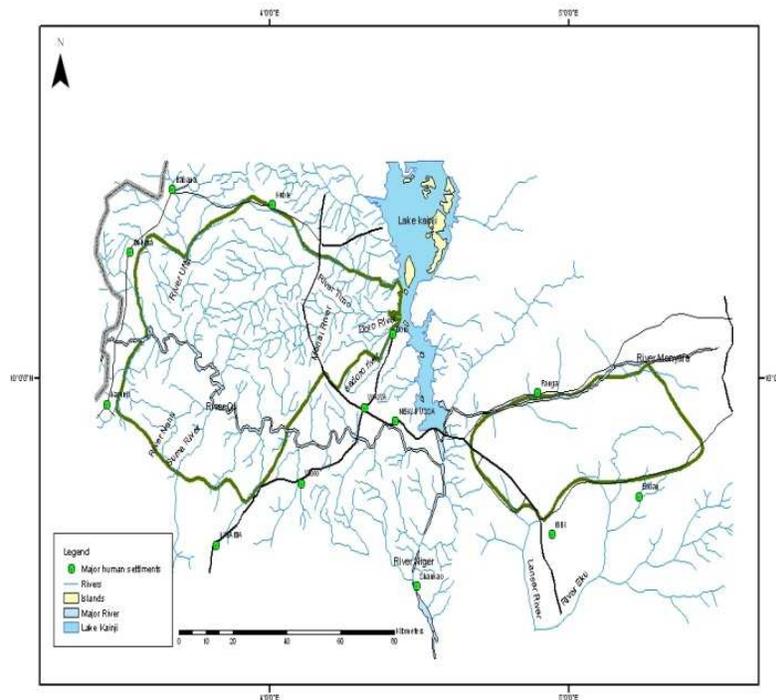


Figure 2. Showing the Geo-reference Map of Kainji Lake National Park in respect to the Lake and Salt lick sites.

17. Vegetation of the study area

The vegetation of Nigeria consists of forest, savannah and Montane. The forest zone comprises mangrove forest, rainforest and dry forest southern and northern guinea savannah zone, Sudan zone and Sahel constitute the savannah vegetation. Montane vegetation is formed by the Montane forest and grassland. The derived savannah forms the boundary between the forest and the true savannah vegetation types.

The Borgu sector of Kainji Lake National park has transitional vegetation which is between the Sudan and the Northern Guinea savannah type (Onyeanus, 1996). FAO, (1974) also included the vegetation of the study area in the guinea zone in the map of vegetation of Nigeria. FAO, (1974) divides the vegetation into six main vegetations having significance as wildlife habitat types. These are;

- a. The *Burkea/Detarium microcarpum* (Wooded Savannah)
- b. The *Isoberlinia tomentosa* (Woodland)
- c. *Diospyros mespiliformis* (Dry Forest)
- d. *Terminalia macroptera* (Tree Savannah)
- e. **The Riparian forest and woodland**
- f. **The Oli complex**

Burkea africana/Detarium microcarpum (Wooded savannah)

This consists of the majority of the vegetation of study area. The density and height of woody cover varies with soil and influence of fire. *Azela africana* is an associated species which occasionally form patches of woodland. Trees and shrubs common in this area are *Butyrospermum paradoxum*, *Terminalia avicennioides*, *Parinari polyandra*, *Piliostigma thonnigii*, *Maytenus senegalensis*, *Gardenia ternifolia*, *strychnos inocua* (FAO, 1974).

Some of the grasses associated with this community include *Hyperrhenia involucrata*, *Andropogon gayanus*, *A. pseudapricus*, *Genium newtonii*, *Chlosporum tinctorum*, *Indigofera bractolats*, *Hyperthelia dissolute*, *Brachaiaria jubata*, *B. brachylopha* and *Aristida kerstingii*. (FAO1974).

Isoberlinia tomentosa (Woodland)

This associates with quartzite ridges and are extensive on higher ground in the study area. The *I. tomentosa* occur in almost pure stands though occasionally *I. doka* is found where stone intrusions occur. *Azela africana* and *Ostryoderris stuhlmanni* is found adjacent to *I. tometosa* woodland. Grasses such as *Monocynibium cresiforme*, *Schizachhyrium sanguineum*, *Beckeropsis uniseta*, *andropogon tectorum* and *Andropogon gayanus* occurs extensively on poorer sites.

Diospyros mespiliformis (Dry forest)

This distinctive type occurs as units of a few acres extent at scattered localities in the central part of the study area. *Diospyros mespiliformis* forms the bulk of the tree layer while

Polysphaeria arbuscula usually comprises of a dense under storey. The grasses of this type are the broadleaved *Opilismenus hirtellus* (FAO, 1974).

Terminalia macroptera (Tree savannah)

This occurs in the low-lying seasonally inundated areas, characterised by dark grey hot-walled clays. Typically there are few woody plants in this type. They include *Pseudocedrela kotschyi*, *Mitrangyna intermis* and *Daniella oliveri* (FAO, 1974). The grasses are those associated with swampy ground. They include *Panicum paucinode*, *Brachiara jubata*, *Hyparrhenia glabriuscula*, *H. rufa*, *Andropogon perligulatus*, *A.pseudapricus*, *Schizachrium schweinfurhii*, *Hyparrhenia cyanescens* and *Echinochloa obtussiflora* (FAO,1974).

Riparian forest and woodland

This includes the vegetation of all water courses of the reserve with the exception of the Oli and the lower reaches of its two largest tributaries- the Uffa and the Nanu. The riparian/forest woodland which develops in response to the prevailing high atmospheric water content, resembles the moist savannah bordering the forest zone. The common tree species to this vegetation type include: *Cola laurifolia*, *Irvingia smithii*, *Antidesma venosum*, *Pterocarpus santalinoides*, *Diospyros mespiliformis*, *Daniella Oliveni*, *Gardenia Species*, *Strychnos spinosa*, *Terminalia aricenoides* and *Maytenus senegalensis*. The grasses remain green into greater part of the dry season. The grasses include *Acroceras zizanoides*.

The Oli complex

The Oli complex is distinctive in its heterogeneity. It is heterogeneous vegetation which characterises the courses of the Oli River as well as some parts of its main tributaries (e.g. River Nanu, Suna and Suma). Its dominant tree species are assemblages of characteristic rainforest species e.g. *Annogeissus leioxarpus*, *Vitex doniana*, *Khaya senegalensis*, *Mitragyna inernus*, *Chlorophaora excels*. The oli complex and the riparian forest are closely associated.

The valleys have a scattering of *Terminalia macroptera* in grassland of lots of *Hyperrhenia smithiana*. The upland areas are very distinctive but small unit of *Diospyros ruspiliformis* forest. The evergreen nature of the *Diospyros ruspiliformis* and the shrub makes it difficult for fire to penetrate it. *Oplismenus hitellus* grass also occurs in this unit. In the upland, three woodland units are found they are, *Isobertinia doka*, *Isobertinia tomentosa* and *monotes kerstingii* woodlands. The largest vegetation is covered by *Burkea Africana*-*Detarium macrocarpum* wooded savannah.

18. Climate of Kainji Lake National Park

Rainfall: The two major features of the climate of the park are the wet and dry season and they are variable from year to year. The wet season extends from May to November while the dry season extends from December to April. The highest amount of rainfall is always in

	2007	2006	2005	2004	2003	2002	2001	2000
JAN	-	-	-	0.2	-	-	-	-
FEB	-	-	-	-	2.6	-	-	-
MAR	-	-	28	2.8	18.7	-	-	-
APRIL	65.51	30	53.3	67.4	45	84.9	48.5	8.6
MAY	100.7	168.4	58.9	167.6	82.2	34.68	96	70.43
JUNE	119	225.7	179.04	176.5	203.27	103.62	229.9	227.4
JULY	175.8	226.33	184.6	231.3	111.3	154.15	165.23	115.1
AUG	306	166.8	106	158.3	126.56	159.08	111.21	253.8
SEPT	127.2	255.06	329.39	265.76	147.17	122.9	211.65	245.6
OCT	45.8	68.3	110.4	112	110.3	74	119.98	50.12
NOV	-	-	-	12	-	3	-	-
DEC	-	-	-	-	-	-	-	-

Table 1. Kainji Rainfall Data from 2000-2007, Kainji monthly Rainfall (mm)

August (11.89mm) while the lowest rainfall (2.090mm) is in October (Table 1). These values varied yearly. Milligan (1979) indicates that there is a decreased in rainfall from the south to the north and increased rainfall towards the west and east and low condition in central northern regions.

Temperature: The highest is in the dry season just before the rain and lower during the wet season it picks up again towards the end of the wet season and later drops to the lowest value in December and January during harmattan. The minimum temperature during this period ranges from 17.87°C to 19.90°C (Onyeanusu 1998).

Relative humidity: The relative humidity increases gradually from low values at the beginning of the dry season to a peak during the wet season. Generally, the relative humidity follows opposite pattern to that of temperature.

Wind: This influences both incidence and duration of the wet season considering the whole year, southern winds predominate over northern winds in the Borgu sector of the park. There is also a distinct seasonal trend, with the dry, dusty, northern winds prevailing during the beginning of the dry season that is November to February, while the moist southern winds prevail throughout the wet season.

Topography: The landscape of the Borgu Sector of the Kainji Lake National Park is gently undulating. Its features may be related to the lithology and erosion history of the area. The relief is broken in places by quartzite ridges (FAO, 1974). Elevation of the central and Western parts of the park lie between 800 and 1,000ft the highest point in the park is 1135ft in the Northwest. Kubil hill, just outside the Northern boundary of the park has an elevation of 1,684ft (FAO, 1974). The land slope down from the East to the Niger valley. The lowest elevations are along the Kainji shore where the normal maximum high water mark is 465ft contour (FAO, 1974; Afolayan, 1977).

Geology: The Borgu sector of the park is underlain by the Basement Complex which was considered to be Pre-Cambrian in origin (Afolayan, 1977). Most of the area is composed of gneissose rock and other units consist of younger metasediments which are mainly schists and phyllites. According to FAO, (1974), the park is underlain by undifferentiated metasediments in the east and west. The Basement Complex was until recently considered as pre-cambrian. However, Truswell and Cope, (1963) presented age determination which will place it in late Pre-cambrian or early Paleozoic.

Soil: Detailed soil survey of the Borgu sector shows that the soils in the area are low of fertility. It is slightly acid to natural and the acidity increases irregularly with depth. Although the soil nutrient is low, well developed and maintained savanna woodland exists on this soil. Meanwhile, the park has over ferruginous tropical soil and crystalline acid rocks (Anon 1964). Also the soils are shallow.

Drainage: The drainage is to the east because of the slope into River Niger through River Oli which is the largest river in the park. The river Oli and its tributaries drain the western part of the Borgu sector while the eastern part are drained by rivers Doro, Timo and Menai into Kainji lake. The river covers an estimate of about 3.305kms from the Nigeria border with Republic of Benin to where it empties into the Niger River. The river has maximum flow of approximately 600-700mm³/sec of water at the end of wet season breaks into pools in the dry season. The main tributaries of the Oli river are; Uffer, Koa, Nanu, Suma and Suna. Though other unnamed seasonal rivers also feed the Oli river in the wet season. There are six drainage basins in the western part of Borgu sector, viz the lower and upper Oli, Suna, Nanu, Uffa, and an unnamed basin which covers about three quarters of the sector. In the eastern part are seven drainage basins giving a total of thirteen basins. Eroded water from these rivers contributes to the volume and rate of flow of the Oli river in the early part of the wet season. During dry season, surface flow ceases in all the major rivers particularly the Oli River and only pools remain which provides sources of perennial water for wildlife population.

19. Research methodology

Reconnaissance survey: The reconnaissance survey was carried out in the month of June 2008 to get acquainted with the terrain of the park. Information from the park management and the review of previous literature on salt lick mineral in the park served as a bedrock towards successful reconnaissance survey. This aided in choosing the study site and the ecological survey method used. The study covers between June 2008-February 2009 (6month). The following were predetermined to aid sampling design.

Ecological survey: Based on the methodology adopted from Ayodele,(1988), Lameed,(1995) and Akanbi,(1997), which stated that an ecological survey for an area should be conducted on a comparative bases, particularly the heterogeneous to indicate a long term range. The study was carried out in the Borgu sector of Kainji Lake National Park. Out of twenty salt lick areas in the Kainji Lake National Park, four were selected based on concentration of the

salt and species to the spot, management and tourists' preference and proximity to the camp. The inventory of the place was taken which are:

- a. Inventory of the salt lick in three places, that is, the middle, the upper and the lower parts to look at the composition of the minerals.
- b. The fauna and vegetation were assessed by laying four (4) transect 1km each in each of the salt lick. This transect was taken towards the north, south, east and west which form the radii of the utilized areas.

Point Centre Quarter Method (Vegetation sampling): For vegetation, point centred quarter method were taken at every 10m and the fauna were assessed looking into the direct and indirect survey of fauna species to note the absolute and relative density of the species around the area. The relative density is to assess the significant of the spur rate of the species along transect by identifying the faecal samples, foot prints, death/ carcass and calls of the species available within the transect (Hopkin, 1974).

A transect of 1km was cut from each of the sites with the use of a cutlass and a compass to align the transect line. Each transect was marked at 50m intervals. Daily survey of the transect along the salt lick was carried out as early as 6.30am with the assistance of the research officer and a ranger from the park and backed by 2.pm. The early morning study was designed to survey some of the wild animals that are inactive and sluggish in the afternoon whose detection may be difficult and liable to error. At the beginning of each early outing on the salt lick, the following were recorded;

- Location and the name of the tract
- Date
- Time (beginning and stop)
- Number of the salt lick.

Line Transect Survey: A line transect according to Roger, (1975), in a fixed path independent of external features along which survey will take place. At each outing the following equipments were used;

- Binocular for clearer viewing of animals at a long distance
- Camera for taking photographs
- Field notebook, pen and pencil
- A cutlass
- A wristwatch.

The following information was recorded at each salt lick sites

- Name, number and species of the flora and fauna around the salt lick sites
- Activities of the animals
- Droppings of the named and species of the animal found
- Footprints of the named animals
- Food materials. Carcass of the animal
- Calls of the animal

- Habitat type

20. Search method for direct and indirect methods

Both the direct and the indirect methods were used to study the animals that visit the salt lick. This involved walking along the delineated transect line and looking for signs of species presence. The stop and search method was used as an indirect method of estimating wildlife population through the use of faecal droppings, footprints, feeding/remnant and calls of the animals. The following assumptions for animals that visit salt lick was outlined by Burham et al 1980; Seber, (1982). These are

1. The number of footprints of a particular animal was closely examined and traced to the salt lick.
2. The number of faecal samples was observed along the transect
3. The feed/remnants of animal along the transect were also examined
4. The activities of the animals around the area and along the transect was examined
5. Sighting of animals was carried out
6. The faecal droppings containing salt lick was picked and examined
7. Backward movement along transect to confirmed the samples was limited and observation period not more than 10minutes.
8. Samples positioned directly over the transect line was not missed. It was also understood that not all the sample within the survey area was detected. Some was inevitably missed and possibility of detection declined with increase distance from the transect line or survey path.

21. Population density

To determine the population density for each species of the animal encountered during the survey. Time species count was used as outlined by (Ajayi, 2001). The formula is as follows

$$P = \frac{AZ}{2XY}$$

Where:

A = Area occupied by the species

Z = number of animal seen

2 is constant

X = sighting distance

Y = length of transect

The area (A) is determined by multiplying the transect width by the length of the transect.

The number of the animals seen (Z) = species seen/transect

22. Data analysis

All data collected were subjected to appropriate statistical analysis depending on the nature of the study. Correlation, Analysis of variance, descriptive analysis and T-test to differentiate two variables were used to draw conclusion.

Graphs, photographs and diagrams were used at appropriate places for proper result. Chi-square test was also used to analyse the result.

23. Results and discussion

	A	B	C	D
Kobus kobs	65	51	20	20
Hippotamus	39	21	13	33
Roan antelops	1	10	4	-
Red flank dunker	5	13	1	-
Hares	1	2	-	-
Baboons	10	13	9	4
Silvet cat	2	3	5	2
Bush buck	9	2	-	-
Monkey	4	3	2	1
Lion	1	5	-	1
Flankolin	-	-	-	1
Crocodile	-	-	-	1
Total	137	123	54	63
Average	13.70	12.30	7.71	7.86

Table 2. Table 2: Diversity of Wild animals sampled within the various transects studied.

Table 3 shows record of animal sample within various transects at the four sites (A, B, C and D). It was observed that the highest number of animals is recorded in transect A (137) with an average number of 13.7, followed by transect B (123) with an average number of 12.3. the lowest value is recorded in transect C (54) with an average of 7.7.

Parameters	df	ms	f	p-level
Salt lick1	3	81687.34	10.1038	0.0013+
Error	12	8084.833		
Total	15			

Table 3. ANOVAs for Number of trees/hectare

The table 3 above shows that at p-level there was no significant difference ($p>0.05$) in the number of trees/hectare. Therefore the alternative hypothesis was accepted that said there was no significant difference in the trees/hectare in the salt lick sites.

Parameters	df	ms	f-cal	p-level
Salt lick2	3	305.58	2.0204	0.1648
Error	12	151.25		
Total	15			

Table 4. ANOVAs for number of different trees at the salt lick sites (tree diversity)

Table 4 above shows that there was significant difference ($p<0.05$) in the tree diversity across transects at the salt lick sites. Therefore the null hypothesis is accepted while the alternative is rejected.

Parameters	df	ms	f-cal	p-level
Salt lick3	3	1757.67	.390	.7623
Error	12	4702.5		
Total	15			

Table 5. ANOVAs for number of animals/hectare at salt lick sites

The table 5 above shows that at ($p < 0.05$) there was significant difference in the animals across the four transects. Therefore a null hypothesis was rejected while the alternative hypothesis was accepted.

Parameters	df	ms	f-cal	p-level
Salt lick4	3	39.3333	.39008	.762310
Error	12	100.8333		
Total	15			

Table 6. Anova for different animals/hectare at the salt lick sites (animal diversity)

The results obtained from the direct and indirect survey shows that f-cal was significantly difference at ($p > 0.05$). Alternative hypothesis was accepted that said that there is significant difference in animal species across transects as seen in table 6 above.

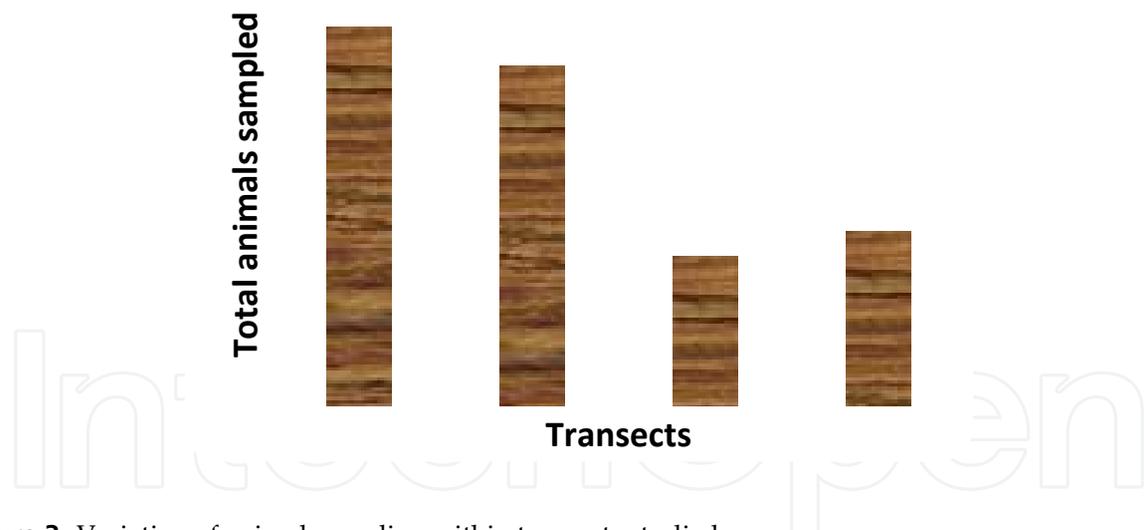


Figure 3. Variation of animal sampling within transects studied.

Figure 3 above and the graph shows that the highest animal sampling was recorded in transect one (13.7), followed by transect two (12.3) and the lowest value was in transect three (7.7).

The table 7 below shows the records of various trees sampled within the transects. Transect three(C) recorded the highest value of trees (213) and the average is 14.20 while the lowest is recorded in transect A (149) and the average of 9.93. Meanwhile *Acacia spp* was found to be dominant species within the four transects.

	Transects			
	A	B	C	D
Trees				
<i>Acacia spp</i>	42	84	28	81
<i>Annogeissus leiocarpus</i>	30	11	33	6
<i>Daniella Oliverie</i>	6	22	6	14
<i>Terminalia spp</i>	32	8	37	10
<i>Detarium microcarpum</i>	4	4	51	2
<i>Burkea Africana</i>	12	7	12	4
<i>Gardenia sokotolensis</i>	2	7	1	1
<i>G. aquala</i>	8	6	9	6
<i>Strychnos spinosa</i>	1	1	4	14
<i>Bytyrospermum paradoxum</i>	1	3	6	9
<i>Darsperus mispiliformis</i>	1	4	1	1
<i>Tamarindus indica</i>	5	7	3	2
<i>Afzelia Africana</i>	2	3	5	2
<i>Tetrap tetrap</i>	2	4	12	6
<i>Acaria spp</i>	1	4	5	2
Total	149	175	213	160
Average	9.93	11.67	14.20	10.67

Table 7. Diversity of Vegetation sampled within transects studied.

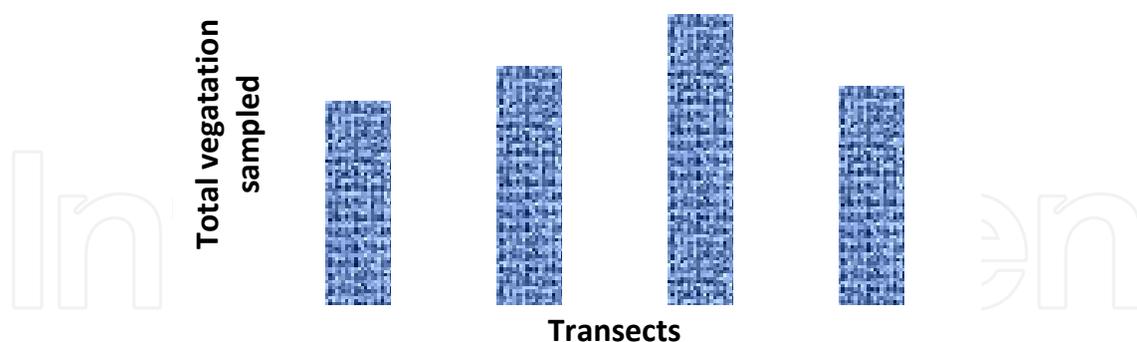


Figure 4. Variation in total vegetation (trees) samples within transects.

Figure 4 above shows that transect three has the highest tree samples (14.2) followed by transect two (11.67) and the lowest was recorded within transect one (9.93).

The results obtained from the direct and indirect survey shows that f-cal from the two survey types was significantly different ($p > 0.05$) from each other. Alternative hypothesis was accepted that said there are significant differences in the trees sampled as seen in table 8 above.

ANOVA: Single Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
			9.93333	179.209
A	15	149	3	5
B	15	175	11.6666	424.952
C	15	213	7	4
			14.2	238.314
			10.6666	3
D	15	160	7	5

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>Df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
	156.183		52.0611		0.91759	2.76943
Between Groups	3	3	1	0.1679	5	1
			310.071			
Within Groups	17364	56	4			
	17520.1					
Total	8	59				

Table 8. ANOVA of trees sampled with the transects groups.

Salt licks	%Na	%Ca	%Mg	%K	Fe (mg/Kg)	%PO4	%SO4
1	3.69	1.79	0.88	6.76	1149	0.73	0.35
2	4.18	3.54	1.23	4.46	992.81	1.93	0.55
3	3.79	1.92	0.81	6.81	1168	0.89	0.39
4	4.21	1.85	0.79	6.95	1173	0.87	0.43

Table 9. Chemical analysis of mineral contents in salt licks.

Fig.5 shows that the level of sodium (Na) is highest in salt lick site four (4.21%), followed by salt lick site two (4.18%). There is no much different between the percentage level of sodium salt lick sites one and three (3.695 and 3.765), but the lowest was recorded in salt lick site one.

Salt lick site two has the highest percentage level of calcium (3.54%), while the lowest percentage level of calcium was recorded in salt lick site one (1.79%). Salt lick site three and four has (1.92% and 1.85%) respectively (Fig. 6).

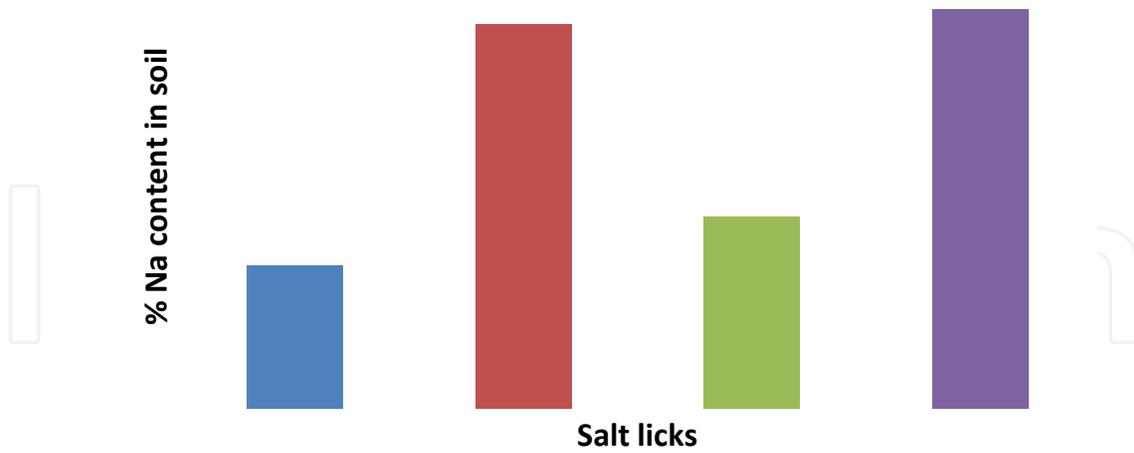


Figure 5. Concentration of Na (%) in salt licks studied.

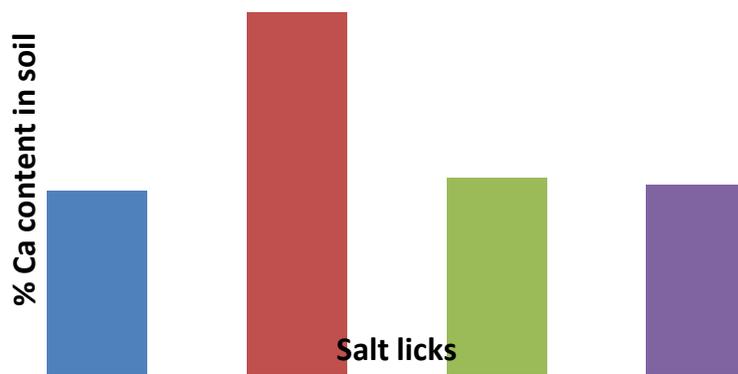


Figure 6. Concentration of Ca (%) in salt licks studied.

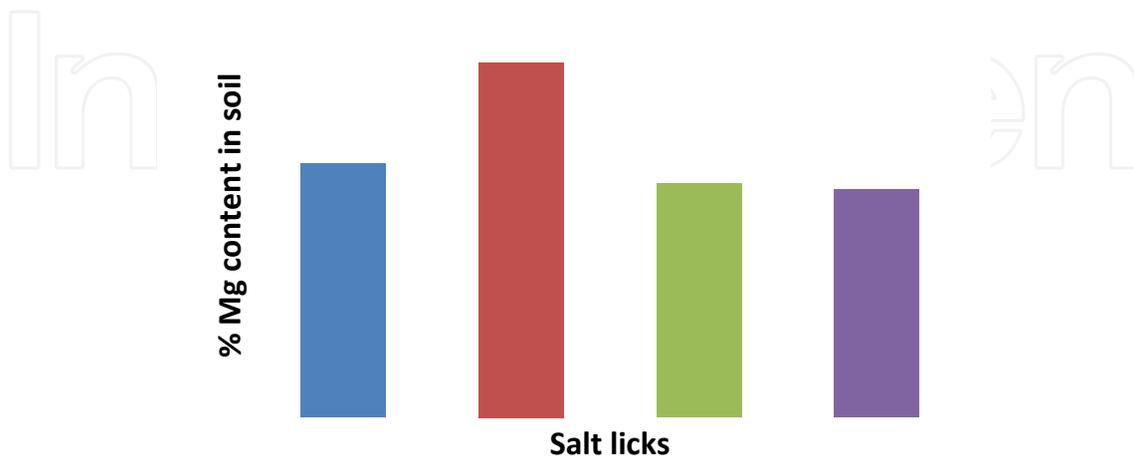


Figure 7. Concentration of Mg (%) in salt licks studied.

Fig.7 above shows that the salt lick site two has the highest level of magnesium (1.23%), followed by salt lick site one (0.88%). The lowest value was recorded in salt lick site four (0.79%).

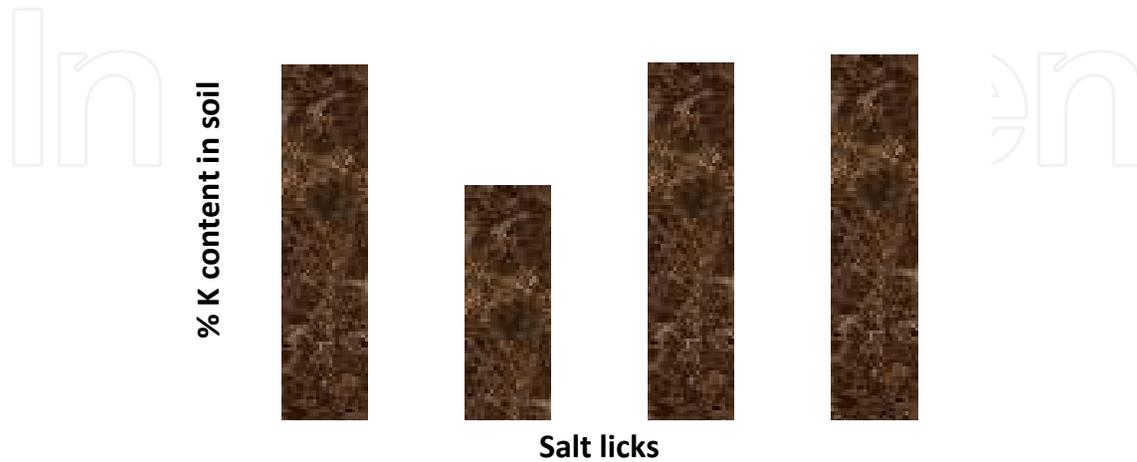


Figure 8. Concentration of K (%) in salt licks studied.

Among all the minerals present in the salt lick sites, potassium was found to be the highest mineral content. Fig. 8 above shows that salt lick site four has the highest level of potassium content (6.95%), followed by salt lick three(6.8%), salt lick one(6.76%) and salt lick two has the lowest (4.46%).

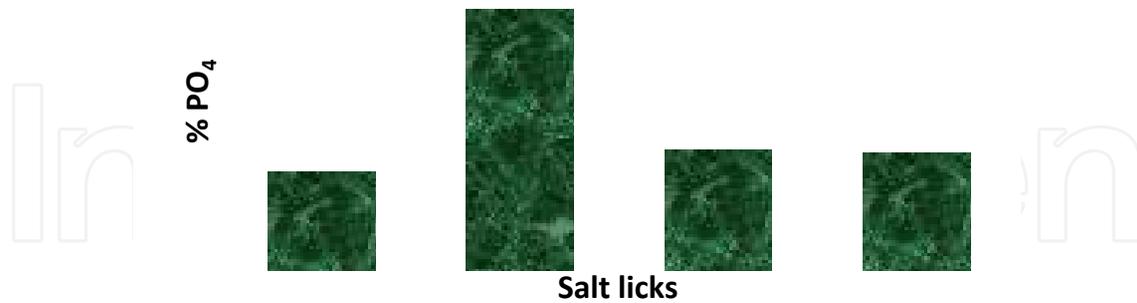


Figure 9. Concentration of PO₄ (%) in salt licks studied.

Figure 9 shows the highest percentage level of phosphate in salt lick two (1.93%). The lowest level is in salt lick one (0.73%). Salt lick three and four have (0.89% and 0.87%) respectively.

Iron is measured in milligramme per kilogramme (mg/kg) and not in percentage. The highest value is in salt lick four (1173mg/kg), while the lowest is in salt lick two (992.81mg/kg). Salt licks one and three have (1149mg/kg and 1168mg/kg) respectively (Fig. 10).



Figure 10. Concentration of Fe (mg/Kg) in salt licks studied.

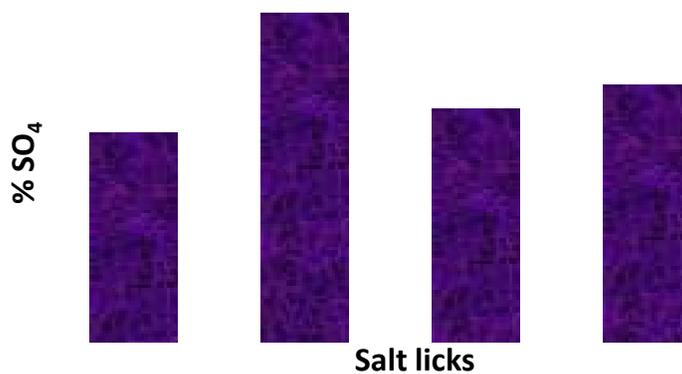


Figure 11. Concentration of SO₄ (%) in salt licks studied.

Sulphate was found to have the highest percentage value in salt lick two (0.55%), and the lowest percentage value in salt lick one (0.35%). Salt lick four has the value of (0.43%) and salt lick three has 0.39% (Fig. 11).

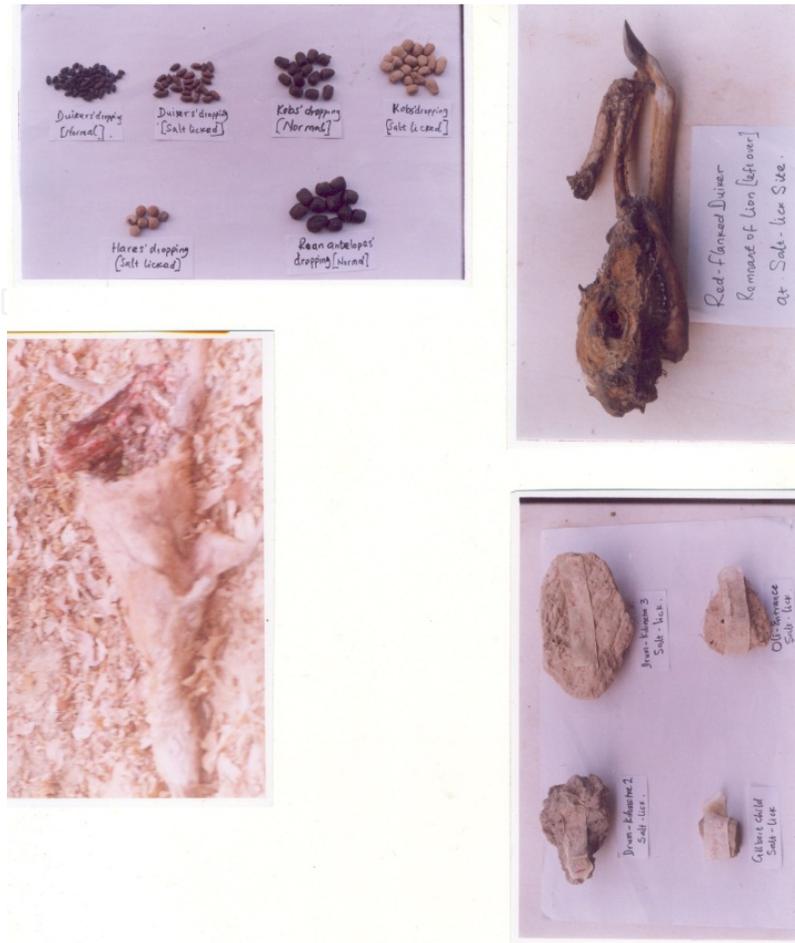


Figure 12. Droppings of wild animals and remains of some species killed by carnivores utilizing the saltlick site within the KLNP.



Figure 13. One of the carcass of infant herbivores found at the saltlick site with the collected droppings.



Figure 14. Elephant is one of the common preferred species visiting saltlick site in the Park.

24. Conclusion and recommendations

Kainji Lake National Park is an important reservoir for several wild herbivores. From this study, the results show that the highest population of animal was recorded in salt lick site three (3) and one (1), that is the Oli Entrance and kilometre three Drum. This was significantly different ($p < 0.05$) and higher than those in salt licks four (4) and two (2). Therefore it could be deduced that herbivores have more preference to salt licks near river sides than those that are not.

The population density of the animal in the area was established by indirect/relative survey, since it has to do with the observation of some indices like footprints, feed remnants/signs, and faecal droppings. Carnivores were also noticed at the study site like lion by the carcasses and call of the animal. It was observed that there was an interrelationship between animals in the lick as some fruits were found at the lick sites. Most of the animals were not seen due to their nocturnal nature and shyness. Therefore indirect/relative method of transects survey was ideal to established their presence, distribution and abundance. The activities of the animals were also assessed.

From the study, the result of the analysis shows that both the macro and trace elements are present in the salt licks of the park. The mineral elements identified in the salt lick are; calcium, sodium, potassium magnesium, phosphate, iron, and sulphate. Potassium is most abundance mineral element in the salt licks while sulphate is the least abundant. The analysis revealed that the salt lick of the Oli complex contain the highest potassium and iron. This is probably due to the accumulation of dead leaves, defecations, urination and soil parent materials. The salt lick one has low calcium and sodium mineral elements due to the fact that there was less abundance of vegetation due to erosion of the upper slope of the reserve. Hence these minerals could have been leached away by erosion.

Salt lick spot are quite abundance in Kainji Lake National Park (KLNP) which is frequently used by different herbivores and carnivores. Hence the lick plays an important role in

supplementing minerals lacking in the animal's diets. The licks therefore helps in preventing nutritional diseases and disorders that could result due to lack of these minerals and also in biodiversity conservation of wild fauna species of the park.

25. Recommendations

The results show that different herbivores utilize the salt licks in the park and this cannot be completely exploited on short duration and single handed project of this nature. It required continuous research work to be carried out on many other areas of interrelationship with natural ecosystem where they are found. Effort should be made to establish the proximate population and consistence to monitor the population. This will enable the management of the national park to know if the government and non governmental investment is achieving the desired impact.

Efforts should be made towards the rate of poaching activities in the park by reintroducing the special squad to complement the effort of the forest guards. Communication equipments like walkie-talkie, GSM antenna should be provided in the park, handsets, boots and patrol cloths should be provided for the guards to carry out their duty effectively. The numbers of park guards present are grossly not adequate as compared to the increase number of poachers daily. More park stations should be created to boost the morals of the guards and more sophisticated arms given in view of the risky nature of the job. Residential quarters should be built by government for the park guards to live as the situation of rented building is exposing them to high risk and at the same time stand a chance of compromising their work with the poachers. Good incentives like food, medicals allowances should be provided for the park guards. Unannounced visit to the park station by senior officers should be vigorously carried out to ascertain if guards are on patrol regularly.

The Support Zone Development Programme (SZDP) should supervise the disbursement of loans to the community and the use of the loan to the community. The enlightenment on the conservation should be fully understood by the people. Therefore it should go beyond radio, television announcements, pamphlets and seminars, but house -to- house enlightenment should be used for the message to be fully understood. Infrastructures should be provided for the host community to justify the forfeiting of their resources to the government. Indigenes should be given scholarships to enable them go to school to reduce their dependence on hunting and logging which they carried out as a means of livelihood.

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