LAKE OL' BOLOSSAT
SYNTHESIS REPORT

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DECEMBER, 2017

THE EAST AFRICAN WILD LIFE SOCIETY

The Rufford Foundation
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Acknowledgement

This Synthesis Report was produced by East Afrian Wild Life Society (EAWLS), with the generous support of Rufford Foundation through "Building a case for sustainable management and gazettement of Lake Ol' Bolossat through ecosystem information collation and synthesis" Project.

Jabes Okumu prepared the Report. Special thanks to Charles Mwangi (EAWLS Head of Programmes) and Wamiti Wanyoike who reviewed the Report. Development of this Report was possible because of the information which was gathered from various Government, Non-Governmental institutions and individual researchers. Many thanks to National Environment Management Authority, Water Resources Authority, Kenya Wildlife Service, County Government of Nyandarua, Kenya Forest Service, Kenya Wetlands Forum, Nature Kenya, Birdlife International and Nyahururu Bird Club. Their contribution is highly appreciated.

Disclaimer: The views expressed in this publication do not necessarily reflect the views of Rufford Foundation

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Acronyms and Abbreviations

A.S.L	Above Sea Level
AEWA	Agreement of the Conservation of African-Eurasian Migratory Waterbirds
ASAL	Arid and Semi-Arid Land
CEPF	Critical Ecosystem Partnership Fund
CETRAD	Centre for Training and Integrated Research in ASAL Development
CIDP	County Integrated Development Plan
CMS	Convention on Migratory Species
DRSRS	Department of Resource Survey and Remote Sensing
E	East
EAWLS	East African Wild Life Society
EC	Electrical Conductivity
ENNDA	Ewaso Nyiro North Development Authority
G.O.K	Government of Kenya
GDP	Gross Domestic Product
IBA	Important Bird Area
IDPs	Internally Displaced Persons
IGAs	Income Generating Activities
KBA	Key Biodiversity Area
KM	Kilometres
KWF	Kenya Wetlands Forum
KWS	Kenya Wildlife Service
M	Meters
MEA	Millennium Ecosystem Assessment
N	North
NBC	Nyahururu Bird Club
NEMA	National Environment Management Authority
NLC	National Land Commission
NMK	National Museums of Kenya
RCMRD	Regional Centre for Mapping of Resources for Development
S	South
Sq. Km	Square Kilometre
WRMA	Water Resources Management Authority

Executive Summary

Lake Ol Bolossat is the only lake in Central Kenya and is also the East African's highest altitude lake of its size, lying at an average altitude of 2340 metres above the sea level. The lake is unique in the sense that it is both salty and freshwater. It is uniqueness offers a variety of habitats making it reach in biodiversity. It is the main catchment for the Ewaso Nyiro River that flows through key national conservation areas, among them Samburu National Park and Buffalo Springs, all of which are designated Important Bird Areas (IBAs) supporting lifelines for people, livestock and wildlife in most Kenyan dryland areas.

Being close to the Great Rift Valley, the lake sits along one of Kenya's most important bird migration flyways, hence a suitable site for feeding and resting, and probably as a wintering ground for the Palearctic migrants. It home to hippos and over 100 species of birds. The lake is listed among the IBAs in Danger due to the ever-increasing threats it faces which include but not limited to siltation, encroachment, pollution, over-exploitation, human-wildlife conflict and invasive species.

EAWLS explored available literature about this lake and produced a synthesis report with support from Rufford Foundation through the project ***"Building a case for sustainable management and gazettement of Lake Ol' Bolossat through ecosystem information collation and synthesis"***. The aim of this project was to consolidate all the available information about the lake and use it to influence the gazettement of the lake and inform the review of the Lake's Integrated Management Plan.

This report therefore summarises existing information about the lake and recommendations for research to fill the existing information gap.

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CHAPTER ONE

INTRODUCTION

1.1 Background information

Recently, with funding from Birdlife International through Critical Ecosystem Partnership Fund (CEPF), EAWLS undertook a six-month project entitled ***"Enhancing Environmental Regulations in Safeguarding Lake Ol' Bolossat in Nyandarua County, Kenya".*** This project aimed at promoting conservation of Lake Ol' Bolossat for its environmental services and values. One of the key components of this project was a multi-stakeholder workshop in which challenges facing Lake Ol' Bolossat were discussed and possible solutions proposed. The end output of this workshop was a joint action plan.

One of the key issues identified under the action plan was that the information about Lake Ol' Bolossat is largely fragmented with limited accessibility. A situation which was attributed to the fact the lake lacks formal protection status and thus no custodianship. It was therefore agreed that there is need to collate and synthesize the available information about the lake. In response to this need, EAWLS initiated a project entitled ***"Building a case for sustainable management and gazettement of Lake Ol' Bolossat through ecosystem information collation and synthesis"*** with funding from Rufford Foundation. This project aimed at collating and synthesizing existing information about Lake Ol Bolossat to initiate and influence policy dialogue on gazettement of the lake and inform the review of the management plan and the County Integrated Development Plan (CIDP). This project therefore was complementary and important in actualizing an important recommendation of EAWLS' previous work at Lake Ol' Bolossat, and was to provide strong basis to advocate for better management and gazettement of the lake. This report therefore provides a summary of all the existing information about the lake that will form a basis for pushing for its eventual protection and sustainable conservation.

The report summarizes all the existing information about the lake that was reviewed and synthesized. This include but no limited to the general description of Lake Ol Bolossat (geographical location and size, hydrological characteristics, topography, geology and soils), conservation status, ecological and socio-economic setups, conservation challenges, and land use and land use changes. The report also provides recommendations based on the information gaps identified during the literature review and interviews.

1.2 Methodology

The main method employed in this study was desk review. Data was collected through a systematic review of available documents relevant to Lake Ol Bolossat as well as from web research. Key informant interviews with experts who have worked with in and around this area were also conducted. The documents reviewed included research papers, workshop reports,

newspaper articles, meeting minutes and project reports among others. The desk review of information regarding the lake was preceded by three key activities: (1) Analysis of stakeholders (information holders); (2) development of information collation checklist and; consultative meetings with some of the key stakeholders. The analysis of the stakeholders was done under the auspices of the Kenya Wetlands Forum (KWF) to ensure wider coverage of the stakeholders.

Key institutions such as the county government of Nyandarua, National Museums (NMK) of Kenya, Nature Kenya, Kenya Wildlife Service (KWS) - Nyandarua County, Water Resources Management Authority (WRMA) and Nyahururu Bird Club (NBC) among others were consulted during the information gathering. Individual researchers who have conducted research within and around the lake were also consulted. Consultations involved face to face discussions and email conservations.

The information collected was sorted for easy review and was synthesised into a report that was validated Kenya Wetlands Forum.

1.3 Limitations

Generally, there is lack of sufficient and reliable in-situ data about the lake. The available datasets are scanty and hardly updated on a consistent basis to provide the required thematic information. The existing information about the lake is also largely fragmented and thus this report may not reflect all the available literature about the lake. A large proportion of the information reviewed about the lake is outdated and thus may not necessarily reflect the current situation of the lake.

CHAPTER TWO

GENERAL DESCRIPTION OF LAKE OL' BOLOSSAT

2.1 Physio-chemical features

2.1.1 Geographical location and size

Lake Ol' Bolossat is a tiny alkaline lake known as the only natural highland lake, higher than any of the Rift Valley lakes (Crafter et al., 1992). The available literature classifies the lake as both salty and freshwater lake. The streams that recharge the lake are freshwater while the salty nature of the lake has been attributed to high evaporation rates and the geology of the lake. It is situated on a flat plain northwest of the Aberdare Range in Nyandarua County (Central Kenya) bordered by Ndaragwa, Ol' Kalou and Ol' Joro Orok Divisions, lying on the north Kinangop Plateau at the base of the Satima Escarpment (Figure 1). It is located approximately 195 km north of Nairobi, at around a latitude of 0° 09' S and longitude 36° 26' E. It has an estimated area of 43.3 square kilometers (Krhoda, 1992) of which open water covers about 4 Sq. kilometres (NEMA, 2007).

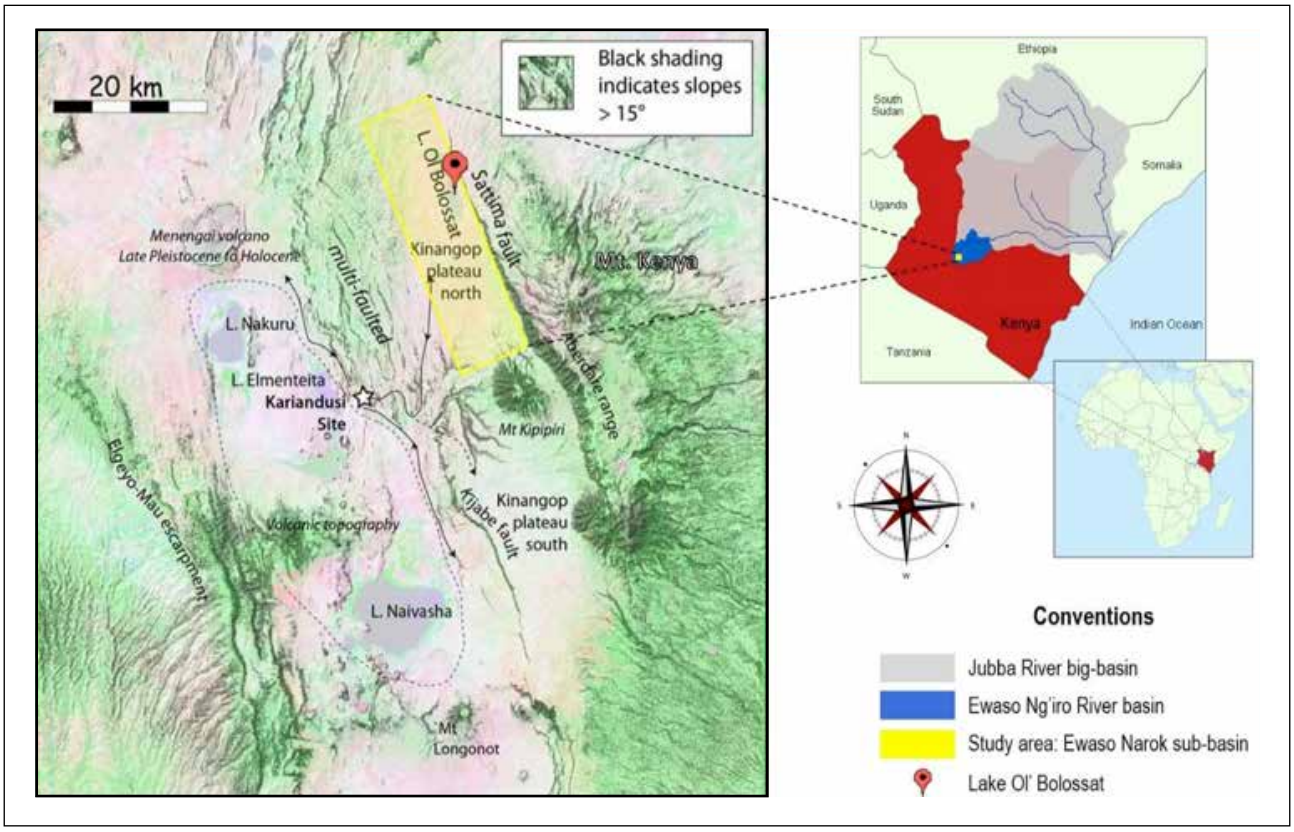

Figure 1: Geographical location of Lake Ol' Bolossat

2.1.2 Topography

The main physical features of Lake Ol' Bolossat region include Kinangop Plateau and Ol' Kalou/ Ol' Joro Orok plateaus which have slopes that are interrupted by low undulating hills and sloping depressions. The gentle slopes flatten to plain-like features encouraging the formation of marshlands, swamps and Lake Ol' Bolossat. Lake Ol' Bolossat ecosystem, therefore, provides a variety of important ecosystems including open waters, floating swamps and marshes, savannah and riverine forests and feeder springs (Lake Ol' Bolossat Management Plan, 2008).

The Ol' Bolossat plain was affected by volcanic and faulting which gave rise to major land forms; the Great Rift Valley to the west and Aberdare ranges to the east. Further to the west, the land surface is broken by faults forming a complex of shallow horst and graben structures. The graben in which Lake Ol' Bolossat lies is bounded by weak faulting on the west, developing increasingly to the south, and on the east by the Satima Escarpment (36 km-long and 2,500 m A.S.L. altitude) running south from Thomson's Falls, where it takes the place of the Laikipia and Chui-Lolderodo Escarpments as the eastern most scarp of the Rift Valley. The lake lies at an average altitude of about 2,340 m A.S.L. in a wedge-shaped rift valley floor known as Ongata Pusi. In the south-east corner of the area, Mount Kipipiri which is part of the Aberdare (Nyandarua) Mountains is 3,349 m A.S.L (Birdlife International, 2017) and 914.4 m from the Ol' Bolossat plain, is an isolated volcanic eminence separated from the Satima massif by the deep cleft of the Wanjohi Valley (McCall, 1967).

2.1.3 Climate

The region enjoys favourable climate for most periods of the year. Climate is semi-humid and is strongly influenced by local topography due to the surrounding highlands. The mean annual rainfall ranges between 400 - 1,000 mm increasing southwards and westwards of the region. Njuguna *et al.* (2014) describes the lake to be in an Agro Climatic zone receiving between 900 and 950 mm of rainfall in the north and south respectively. Areas near the Aberdare slopes receive sufficient rainfall (< 1,000 mm) while the Ol' Bolossat plateau receives scanty and erratic rainfall (400 – 600 mm). Rainfall regime is bi-modal with peaks in April–June and October–November, although the instability of the air near the equator causes rain especially from July to September between the sub-humid periods of April–June and September. Over 60% of the annual rainfall is received in the first wet season (Figure 2).

Figure 2: Mean annual rainfall distribution in Ol' Bolossat Catchment area. (Mathenge, 2013).

The mean temperature is 23.5° C, with little monthly variations between 10° and 28°C. The highest temperatures are experienced in December and January and the lowest occur in July. Although in January and September when extremely cold, winds originate on the moorlands of the Aberdare Mountains and blow to Ol' Bolossat plateau, there are major diurnal variations resulting in incidences of frost which destroy food crops, fodder and wild vegetation especially grasses. The cold winds are trapped in the valley and hence the area experiences night frost nearly every month of the year. The temperatures in these periods can fall to between 1.20 C and 1.30 C which last for few hours before sunrise (Wamiti et al., 2008).

2.1.4 Geology

The basin fills consist of Mid-Pleistocene to Holocene lake sediments interbedded with volcanic ash and pyroclastic deposits (McCall, 1967; Bergner et al., 2009). The region is dominated by volcanic rocks, and volcanoclastic and lacustrine sediments (Figure 3). The volcanic rocks are predominately lavas and pyroclastic deposits from the Late Miocene to the present (Baker *et al.*, 1988).

The oldest volcanic units are Late Miocene plagioclase-rich basalts of the Aberdare and Mount Kipipiri. Early Pliocene basalts and phonolites outcrop along the Satima fault Escarpment and the northern part of the Aberdare range. The Kinangop plateau is mostly Pliocene and Pleistocene tuffs and ignimbrites with trachytes to the south and north. Basalts dominate the Sattima fault, Mount Kipipiri, and the Aberdare range (McCall, 1967; Leat, 1991).

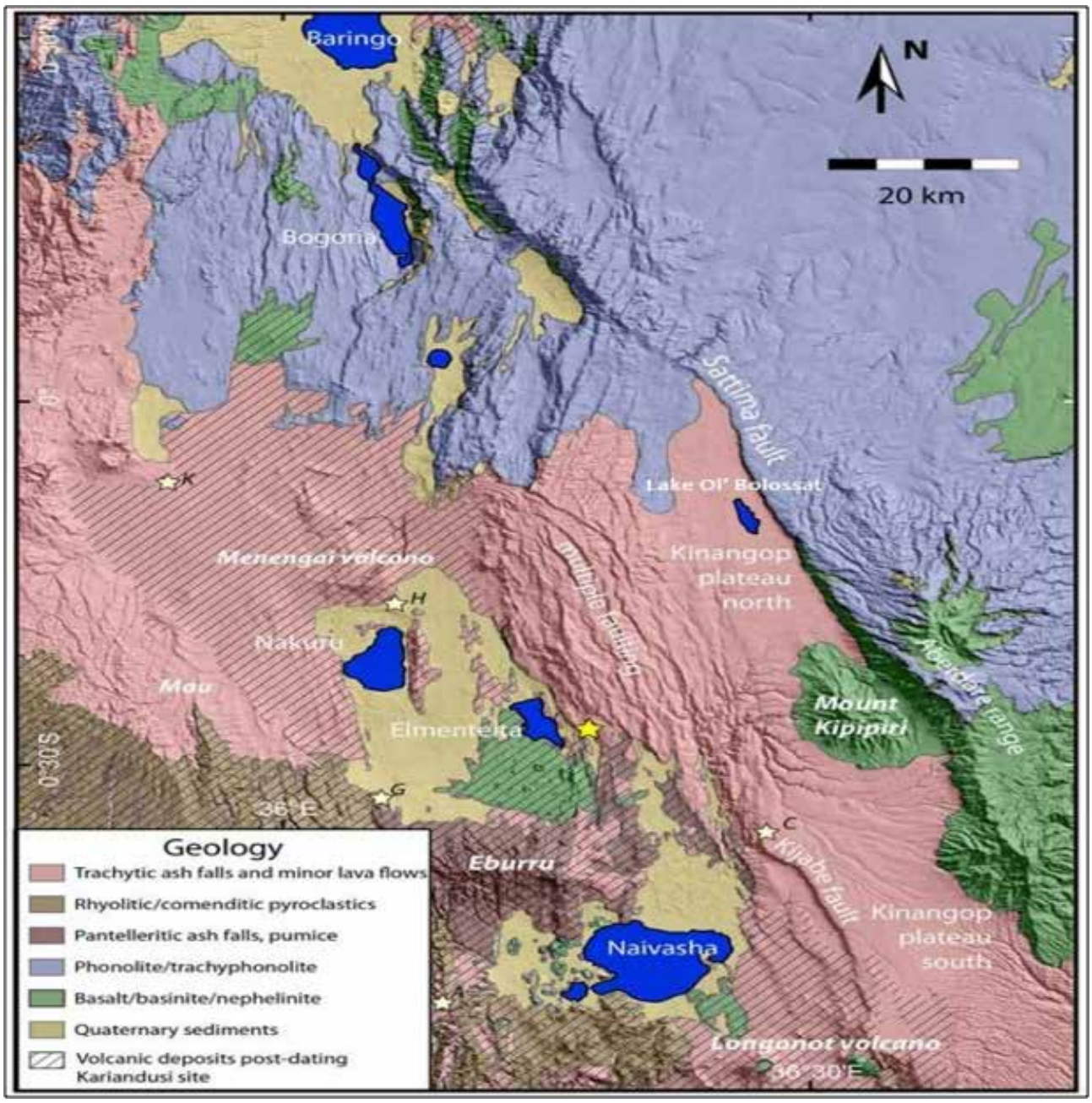

Figure 3. Geological map of the rift and flanks from Lake Naivasha to Lake Baringo.

In figure 4, the Lake is located in the Kenya dome, an area where structures resulting from a variety of tectonic events converge. The area has been affected by (1) thrusting related to one or more collisional events during the formation of the Mozambique belt, (2) deformation associated with its location between the Nyangea–Athi–Ikutha shear zone to the north and the Aswa–Nandi–Loita shear zone to the south, which are major NW–SE-trending zones of ductile shear and thrusting in the underlying Precambrian basement, and (3) sub-Miocene uplift and doming followed by magmatism and N–S-trending rift faulting. All these events must have some influence on the gravity anomalies observed today (Keller, 2015).

Figure 4: Tectonic map of the southern Kenya rift showing the surface distribution of the major lithologic units. Mfz: Mau fault zone; Sf: Sattima fault; Kf: Kinangop fault zone; Ol: Oloolo Escarpment; Ok: Olkaria volcanic centre (Keller, 2015).

Ol Bolossat plain near Ol' Kalou is bounded on the west by a series of tilted fault blocks separated by more than a dozen fault scarps which drop the land surface from the Bahati uplands down to the Bahati plain. There are no rocks exposed in the area older than the Tertiary era, and the entire sequence represented belongs to the Tertiary-Quaternary volcanic suite or to the sediments associated with this suite. The eruptive in each episode starts with basalt. The basalts are calc-magnesian with slight alkaline content, the intermediate lavas are distinctly alkaline and predominantly sodic. The rock types, basic and intermediate, preserve a remarkable uniformity of composition throughout Tertiary and Quaternary times.

The Sitima lavas described by Shackleton (1945) only just extend into the area in the south-east corner, equivalent basaltic volcanic succession. They are trachytes and phonolites with well-exposed dyke feeders on Satima. It is suggested that the commonly seen pattern of central and fissure eruptions, occurring concurrently, was operative and that these volcanic rocks erupted

from dykes congregated around the Satima-Kipipiri massif at the same time as the plateau phonolites were erupted from fissures along the margin of the rift zone.

In the south-east corner of the area an equivalent basaltic volcanic succession, the Simbara basalts, is exposed. These include agglomerates and tuffs, and form two massifs, the Satima (Aberdare) massif and Kipipiri. The latter is certainly a dissected central volcano, but whether Satima is not the flank of the same volcano, rather than a separate central volcano left far above Kipipiri by the subsequent faulting, is open to question. Feeder dykes of the Simbara lavas are numerous on Satima. The Samburu lavas are locally over 1,500 feet thick and the Simbara lavas have at least an equivalent thickness. There is an upper series of plateau phonolite–the Thomson's Falls phonolites–of rather a different lithology, which is easily distinguishable to the east of Thomson's Falls but appears to be intercalated within the Rimuruti phonolites elsewhere (Keller, 2015).

2.1.5 Soils

Njuguna et al. (2014) describes the soils of the Lake basin as luvisol. Most rock systems have lines of weaknesses occasioned by faulting which allows porosity and easy percolation. These are igneous rocks, volcanic, and alluvium. The soils in Nyandarua County are of volcanic origin and vary in both fertility and distribution. The county is endowed with moderate to high fertile soils. Soils in the Kinangop and Ol 'Kalou plateau are poorly drained clay loams. However, Ndaragwa, the northern part of Ol Joro Orok and Ol 'Kalou has well drained clay loams. These soils have different crop production potentials. (NCG, 2013).

The Satima escarpment is composed mainly of igneous rocks with a few areas having metamorphic rock strata. The soils on the Satima escarpment are grey loams dominated mainly by andosols and phaeozems and in the lake basin the soil is of black cotton soils, which are poorly drained, dominated by nitosols and xerosols. On the western side there are andosols and phaeozems (Mburu, 2014; NEMA, 2007).

2.1.6 Hydrology

The catchment area of Lake Ol' Bolossat is approximately 4800 km2. The area encompasses Nyandarua range, Satima escarpment, and Ndundori Hills. The lake serves as a catchment for Ewaso Nyiro River and supports important functions and lifestyles of communities living in the arid and semi-arid parts of North Eastern, Eastern and Rift Valley provinces. The marshes and swamps that form 85% of the lake ecosystem filter and purify the water (NEMA, 2007).
Figure 5 shows that Lake Ol' Bolossat region is part of the upper Ewaso Narok sub-basin on the western side of the Ewaso Ng'iro basin which derives most its waters from Nyandarua Range and Mount Kenya and whose major tributaries are Ewaso Narok and Ewaso Ng'iro-Mt. Kenya Rivers (Kinoti, 2011).

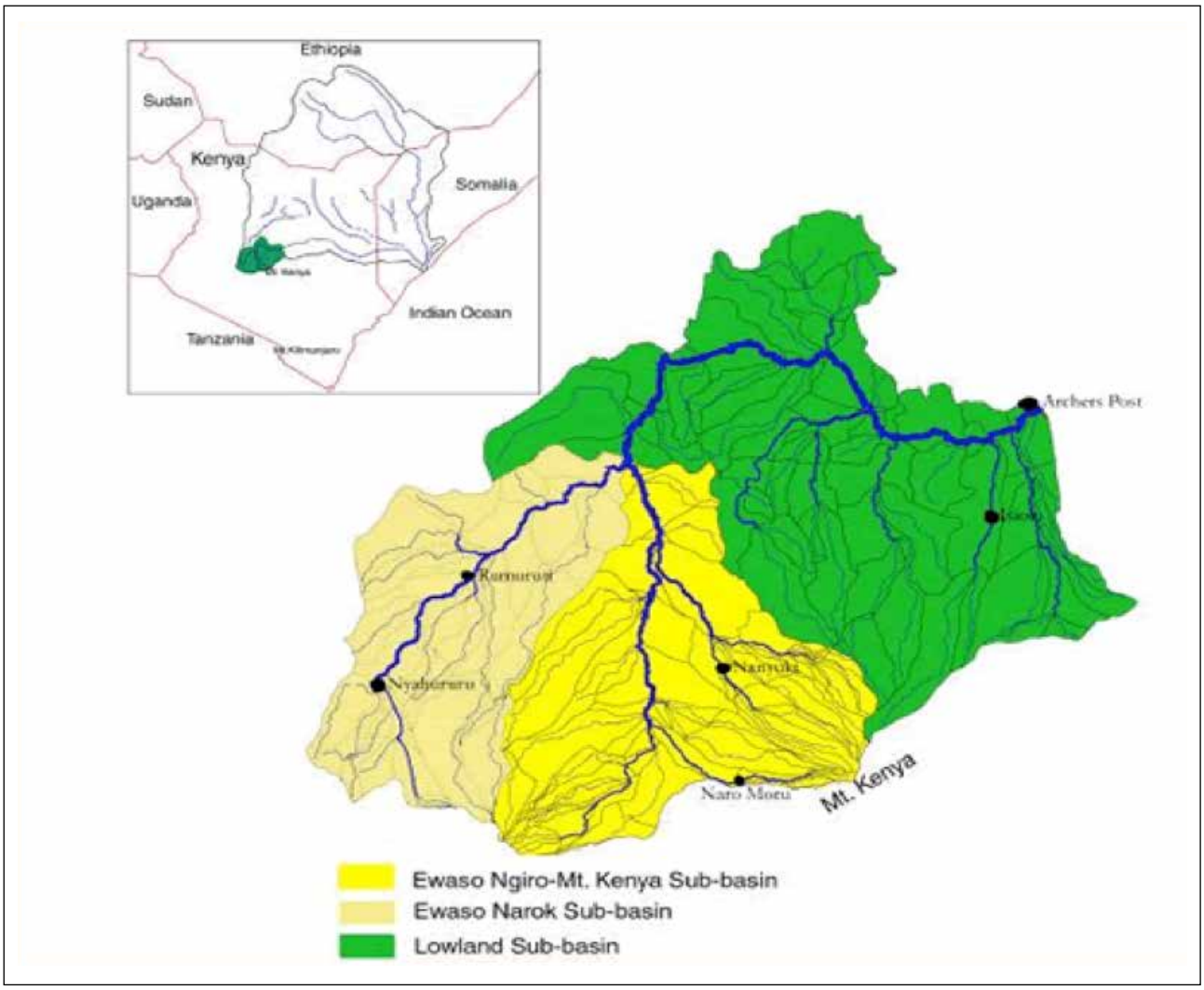

Figure 5: The upper Ewaso Ng'iro Basin (Kinoti, 2011)

The Ewaso Narok system consists of Rivers Ewaso Narok, Pesi and Mutura. There are swamps on each of these tributaries namely Ol' Bolossat, Ewaso Narok, Pesi and Suguta-Naibor, and mostly all these swamps have a high salt content possible due to high evaporation rate and partly to nature of sediments that constitute the area (Krhoda, 1992).

The water from the basin flows northwards through Thomson's Falls into the northern part of Ewaso Nyiro River. The Melawa River drains off Satima, its headwaters reaching up into the highest upland valleys. It plunges down the Sattima Escarpment onto the Ol' Bolossat plain through a magnificent steep-walled gorge, with walls nearly 3048 m high, the Malewa 'Ndogo' gorge. The river cuts a deep trench across the Ol' Bolossat plain passing very close to the south end of the lake and separated from it by a divide of very low relief, probably not more than 9 m. The river turns south and cuts another deep gorge, the lower Malewa gorge, along a fault line, to its confluence with the Turasha River just south of the Melawa Water Scheme Intake. Lake Ol' Bolossat it is perched on the divide between the Ewaso Narok drainage northwards towards the arid flats of the Northern Frontier Province (McCall, 1967). The faulting activity in the area resulted in a complex drainage system that separates major drainage basins. According to

Mwaura (2006), the Lake is located in a hydrological cross border zone between the Rift Valley basins of Lake Naivasha, Lake Elementaita and Ewaso Ng'iro River Basin to the northeast and therefore suggests that a future hydrological linkage between Ewaso Ng'iro and Lake Naivasha basins is likely.

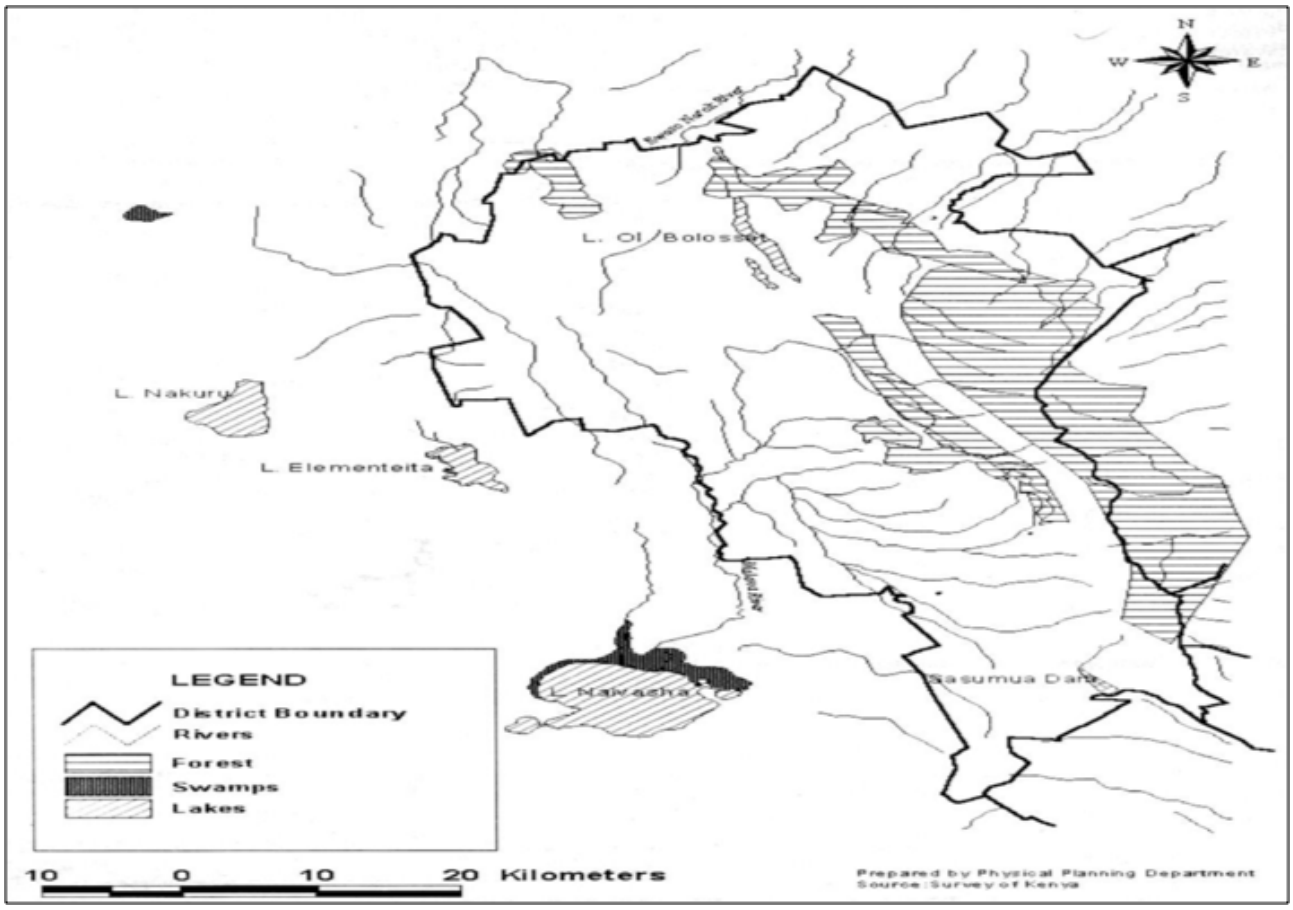

Figure 6. Drainage patterns of the Ol' Bolossat catchment (Githinji, 2012).

Lake Ol' Bolossat drainage system comprises of the springs and streams along the Satima escarpment, open water, Wellmont, Ol' Joro Orok and Ol' Bolossat swamps, Ewaso Narok river, the numerous springs along the upper reaches of Ewaso Narok river, and springs and streams on the western side of the catchment. The springs and streams from the Satima escarpment and to a lesser extent by streams that flow from the Ndundori hills on the western side recharge the lake. Most streams flow for a distance and then disappear underground recharging the lake as sub-surface flow. The main streams are Nduthi to the east, and Simba and Maji Chemka to the west. The system loses water through the continuous flow of Ewaso Narok River and evapotranspiration. (NEMA, 2007).

The hydrology of Lake Ol' Bolossat is influenced by the effects of long-term and seasonal variations in climate and water inflow from the surrounding highlands. The lake water level is highest during the rains, especially in July. Macharia (2011) reports an average depth of 2.0 m while Thenya et al., (2014) a maximum depth of 4 m.

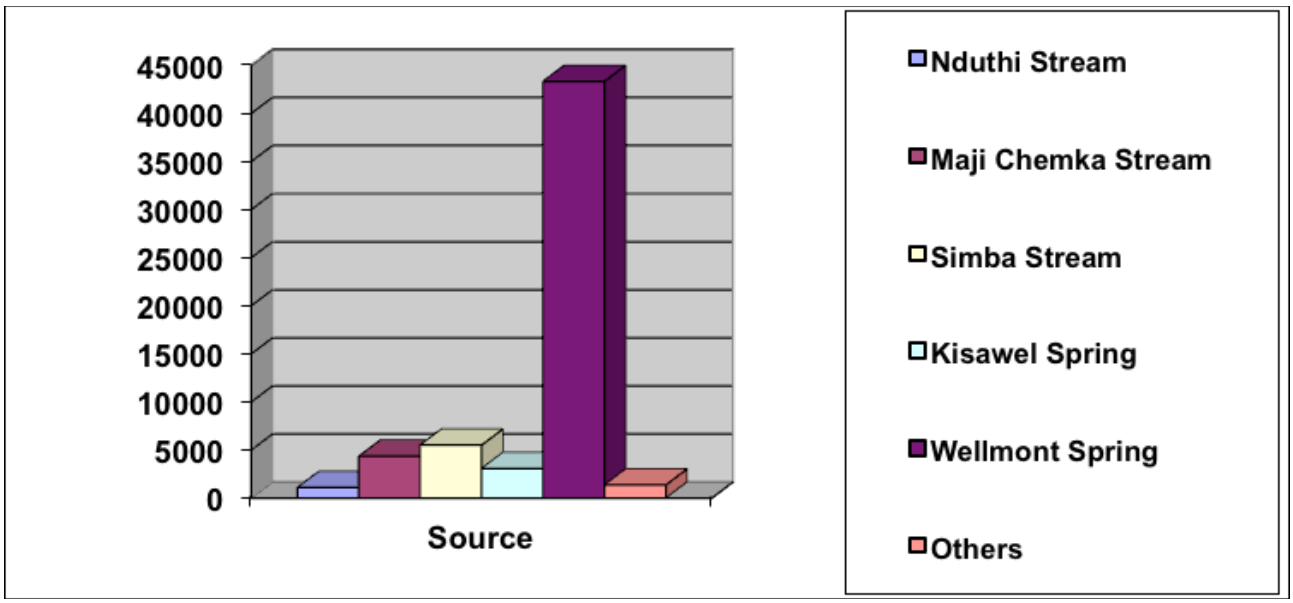

Figure 7: Average Flow of Streams feeding into Lake Ol' Bolossat (adopted from Lake Ol Bolossat Integrated Management Plan 2008-2013)

2.1.7 Water quality

The lake water is moderately saline with electrical conductivity (EC) varying from 150 to 300 x 106 uS/cm, while pH varies from 6.5 to 9.6 at 200 C (Macharia, 2011). Conductivity and alkalinity are elevated during the dry season due to evaporation, with dilution in the wet season. The lake water is unsuitable for both domestic and irrigation due to the high alkalinity. Water characteristic exhibit strong geological influence with relatively higher alkalinity in upper catchment of Ol' Bolossat with average pH of 7.68 and EC in the range of 180-273uS. This reduces slightly downstream with pH moving towards acidity and with lower conductivity. Analysis of water samples drawn from the lake and run-off flowing towards the lake found the lake water to be highly contaminated and unsafe for domestic use. The concentration of minerals in the lake water was lower than that of the run-off water. This indicates that the contamination originated from surrounding farms but once it enters the lake gets diluted by clean water from springs and streams that drain into the lake (Mathenge, 2013).

2.2 Biodiversity (Flora and Fauna)

The area is rich in flora and fauna, with over 200 plant species, over 180 bird species and over 15 species of mammals. There are also species of fish, reptiles and amphibians as well as a vast number of invertebrates.

2.2.1 Vegetation (including forest)

The basin and its catchment have characteristic natural vegetation of grassland, acacia, forest, cedar forest with thin undergrowth, reeds, swamp grass, *Themeda-pennisetum* grasses and floating macrophytes (Wamiti *et al*., 2008). Tall trees of indigenous species are sparse. The main tree species projecting out of the escarpment are *Juniperus procera, Cussonia spicata, Euphorbia candelabrum, Acacia tortilis* and *Croton megalocarpus* which are frequently cut for fuel

wood and charcoal for domestic use by the local people. Except for the gallery forests, much of the escarpment is devoid of trees. A few exotic tree species such as *Eucalyptus, Cupressus* and *Grevillea robusta* have been planted on farmlands at the bottom of the escarpment. The open water has a wide range of floating and submerging macrophytes, nitiritus aquatic weeds have also invaded the lake. Submerging macrophytes occur in areas of the lake with clear water (Millennium Ecosystem Assessment, 2005).

There are human-induced changes in the structure and composition of the natural vegetation. The escarpment is currently dominated by grasses and shrubs such *Grewia* species, *Scutia* species, *Rhus nalatensis* and *Buddleya polystachya* which has replaced the natural vegetation. The swamp vegetation includes *Cyperus immensus, Cyperus rigidifolia, Cirsium vulgare, Phalaria arudinacea, Cyperus papyrus* and *Cyperus latifolia* (Wamiti *et al*., 2008). Frequent burning of the escarpment has reduced the density of shrubs and grasses are dominant in certain parts, especially in the north and south.

The forest adjacent to Lake Ol' Bolossat is called Ol' Bolossat Forest and it is in Ol-Joro-Orok constituencyin Nyandarua County. The forest is marked by an uncontrolled felling of trees and deliberate fires resulting in loss of tree cover. Cultivation on steep land aggravates the problem. The Satima escarpment is degraded and its sloping nature accelerates soil erosion (NEMA, 2007).

2.2.2 Wildlife

Birds

The Lake and entire surrounding areas including Satima Escarpments, Aberdare Forests and National Park, Marmanet Forest Complex, agricultural lands and urban centres have over 350 species of birds (Citation).

Waterbirds are the most conspicuous wildlife on the lake where over 100 species of waterbirds have been recorded (Wamiti, pers. comm., 2018). Waterbirds are species of birds that live in or near water. Birds in general are an important indicator of environmental health and can give an early warning of undesirable ecological changes. Among the waterfowls, the most abundant groups are Afro-tropical ducks and geese, rails, gallinules and coots. Several Palearctic and Afro-tropical migrant species have also been listed in the African-Eurasian Waterbird Agreement (AEWA) under the Bonn Convention on Migratory Species (CMS).

The area around Lake Ol' Bolossat holds a significant area (39 sq.km.) of unique montane grasslands. Some of the key bird species sighted within the lake grasslands and the surrounding farms include Sharpe's Longclaw *Macronyx sharpei*, a globally-threatened and Kenyan high-altitude grassland endemic bird (BirdLife International, 2000); Jackson's Widowbird, *Euplectes jacksoni*, also a restricted-range species and described as near-threatened (NT) by BirdLife

International (2000); Long-tailed Widowbird *E. progne*, a regionally-threatened species; Hunter's Cisticola, *Cisticola hunteri* (Least Concern) and Grey Crowned Crane *Balearica reguloram* (endangered). A survey by Wamiti *et al* (2008) that led to the designation of the Lake as Kenya's 61st IBA counted 29 individuals of the globally-threatened and Kenyan high-altitude grassland endemic and endangered Sharpe's Longclaw *Macronyx sharpei* at densities of 0.01 - 0.15 birds per acre whereas 11 individuals of East African endemic Jackson's Widowbird *Euplectes jacksoni* were observed only in private farms at a density of 0.08 - 0.17 birds per acre. Also recorded were regionally-threatened Long-tailed Widowbird *E. progne*, Hunter's Cisticola *Cisticola hunteri*, Great White Egret *Egretta alba* and African Marsh Harrier *Circus ranivorus*. Maccoa Duck *Oxyura maccoa*, Saddle-billed Stork *Ephippiorhynchus senegalensis*, Great Crested Grebe *Podiceps cristatus* and White-backed Duck *Thalassornis leuconotus* have also been recorded previously. The Lake is known to be important for Palearctic migrant waterbirds. During the 2007 survey, 17 waterbird species that are listed by the African-Eurasian Waterbird Agreement (Ng'weno *et al*., 1999) were recorded. The lake being close to the Great Rift Valley forms one of Kenya's important migration flyways, thus offering a suitable site for feeding and resting, and probably as a wintering ground for the Palearctic migrants. A comprehensive list of birds is attached in annex 1.

The lake recorded the highest bird population and diversity in 1999 January census while January 2007 recorded the second highest species of birds but with the lowest population as shown in Figure 8. Figure 8 compares the results from past African Waterfowls Census at Lake Ol' Bolossat adopted African Waterfowl Census 2015 Report published by National Museums of Kenya. The most recent waterbird census conducted in January 2018 recorded 72 water bird species with a total population of 14, 423 individuals (NMK, 2018)

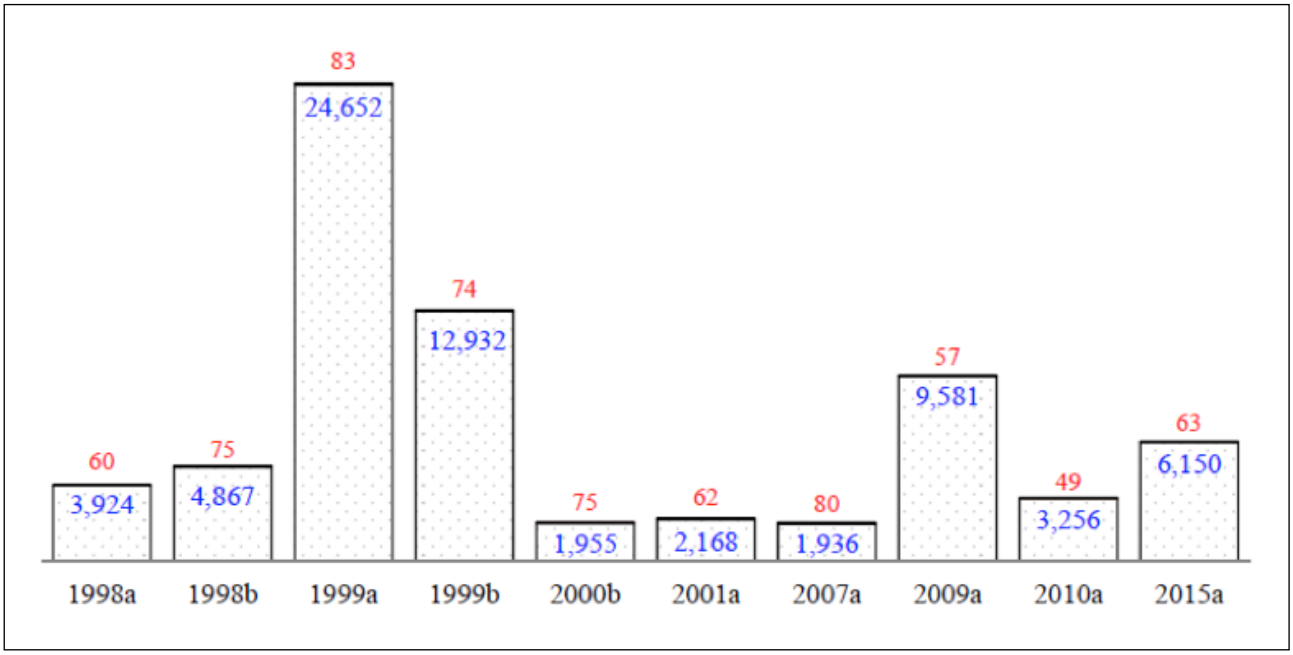

Figure 8: Comparison of number of birds (numbers inside bar) and number of species (numbers above bar) in different years where 'a' refer to January and 'b' to July censuses.

Mammals

According to a study conducted by Njeri (2003) estimated the density of hippopotamus, *Hippopotamus amphibious* in Lake Ol Bolossat at 1.9 hippopotamus/km and the distribution depended on availability of water. The study further established that the distance travelled by hippopotamus while foraging is related to the availability of resources. The hippopotamus therefore travel long distances when food is scarce. The distances travelled by hippopotamus in eastern and western side were not significantly different (p=O.215).

According to the Integrated Management Plan for Lake Ol'Bolossat 2008-2013, the number of hippos recorded at Lake Ol Bolossat from 1987 to 1989, ranged from a mean minimum of 89 and a mean maximum of 176. The maximum number coincided with wet seasons while the minimum number coincided with dry seasons. The distribution of hippos on the lake is dependent on biomass distribution of green herbage on the riparian area. Hippopotamus numbers fluctuate, for instance as a result of competition with livestock, changes in land use and droughts. Competition between hippopotamus and livestock is prevalent along the narrow stretches of land bordering the lake especially during the dry seasons. According to the management plan (2008-2013), the population of hippopotamus (*Hippopotamus amphibious*) in the lake is estimated at 200 individuals.

Leopards are sometimes sighted and they attack livestock at night. Coypu rat *Myocastor coypus* is an invasive mammal occupying the swamps and marshes that has no natural enemies (Ruhiu, 2000).

Fish

Wetlands are important for freshwater fish, most of which require shallow water for breeding. The thick vegetation provides protection for smaller fish against predators (Creel, 2003). The marshes and swamps support catfish while dams in Lake Ol' Bolossat region are stocked with several fish species such as tilapia and common carp. Exploitation of the fisheries resource in this area is limited due to lack of fishing gears.

There is small scale fishing in the central parts of the lake for both subsistence and commercial purposes, but the production is hampered by weeds that have taken root. There is low population of fish in the open water due to the high rate of evaporation and alkalinity of the waters. The dominant fish species in the lake is mudfish. Fishing affects livelihoods positively by supplementing the community protein food.

In 1972, the Fisheries Department established that Lake Ol' Bolossat water is too turbid for fresh water fish to survive in it. The mudfish does well under such conditions. Habitat loss and degradation ruin the fisheries through water abstraction, removal of vegetation for development and agriculture (Nielsen *et al*., 2004). The lake therefore has mudfish which increases during rainy seasons.

2.3 Socio-demographic characteristics

2.3.1 Human population

According to Kenya National Census 2009, the human population density in the lake basin and the lake's watershed is approximately 202 per km2. The human population in the lake basin has shown an upward trend (NEMA, 2007). The data collected from the district statistics Office in Nyahururu indicated the population for both females and males has increased by an average of three thousand each year (G.o.K., 2009). The pressure of rapid population growth engenders environmental problems within Lake Ol' Bolossat and its environment.

The population as per division of the area is as shown in figure 10 below:

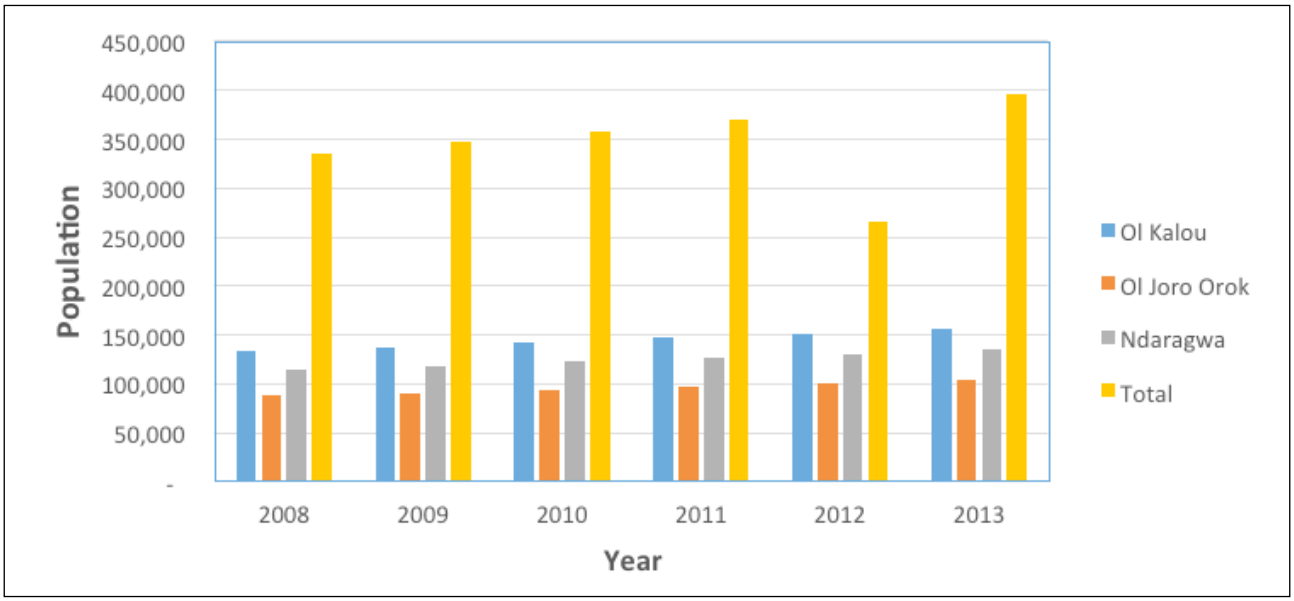

Figure 9: Human Population of Lake Ol' Bolossat Basin by Division between 2008 and 2013

The people living around Lake Ol' Bolossat are subsistence farmers who grow crops and rear livestock on parcels of land ranging from 2.5 to 10 acres. Nearly 60% of the families own less than 5 acres of land. Since they have free access to pasture around the lake, most of them own more livestock that their 5-acres plots can support.

2.3.2 Land tenure in Lake Ol' Bolossat Basin

The land tenure systems operatives in Kenya have been characterized as private/modern, communal/customary, public/state and open access. These systems overlap in some cases, especially where the tenure reform process is incomplete, as is the case in the trust land awaiting registration where individuals have rights over land legally vested in local County Government as trustees.

Prior to the Second World War, the lake and its surroundings were used as a dry season grazing area by Maasai pastoralists. After the war, the entire area and its catchment were allocated to three retired British Army soldiers and thereafter, a further sub-division to settle more decommissioned British Army soldiers. The settlers used the land for livestock rearing and

large-scale crop farming. Just before independence, a number of the white settlers vacated the land, to pave way for African settlers under the Settlement Fund Trustees. The land was further sub-divided for more settlement under five settlement schemes namely: Ol' Joro Orok, Kirima, Muruai, Salient and Ol' Bolossat. A buffer zone was demarcated between the lake and the settled areas, however, an additional settlement scheme initiated in 1993 settled people on this buffer zone. As a result, some peoples' land runs well into the high water mark level of the lake. The survey conducted by Homeland Surveys (2012) to establish/Re-establish the extent or boundary of Lake Ol' Bolossat revealed that the lake is surrounded by Ol' Joro Orok, Lake Ol' Bolossat, Ol Kalou and Kirima Settlement Schemes among others. It further indicated that there are squatters on the land reserved for the lake. These squatters were displaced from Rift Valley and were settled in the lake riparian land by the provincial administration following the tribal clashes of the 1992, 1997 and 2007 elections.

According to a study conducted by Zachariah et al. (2013), about 48% of the land in Lake Ol' Bolossat basin is recognized as trust land. Land holdings vary but for the majority of the household land holding is relatively small with 52% of the households interviewed having up to 3 acres; 20% have 3.5 - 5acres; 22% have 6-10 acres and 6% have 11 – 16 acres, most of which have been acquired through land buying company upon sub-division of the former white farmers land. Kenya political disturbance in 2008 triggered increased flow of people to the wetland area mainly in search of settlement. Land tenure trends reveal that land unit sizes have been decreasing in the catchment areas as a whole. Presently the existing land unit is under heavy demographic pressures.

CHAPTER THREE

LAND USES AND LAND USE CHANGES

3.1 Land Uses

According to Lake Ol' Bolossat Management Plan (200-2013), there are several land use practices within and around the lake. These include agriculture, forestry, fishing, wildlife conservation, mining and infrustructural development and have been described in details in the subsequesnt sub-sections. The land use practices have impacts on the overall ecosystem integrity.

3.1.1 Agriculture

The Lake Ol' Bolossat area is a fertile agricultural area classified as Agro-ecological zone UH3IV on upper highland division (Citation). According to Thenya et al. (2011), agriculture is the main land use in Lake Ol' Bolossat basin and is mainly rain fed with some few fields under irrigation. Crops grown include maize, beans, wheat, potatoes and a wide range of vegetables. Wheat is the main cash crop mainly grown in Ol' Joro Orok division. The acreage under pyrethrum was constant between 1992 and 1994 due to drought but; with an extensive education comparing by the pyrethrum board and agricultural extension personnel, the acreage and yield have been steadily rising. Ol Kalou division has been producing over 50% of all the maize produced and has the highest output of horticultural produce.

The springs and streams that drain into the lake are the main sources of water for domestic and irrigation uses. Water is continuously transferred from the streams and springs that feed the lake for growing crops. Increased horticultural activities especially flower farming (Primarosa and Suera flower farms) in the area have contributed to increase in irrigation activities around the lake, thus contributing to reduction of water flow into the lake. Almost 50% of the wetland riparian land has been converted into agricultural farms Farmers control pests using commonly used pesticides; however, some pesticides have been reported banned for use in the area. The main challenges affecting crop production in the area around the lake are crop damage by wildlife especially hippopotamus, and low extension services to farmers (Thenya *et al*., 2011).

The Lake Ol' Bolossat basin forms an important area as a source of pastures and other cultivated livestock feeds more so during the dry period. As a result, its ecosystem is vulnerable to mismanagement in terms of overstocking, leading to overgrazing and subsequent land degradation.

The main markets for the agricultural products are local urban markets such as Nyahururu, Ol' Kalou and Ol' Joro Orok. The sale of these products is largely controlled by brokers and thus the farmers get a lower deal on "value of crops"

Plate 1: piping of water from the lake.

3.1.3 Forestry

Indigenous forest cover in the area has declined tremendously due to human settlement, deliberate fires and indiscriminate felling of trees for firewood and other uses. However; farmers practice agro-forestry and farm forestry on a limited scale. Currently, there are local initiatives to establish tree nurseries but these are hampered by lack of suitable seeds and sites for putting up nurseries. The restoration of the forest on Satima escarpment is vital since it is one of the catchment areas for the lake.

The main source of fuel in the catchment areas was and has remained wood, charcoal and paraffin for cooking and lighting houses. According to Thenya *et al*. (2011), fuel wood makes over 80% of the sources of domestic energy around Lake Ol' Bolossat. Key forests around the lake include Ol' Bolossat forest, Ndaragwa forest and Aberdare forest. Ol' Bolossat charcoal producers association has been formed and this is enabling the charcoal producers to sell and supply charcoal in bulk hence benefitting from economies of scale and cooperative movement in the surrounding towns. Kenya Forest Service (KFS) has also realized successful revenue collection from charcoal movement permits (KFS, 2011). Eucalyptus tree species, *Casuarina equisetifolia* and *Acacia mearnsii*, for instance, are some of the species that have been found to produce high quality charcoal in Ol' Bolossat area.

3.1.4 Fisheries

The lake still does not support commercial fisheries, but there is subsistence fishing particularly in the central and southern parts of the lake. Nonetheless, the aquatic weeds that infest this part of the lake hamper exploitation of the fisheries potential. The situation is made worse by the absence of fish in the open waters of the lake due to the high alkalinity of the waters.

Plate 2: photo of Two community members carrying a fish (Mad fish) from the lake:

3.1.5 Wildlife Conservation

The lake and its catchment are important for wildlife conservation with a variety of wildlife species that include hippopotamus, birds, leopard, and small mammals. Lake Ol' Bolossat basin is important for the conservation of hippopotamus and birds. Hippopotamus require a substantial amount of riparian land for grazing. However, this riparian grazing land has been greatly reduced due to human settlement and encroachment. Consequently, there is competition between hippopotamus and livestock for the pastures. The number of hippopotamus is regulated by occasional problem animal activities driven by the need to minimize crop and property damage. From the years 1984 to 2000, 47 hippos were killed in problem animal management operations (Source?).

Abundant waterfowl, inhabiting the open water and the marshes, make the lake popular for bird watching.

3.1.6 Tourism

Lake Ol' Bolossat falls in the central tourism region circuit, Nyeri - Nakuru, Naivasha - Maralal -Baringo and Nanyuki – Baringo. However, the tourism potential of the lake basin has not been fully exploited. The water-point supports migratory birds and this, coupled with other scenic sites, attracts tourists in the area (Carney, 1999. The features range from the quiet and cool environment, various physical land formation features and the beauty of wild animals inhabiting the forest, including birds promote ecotourism.

Tourism in the area can be linked to Thompson Falls and Aberdares National Park. The flow of tourists through Nyahururu is high and visitors on transit would consider a diversion to the lake to see birds, hippopotamus and the beautiful landscape. Lake Ol' Bolossat has recorded over 100 species of waterfowls (such as the Grey Crowned Crane and a variety of ducks) and spectacular terrestrial species including the Kenyan endemic and endangered Sharpe's Longclaw that thrives in the riparian grasslands making it one of the sites in Kenya to see the species with ease. It is important to encourage tourism in the lake for economic, educational and conservation purposes.

As reported by EAWLS (2008), watching of birds have dropped to 8,000 from 10,000 bird watchers in Nyahururu and Lake Ol' Bolossat clubs and just 500,000 bird watchers in Kenya against the world's seven millions bird watchers.

3.1.7 Mining

The local communities also carry our rock mining to earn income. A recent survey around the Lake by East African Wild Life Society (2016) documented over five quarrying sites most which are on public land and are within less than 100 m from the lake boundaries. Over 75% of these quarries are unregistered as required by law and operates without observing the existing environmental laws and regulations. These activities however are very detrimental to the lake integrity as they result in siltation of the lake.

3.2 Land use changes

The region around Lake Ol' Bolossat in the central Kenyan highlands has witnessed significant land-use changes, which are believed to be the major cause of the dwindling Lake volumes. Prior to 1965, much of the land was used for large-scale agriculture and livestock rearing. Between 1965 and 1970, the large–scale farms were sub-divided into smallholdings, and allocated to immigrant families from other parts of the country. Consequently, land use intensified considerably and environmental degradation continued to increase as the plot holders sub-divided their land for sale or allocation to family members. It is evident the land-use changes favour agriculture, rural and urban development.

A study was conducted by Zecharia *et al* (2013) to investigate the land cover changes around Lake Ol' Bolossat region using data obtained from Landsat satellite remote sensing. The results of this study as shown in table 2 and figure 13 indicate that the area under water was noted to have reduced from 2127 ha in 1989 to 674 ha in 2010, translating into a 68% reduction during this epoch. Several activities around the lake could have contributed to this contraction of the Lake size. Predominant amongst these, however, is the increased settlements and farming activities in the lake's riparian land. In addition, the need for fertile land for cultivation areas has led to encroachment into the lands left fallow as the Lake recedes, beginning with livestock grazing around the lakes wetland area. Moreover, farming as far as to the shores of the lake has resulted in high levels of eutrophication as minerals from fertilizer are eroded to the lake

from non-point sources. In the recent past, some farmers around Lake Ol' Bolossat have begun planting of Eucalyptus trees both in the encroached land and in the farms. This activity is likely to create further damage due to the high water absorption associated with the tree species.

The floodplains size changed from 50,674 ha to 37,295 ha over the same interval indicating a 26% reduction. This is largely because of the fact that a majority of the area is slowly being swallowed-up by the need for increased farm land to supplement the needs of the rising local population in Manguo, Kanguo and Ziwani areas located adjacent to the Lake's flood plain. The built-up land was noted to have risen by an area of about 8345 ha representing a 33% increment during this period. This phenomenal growth of settlements is attributed to increased population coupled with internal migration from the neighbouring Counties. The migration was augmented a lot by the influx of internally displaced people, popularly known as IDPs in Kenya, following ethnic tension due to competition for land and water resources. The other reason likely to be associated with the change is the rise in commercial floriculture from such farms as Suera and Primarosa, requiring more man power and human resource for the expanded agricultural activity.

Forest land was noted to decline from 38657 ha in 1989 to 26946 ha in 2010 representing a 30% reduction in the coverage. The encroachment into the Aberdare and Ndaragwa forests started through the abuse of Shamba system which was introduced by the Kenyan Government in the mid -1980s to allow farmers living in the highland areas to inter-crop annual crops with targeted tree seedlings capable of preserving the indigenous forest environment. The failure of this system was largely promoted by inadequate law enforcement and regulations and, in other areas, political influence and interference. This led to the cultivation of forest land for long periods resulting to permanent occupation of forest land, concealed and illegal indigenous tree felling for timber and charcoal production in some regions, especially in the region around Ndaragwa forests. Generally, the region between 1980 and 2000 witnessed a lot of deforestation in most headwater catchments in Kenya.

Noteworthy from the results obtained is the significant drop in the size of the Lake, a consequent of the rigorous anthropogenic influences around the region. The degradation arises largely from increased deforestation, human settlements and agricultural activities instituted for socio-economic reasons.

Table 1: Characteristics of the Land cover types in Lake Ol' Bolossat region

Land cover classes	Characteristics
Farmland	Very open shrubs with closed to open fields, includes sparse vegetation cover that is likely to change to other uses in the near future
Floodplain	Mainly areas surrounding the lake that floods during rain seasons, and include the regions covered by short graminoidal plants and grasses
Built-up area	Areas occupied by settlement both in urban and rural areas, other land-uses that may contribute to this area are roads and airstrips
Forest	Closed broadleaved trees with closed to open shrubs/herbaceous plants.
Water	Perennial/Non-perennial, standing/flowing Water bodies

Source: Zacharia *et al* 2013

Table 2: Relative change of the classified maps for 1989 and 2010

Land cover classes	Classified areas						
	1989		2010	2010		Relative change	
	area (Ha)	%	area (Ha)	area (Ha)	%	Area (Ha)	%
Farmland	58002	33.3	76200	76200	43.7	18198	31.4
Floodplain	50674	29.1	37295	37295	21.4	-13379	-26.4
Built-up area	24964	14.3	33309	33309	19.1	8345	33.4
Forest	38657	22.2	26946	26946	15.4	-11711	-30.3
Water	2127	1.2	674	674	0.4	-1453	-68.3

Source: Zacharia *et al* 2013

The changes presented in table 3 were represented diagrammatically as shown in figure 13

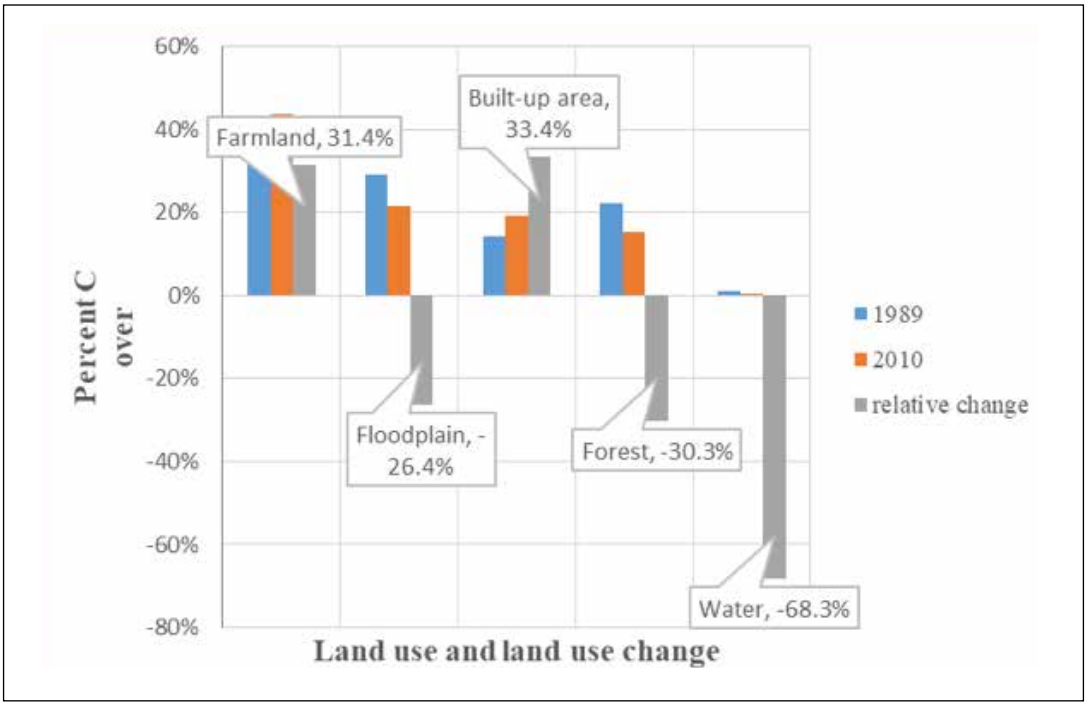

Figure 10: Comparison of land use changes in the Lake Ol' Bolossat region for 1989 and 2010

CHAPTER FOUR

CONSERVATION STATUS, CHALLENGES AND IMPACTS

4.1 Conservation status

A survey of grassland birds in the riparian grasslands around the Lake led to confirmation of globally-threatened birds that led to its designation as Kenya's 61st IBA (Wamiti et al., 2008)by The National Liaison Committee on IBAs led by Nature Kenya, on 26 March 2008. Important Bird Areas (IBAs) are priority sites for conservation, identified using birds (Bennun & Njoroge, 1999). A site qualifies as an IBA when it hosts: (i) globally threatened species – birds threatened with extinction (ii) restricted-range species – birds that have highly restricted distributions (iii) biome restricted species – a series of bird species characteristic of a particular biome (iv) exceptionally large numbers of congregatory (flocking) birds. An IBA may qualify using one or multiple criteria. Lake Ol' Bolossat species qualifies under criteria A1 (globally-threatened), A2 (range-restricted) and A3 (biome-restricted) (Wamiti et al., 2008). This listing elevated the wetland's conservation status both locally and internationally.

Despite this recognition, the lake is not formally gazetted as a protected area under the Kenyan laws. This has rendered most of the past initiatives to conserve and protect the lake and its catchment ineffective. With the rate at which the lake is diminishing, it is unlikely to survive the next two decades if it is not gazetted as a protected area urgently. Efforts to have the lake gazetted have been futile.

4.2 Conservation challenges and associated impacts

Lake Ol' Bolossat is severely threatened with extinction despite its declaration as an Important Bird Area (IBA) years back. The lake has been in the limelight because of its severe degradation. Environmental pressures in the catchment, arising from human induced changes, threaten to disrupt the ecological integrity of this wetland. These threats include deforestation of catchment areas, abstraction of water from Feeder Rivers, pollution, waste disposal, land use changes, soil erosion and siltation. The increasing human population and the change from subsistence to commercial exploitation of wetland resources continue to exert increasing pressure, resulting into further decline of wetland ecological services, quality of water, and general integrity of the lake.

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A management plan for Lake Ol' Bolossat for the years 2008-2013 was developed and was never implemented in full. This is because the lake lacks formal protection and thus lacks the lead agency to oversee the implementation of the management plan. This plan expired in 2013 and needs to be reviewed and updated accordingly. Lack of lake's custodianship rendered the management plan obsolete and the several initiatives implemented within and around the lake to enhance its conservation ineffective and with very minimal impacts.

The lake experiences a case of the "*tragedy of the commons*". There is a high livestock (cattle, goats, sheep and donkeys) stocking rates on the lake grassland, which the grasslands generally seem unable to accommodate. Overgrazing by livestock seems to pose a major threat to

grassland habitat quality and density, and has rendered recovery of vegetation around the lake futile. It also exposes topsoil to wind and water erosion. The situation is further exacerbated by the presence of hippopotamuses (*Hippopotamus amphibious*), estimated at over 200 individuals (Source), which graze at night. Hippopotamus and livestock compete for pasture within the lakes riparian leading to environmental degradation and human-wildlife conflicts around the lake region.

A survey by the National Museums of Kenya (NMK, 2006) revealed that farmers use agro-chemicals such as pesticides and fertilizers without standard measurements. The demand for high yield has led to over-use of agro-chemicals. The chemicals infiltrate into the soil and run-off to pollute the lake. Fertilizers are beneficial in the farmers' field but not in a lake where they promote the growth of weeds and algae which reduce the ecological value of the water. Pollution from toxic chemicals also kills the aquatic animals, plants and micro-organisms. Cultivation on steep land aggravates the problem.

Water abstraction also presents a serious challenge to the hydrological balance of the lake basin. The springs and streams that drain into the lake are the main sources of water for domestic and irrigation uses. Water is continuously transferred from the steams and springs that feed the lake for growing crops such as carrots, potatoes and peas. This abstraction is compounded the commercial floriculture from such farms as Suera and Primarosa, requiring more water. This is one of the key contributors to the dwindling lake water volumes. Other community members directly pipe water from the lake into their farms further causing reduction of water levels within the lake.

Human population pressure in the catchment is steadily increasing causing pressure on the available land and other natural resources. High human population density has caused land fragmentation, dispersal of animal communities, habitat loss, degradation and species extinction (Ruhiu, 2000).

Development pressure or need for economic growth has led to over-exploitation of natural resources as revealed by a survey conducted by East African Wild Life Society in 2016. The cost of exploiting the resources outweighs the benefits of economic growth. The local communities excavate stone in quarries around the lake and this leads to water pollution and sedimentation of the lake. This problem is further aggravated by the recent upgrade of the feeder roads done by the county government without complying with the environmental regulations and standards.These threats and their level of severity has been summarised in table 3.

Table 3: Threats (Pressure) facing Lake Ol' Bolossat and their levels of severity

Threat Level 1	Threat Level 2	Timing	Scope	Severity	Result
Agricultural expansion and intensification	Timing Scope Severity Result livestock farming and ranching (includes forest grazing) - small-holder grazing, ranching or farming	Happening now	Some of area/ population (10-49%)	Slow but significant deterioration	Medium
Biological resource use	Hunting & collecting terrestrial animals - intentional use (species being assessed is the target	Happening now	Some of area/ population (10-49%)	Slow but significant deterioration	Medium
Climate change and severe weather	Drought	Happening now	Whole area/ population (>90%)	Slow but significant deterioration	High
Climate change and severe weather	high storms and floods	Happening now	Small area/ few individuals (<10%)	Slow but significant deterioration	Low
Human intrusions and disturbance	Work and other activities happening	Happening now	Majority/ most of area/ population	Moderate to rapid deterioration	High
Invasive and other problematic species and genes	Invasive non-native/ alien species/ diseases - named species	Happening now	(50-90%) Some of area/ population (10-49%)	Slow but significant deterioration	Medium
Pollution	Garbage & solid waste	Happening now	Small area/ few individuals (<10%)	No or imperceptible deterioration	Low
Residential and commercial development	Housing and urban areas	Happening now	Some of area/ population (10-49%)	Some of area/ population (10-49%)	Medium

Source: Birdlife International (2017)

CHAPTER FIVE

FUTURE OF LAKE Ol' BOLOSSAT

5.1 Why is conservation of Lake Ol' Bolossat important?

Lake Ol' Bolossat and its catchment is a unique ecosystem containing a variety of habitats that include an alkaline lake, the Satima escarpment and the plains of grasslands in the lake basin. The nature, geology, climate, soils and ecology all interact to make this a vulnerable and fragile ecosystem.

The lake acts as the headwaters of Ewaso Nyiro river basin, the largest basin in Kenya, supports wildlife, livestock and lifelines of communities living in Nyandarua, Laikipia, Samburu and Isiolo Counties. The lake ecosystem is a source of water for Nyahururu town that serves a population of over 15,000 and the communities living downstream. It is also an important livestock dry season grazing area for the pastoralists Samburu and local communities. Drying of this lake can be catastrophic and can lead to resource conflicts in all the four counties.

The lake is home to hippopotamus and over 100 waterbird species which are either residential or Palearctic or afrotropical migrants. Some of these birds are listed as endangered while others are either threatened or are endemic to Kenya. Occasionally, leopards, otters and gazelles among others have also been witnessed within and around the lake. The area has been designated as an Important Bird Area and being close the Great Rift Valley, forms one of Kenya's important migration flyways, thus offering a suitable site for feeding and resting, and probably as a wintering ground for the Palaearctic migrants. This makes this site a Key Biodiversity Area (KBA) where both biodiversity conservation and tourism can thrive.Tourism is an important contributor to the Kenyan GDP and a driver of the economy which is one of the pillars in Kenya's development blue-print Vision 2030. There is a thriving tourist industry in Samburu, Shaba and Buffalo Springs National Reserves that is made possible by the flow of the Ewaso Nyiro River whose origin is Lake Ol' Bolossat. This is key for the community livelihoods as well as local and national economic development.

A great majority of the communities living around the lake practice agriculture as their main source of livelihood. The lake forms the backbone of the thriving agricultural production in the area. Communities draw water from the streams and springs feeding the lake for irrigation of agricultural farms and for their livestock. Therefore the lake acts as a line of defence for the community livelihoods in the area.

5.2 Need for the Legal Protection of the Lake

Lake Ol' Bolossat has continued to experience intense pressure from human and natural-induced stressors such as unsustainable livestock / agricultural production, encroachments for

human settlements and climate change and climate variability among others. These stressors have resulted in its degradation and over-exploitation of its resources. The lake was recently declared by Birdlife Intentional as an IBA in danger in early 2017.

The various conflicting and competing land uses have posed serious and deleterious effects on the lake ecosystem with resultant profound negative impacts on the ecological integrity and health of this wetland despite the development and launch of Lake Ol'Bolossat Integrated Wetland Management Plan, a framework that was developed through a rigorous multi-stakeholder consultative process to safeguard the lake from such unsustainable practices. The ubiquitous land-use changes are believed to be the major cause of the dwindling volumes of the lake.

The various conflicting and competing land uses have posed serious and deleterious effects on the lake ecosystem with resultant profound negative impacts on the ecological integrity and health of this wetland despite the development and launch of L. Ol Bolossat Integrated Wetland Management Plan, a framework that was developed through a rigorous multi-stakeholder consultative process to safeguard the lake from such unsustainable practices. The ubiquitous land-use changes are believed to be the major cause of the dwindling volumes of the lake.

Plate 3: Picture of the lake in 1986(2127ha)

Plate 4 : Picture of the lake in 2010 (674ha)

The two land cover satellite imageries for 1989 and 2010 above were used to detect changes within the Lake. The area under water was noted to have reduced from 2127 ha in 1989 to 674 ha in 2010, translating into a 68% reduction during this epoch. This is mostly likely to continue if no urgent conservation measures are implemented and the lake brought under control.
The reduction can be explained by the extent of encroachment of the lake riparian land for agriculture, human settlement, infrastructural development and livestock grazing.

Residents of Ol Bolossat catchment area acknowledge that there is free accessibility into the wetland. There are, however, no regulatory measures taken by the Government or the community to prevent over-use and degradation. An essential step to salvage dwindling the Lake ecosystem from further destruction is for the concerned county authorities to delineate and set up a buffer zone around the Lake to safeguard and push for the gazettement of the lake. If the current destruction, unregulated water abstraction and over grazing continue at the present rate, the lake is unlikely to survive the next two decades.

Protection of this lake is essential for the survival and conservation of the grassland bird endemics, other national genetic resources and for the growth and development of both local and national economy through enhancing food security and tourism among others.
Legal protection of the lake can only be achieved by gazetting the lake as a protected wetland under the Kenyan laws which requires collaborative and integrated efforts of the concerned stakeholders, including but not limited to NEMA, KWS, WRMA, ENNDA, KFS, the County Governments of Nyandarua, Laikipia, Samburu and Isiolo, civil society organizations, donor and the local communities directly depending on the Lake services for livelihood (including water resource users) among others.

The lake may not survive the next two decades if no urgent measures are taken to protect it by law and conservation initiatives to restore the degraded parts initiated. The gazettement will give the lake a legal protection and provide an institutional framework for its management thus harmonizing and coordinating all the conservation efforts in the area.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

The available literature qualifies Lake Ol' Bolossat basin as the bedrock for the survival of wildlife, livestock and the communities living in Nyandarua, Laikipia, Samburu and Isiolo counties. It drives socio-economic development in these areas and is essential for conservation of wide range of bird species (both residential and migratory) and other biological resources. The actual value of this lake is not known to many as the available *insitu* data is limited and is not consistently updated. The lake is under intense pressure contributed hugely by the anthropogenic stressors and its deteriorating conditions can be witnessed through the dwindling water volumes and quality, fast spread of invasive species and human wildlife conflicts among others. The condition of the lake is likely to worsen if it remains unprotected and little attention given to its conservation. Gazetting this lake as a protected area will help solve a significant threats currently facing it and provide an institutional and legal framework that will anchor all the conservation and development initiatives around the lake and most importantly allow for consistent biodiversity monitoring.

5.2 Recommendations

During the reviews, a good number of information gaps and needs were identified. Based on these gaps and identified needs, this desktop research recommends the following:

- A comprehensive biodiversity survey on major taxa: invertebrates, fish, plants, mammals and herpetofauna are needed to identify flagship species for monitoring.
- Research is also needed on aquatic life and water physical parameters so that a baseline data is established for monitoring water quality (at specific points) in the future.
- The lake has been invaded by an invasive species, *Azola spp*, however, no literature is available on its impact on the lake system. Therefore, there is need to conduct research to determine the impacts of this invasive species on the lake ecosystem (especially on hippopotamus's distribution and density) and its economic benefits to humankind, if any.
- Information about bird species within and around Lake Ol' Bolossat ecosystem is largely fragmented with no consolidated checklist published. There is need to conduct further survey of birds within the lake, its riparian land, surrounding farms and catchment areas, and develop and publish a comprehensive checklist of birds.
- Water abstraction is rampant within the Lake Ol Bolossat basin. However, the extent has not been documented. A survey needs to be conducted to determine and document water demand within the lake basin and the extent of dependability by the communities on the lake water.
- The exact size of the lake is unknown; however, it is estimated as 43.3 km2 according to the Integrated Management Plan 2008 -2013. A survey should be done to delineate, map out

and gazette the exact boundary of the lake including the riparian land.

- There has been inconsistence in the African Waterfowl Census at Lake Ol' Bolossat. Consistence data is needed so that numbers of all waterbirds and key species are closely monitored.
- Study on the rate of habitat loss and fragmentation and factors affecting and influencing its quality. This study should also consider the most suitable form of land use suitable for key species conservation in the basin.
- A study should be conducted to determine the distribution and population size of hippopotamus (Hippopotamus amphibious) in the basin. This will provide baseline data for monitoring.
- Ecological studies need to be conducted to determine the number of hippos that can be supported by the lake ecosystem.
- Conduct an assessment of wetland resource use in Lake Ol Bolossat by different user groups and gender.

References

Adhola, T., Ng'weno, F., Matiku, P., Mulwa, R., Ngari, A., Barasa, F., Madindou, I., Wanyiri, M., Mwango'mbe, J., Musyoki, C., Ndonye, P., Ogoma, M., Machekele, J. and Musila, S. (2009). Kenya's Important Bird Areas: Status and Trends 2008. Nature Kenya, Nairobi

Baker, B, Mitchell, J and Williams, L. 1988. Stratigraphy, geochronology and volcano-tectonic evolution of the Kedong-Naivasha-Kinangop region, Gregory Rift Valley, Kenya. *Journal of the Geological Society* 145: 107–116, DOI: **https://doi.org/10.1144/gsjgs.145.1.0107**

Baker, B, Williams, L, Miller, J and Fitch, F. 1971. Sequence and geochronology of the Kenya rift volcanics. *Tectonophysics* 11: 191–215, DOI: https://doi.org/10.1016/0040-1951(71)90030-8

Bennun, L. and Njoroge, P. (1999) *Important Bird Areas of Kenya*. East Africa Natural History Society, Nairobi, Kenya. Pp318.

Bergner, A, Strecker, M, Trauth, M, Deino, A, Gasse, F, Blisniuk, P and Dühnforth, M. 2009. Tectonic and climatic control on evolution of rift lakes in the Central Kenya Rift, East Africa. *Quaternary Science Reviews* 28: 2804–2816.

Birdlife International (2017) Important Bird Areas factsheet: Lake Ol' Bolossat. Downloaded from **http://www.birdlife.org** . On 10/10/2017.

Blomqvist T. (1997). A Hydrological Investigation of Lake Ol Bolossat Swamp, Nyandarua District, Kenya. Swedish University of Agricultural Sciences.

Crafter, S. A., Njuguna S. G. and G. W. Howard (Eds.). 1992. Wetlands of Kenya. *Proceedings of the KWWG Seminar on Wetlands of Kenya*, National Museums of Kenya, 3-5 July 1991. International Union for Conservation of Nature and Natural Resources – IUCN. 183 p.

Crafter, S.A., Njuguna S.G. and Howard G.W. (eds) Wetlands of Kenya. Proceedings of the KWWG Seminar on wetlands of Kenya, NMK, Nairobi, Kenya, 3-5 July 1991. Gland: IUCN

East African Wild Life Society (2017). *Enhancing Environmental Regulations in Safeguarding Lake Ol Bolossat in Nyandarua County, Kenya*. Stakeholders Workshop Report.

FAO (Food and Agriculture Organization of the United Nations). 2006. Country Pasture/ Forage Resource Profiles: Kenya. Kitale, Kenya. 16 p. **http://www.fao.org/ag/agp/agpc/doc/counprof/PDF%20files/Kenya.pdf**

G.O.K, (2009) *Kenya population and housing census* volume IA. Population Distribution by Administrative Units. Kenya National Bureau of Statistics. Ministry of State for Planning & National Development and Vision 2030.

G.O.K. (2009), *National State of Wetland Ecosystem Report*. Government Printer, Nairobi.

Githinji, C. 2012. Conflict resolution in the utilization of Malewa river system for domestic purposes: a case study of the stretch cutting across Ndemi Sub-location, Nyandarua County. Howard, Wetlands of Kenya, Proc Int seminar on wetlands of Kenya, Nairobi, Kenya. Gland: IUCN, 13-22.

Keller, R. 2001. An integrated geophysical analysis of the upper crust of the Southern Kenya rift. *Geophysical Journal International* 147: 543-561.

Kinoti, J. 2011. Planning of system innovations in watersheds: spatial mapping of environmental and hydrological determinants in Pangani and upper Ewaso Ng'iro north river basins, Africa. Faculty of Geo-Information Science and Earth Observation of the University of Twente – ITC.

Krhoda GO (1992) The Hydrology and Function of Wetlands. In: SA Crafter, SG Njuguna, GW Leat, P T. 1991. Volcanological development of the Nakuru area of the Kenya rift valley. *Journal of African Earth Sciences (and the Middle East)* 13: 483–498, DOI: **https://doi.org/10.1016/0899-5362(91)90111-B**

Macharia GM (2009) Land-use and its Effect on Biodiversity in Lake Ol'Bolossat, Nyandarua, Kenya. Unpublished Phd Thesis, Kenyatta University, Nairobi, Kenya.

Mathenge, M.W. 2013. Effects of natural resource based conflicts on community livelihoods in Lake Ol' Bolossat catchment area, Nyandarua County, Kenya. A Thesis Submitted in Partial Fulfillment of the Requirements for the Award of Degree of Master of Science (Environmental Education). Kenyatta University. 125 p.

Mburu, G. P. 2014. Potential payment for ecosystems services (PES) scheme Lake Ol' Bolossat Nyandarwa County. A Research Project Submitted In Partial Fulfilment for the Degree of Bachelor of Environment Planning and Management. Kenyatta University. 61 p.

McCall, G J H. 1967. *Geology of the Nakuru-Thomson's Falls-Lake Hannington Area*: Degree Sheet No. 35 SW Quarter and 43 NW Quarter (with Coloured Maps). Geological Survey of Kenya.

Ministry of Environment and Mineral Resources (MEMR). (2012) *Kenya Wetlands Atlas*. Progress Press Co. Ltd., Malta.

Muchai, M, Bennun, L., Lens, L., Rayment, L and Pisano, G. (2002). *Land-use and conservation of Sharpe's Longclaw*. Macronyx sharpie in central Kenya. Bird conservation International, 12:107-121. United Kingdom.

Mungai, P and Manegene, S. (1998). *Lake Ol bolosat Waterfowl Counts: January 1998*: *A Report to the Kenya Wildlife Service Netherlands Wetlands Program*. Kenya Wildlife Service.

NEMA (National Environment Management Authority) (2007). Lake Ol-Bolossat Management Plan 2008-2013. *Kenya Wetlands Forum*. Nairobi, Kenya.

Ng'weno, F., Matiku, P. & Mwangi, S. (1999). (eds). *Kenya and the African-Eurasian Waterbird Agreement (AEWA): Proceedings of the Seminar and Workshop held at the National Museums of Kenya, Nairobi, on 29 July 1999*. EANHS.

Oyugi, J.O. & Owino, A.O. (1998). Monitoring of Waterbirds in Kenya, July 1997 and January 1998. Research Reports for Centre for Biodiversity, National Museums of Kenya: Ornithology, 33 (1998).

Oyugi, J.O. & Owino, A.O. (1999). Monitoring of Waterbirds in Kenya, July 1998 and January 1999. Research Reports for Centre for Biodiversity, National Museums of Kenya: Ornithology, 34 (1999).

Ruhiu, J.M., (2000). Environment and Resource Management in District Planning. Case Study of Ol Bolossat, KWS Nyeri.

Teresia, N. (2003). Habitat utilization by birds, hippopotamus (*Hippopotamus amphibious*) and livestock in lake Ol'bolossat, Kenya; Thesis, University of Nairobi.

Thenya, T, Kiteme, B.P., Ouko, C.A., Kahiu, N., Njuguna, E. C., Karanja F., Ojwang' D., Wanbugu G, 2011. Assessment of Ecological Status and Socio-economic Dynamic of Upper Ewaso Ng'iro Basin Wetlands. CETRAD.

Wamiti, W. (2010). Ornithological Treasure of Nyahururu. Kenya Birding,4: 12-15

Wamiti, W. Malaki, P. & Mwangi, A. (2008). *Birds of Conservation Concern Upgrades Lake Ol' Bolossat Status to Kenya's 61st Important Bird Area*. Paper presented at the 12th Pan-African Ornithological Congress, Goudin Spa Conference Centre, Cape Town, SouthAfrica, 7-12 Sept. 2008.

Zacharia M, Elias A, Jeremiah K, Simon1 M, Olang LO (2013) Assessment of Land Cover Changes in Lake Olbolosat Region of the Central Kenyan Highlands using Landsat Satellite Imagery Aided by Indigenous Knowledge. J Biodivers Manage Forestry 2:2.

ANNEXES

Annex 1: A list of bird species recorded at Lake Ol' Bolossat and sorrounding areas.
The species lists has been built up from various sources incluidng: Mungai & Manegene (1998), Oyugi & Owino (1998, 1999), Wamiti et al. (2007, 2008), Wamiti (2010), Wamiti (*unpubl. data*), and records held by the African Waterfowl Census programme at the Ornithology Section of the National Museums of Kenya. Taxonomy and migration status follows Bird Committee (2009) while the IUCN Red list category follows BirdLife International (2018).

Migration status: **PM** = Palearctic migrant; **AM** = Afro-tropical migrant. Lower case (am, pm) indicates a species with non-migrant populations. IUCN category: **LC** = Least Conscern, **Vu** = Vulnerable, **EN** = Endangered, **NT** = Near-Threatened.

Family	Species common name	Species scientific name	IUCN Red List Category	Migration Status
Anatidae: ducks and geese				
1	White-faced Whistling Duck	*Dendrocygna viduata*	LC	
2	Fulvous Whistling Duck	*Dendrocygna bicolor*	LC	AM
3	White-backed Duck	*Thalassornis leuconotus*	LC	
4	Spur-winged Goose	*Plectopterus gambensis*	LC	
5	Knob-billed Duck	*Sarkidiornis melanotos*	LC	am
6	Egyptian Goose	*Alopochen aegyptiacus*	LC	
7	Cape Teal	*Anas capensis*	LC	
8	African Black Duck	*Anas sparsa*	LC	
9	Yellow-billed Duck	*Anas undulata*	LC	am
10	Northern Shoveler	*Anas clypeata*	LC	PM
11	Red-billed Teal	*Anas erythrorhynchos*	LC	
12	Northern Pintail	*Anas acuta*	LC	PM
13	Garganey	*Anas querquedula*	LC	PM
14	Eurasian (Common) Teal	*Anas crecca*	LC	PM
15	Hottentot Teal	*Anas hottentota*	LC	
16	Southern Pochard	*Netta erythrophthalma*	LC	am
17	Ferruginous Duck	*Anas nyroca*	LC	PM
18	Maccoa Duck	*Oxyura maccoa*	Vu	
Podicipedidae: grebes				
19	Little Grebe	*Tachybaptus ruficollis*	LC	
20	Great Crested Grebe	*Podiceps cristatus*	LC	
21	Black-necked Grebe	*Podiceps nigricollis*	LC	

Family	Species common name	Species scientific name	IUCN Red List Category	Migration Status
Phoenicopteridae: flamingos				
22	Greater Flamingo	*Phoenicopterus (r.) roseus*	LC	am, pm
23	Lesser Flamingo	*Phoeniconaias minor*	NT	am
Ciconiidae: storks				
24	Yellow-billed Stork	*Mycteria ibis*	LC	am
25	African Open-billed Stork	*Anastomus lamelligerus*	LC	am
26	Black Stork	*Ciconia nigra*	LC	PM
27	White Stork	*Ciconia ciconia*	LC	PM
28	Saddle-billed Stork	*Ephippiorhynchus senegalensis*	LC	
29	Marabou Stork	*Leptoptilos crumeniferus*	LC	
Threskiornithidae: ibises and spoonbills				
30	Sacred Ibis	*Threskiornis aethiopicus*	LC	
31	Hadada Ibis	*Bostrychia hagedash*	LC	
32	Glossy Ibis	*Plegadis falcinellus*	LC	am, pm
33	African Spoonbill	*Platalea alba*	LC	
Ardeidae: herons, egrets and bitterns				
34	Little Bittern	*Ixobrychus minutus*	LC	am, pm
35	Black-crowned Night Heron	*Nycticorax nycticorax*	LC	am, pm
36	Striated Heron	*Butorides striatus*	LC	
37	Squacco Heron	*Ardeola ralloides*	LC	am, pm
38	Cattle Egret	*Bubulcus ibis*	LC	am
39	Grey Heron	*Ardea cinerea*	LC	am, pm
40	Black-headed Heron	*Ardea melanocephala*	LC	
41	Goliath Heron	*Ardea goliath*	LC	
42	Purple Heron	*Ardea purpurea*	LC	(pm)
43	Great White Egret	*Ardea alba*	LC	
44	Yellow-billed Egret	*Egretta intermedia*	LC	
45	Black Heron	*Egretta ardesiaca*	LC	
46	Little Egret	*Egretta garzetta*	LC	
Scopidae: Hamerkop				
47	Hamerkop	*Scopus umbretta*	LC	
Pelecanidae: pelicans				
48	Great White Pelican	*Pelecanus onocrotalus*	LC	
49	Pink-backed Pelican	*Pelecanus rufescens*	LC	
Phalacrocoracidae: cormorants				
50	Reed Cormorant	*Phalacrocorax africanus*	LC	
51	Great Cormorant	*Phalacrocorax carbo*	LC	

Family	Species common name	Species scientific name	IUCN Red List Category	Migration Status
Falconidae: falcons				
52	Lesser Kestrel	*Falco naumanni*	LC	PM
53	Lanner Falcon	*Falco biarmicus*	LC	
54	Peregrine Falcon	*Falco peregrinus*	LC	pm
Accipitridae: diurnal birds of prey other than falcons				
55	Osprey	*Pandion haliaetus*	LC	PM
56	African Black-shouldered Kite	*Elanus caeruleus*	LC	[am]
57	Black Kite	*Milvus migrans*	LC	am, pm
58	African Fish Eagle	*Haliaeetus vocifer*	LC	
59	Western Marsh Harrier	*Circus aeruginosus*	LC	PM
60	African Marsh Harrier	*Circus ranivorus*	LC	
61	Pallid Harrier	*Circus macrourus*	LC	PM
62	Montagu's Harrier	*Circus pygargus*	LC	PM
63	African Harrier-Hawk	*Polyboroides typus*	LC	
64	Augur Buzzard	*Buteo augur*	LC	
65	Long-crested Eagle	*Lophaetus occipitalis*	LC	
Rallidae: rails and relatives				
66	African Water Rail	*Rallus caerulescens*	LC	
67	Black Crake	*Amaurornis flavirostra*	LC	
68	Purple Swamphen	*Porphyrio porphyrio*	LC	
69	Allen's Gallinule	*Porphyrio alleni*	LC	
70	Common Moorhen	*Gallinula chloropus*	LC	
71	Lesser Moorhen	*Gallinula angulata*	LC	AM
72	Red-knobbed Coot	*Fulica cristata*	LC	am
Gruidae: cranes				
73	Grey Crowned Crane	*Balearica regulorum*	EN	
Recurvirostridae: stilts and avocets				
74	Black-winged Stilt	*Himantopus himantopus*	LC	am, (pm)
75	Pied Avocet	*Recurvirostra avosetta*	LC	am
Charadriidae: plovers				
76	Long-toed Plover	*Vanellus crassirostris*	LC	
77	Blacksmith Plover	*Vanellus armatus*	LC	
78	Spur-winged Plover	*Vanellus spinosus*	LC	
79	Senegal Plover	*Vanellus lugubris*	LC	
80	Black-winged Plover	*Vanellus melanopterus*	LC	
81	Crowned Plover	*Vanellus coronatus*	LC	
82	Common Ringed Plover	*Charadrius hiaticula*	LC	PM
83	Kittlitz's Plover	*Charadrius pecuarius*	LC	am

Family	Species common name	Species scientific name	IUCN Red List Category	Migration Status
Charadriidae: plovers				
84	Three-banded Plover	*Charadrius tricollaris*	LC	PM
85	Chestnut-banded Plover	*Charadrius pallidus*	NT	
Jacanidae: jacanas				
86	Lesser Jacana	*Microparra capensis*	LC	
87	African Jacana	*Actophilornis africanus*	LC	
Jacanidae: jacanas				
88	African Snipe	*Gallinago nigripennis*	LC	am
89	Common Snipe	*Gallinago gallinago*	LC	PM
90	Black-tailed Godwit	*Limosa limosa*	NT	PM
91	Bar-tailed Godwit	*Limosa lapponica*	NT	PM
92	Spotted Redshank	*Tringa erythropus*	LC	PM
93	Marsh Sandpiper	*Tringa stagnatilis*	LC	PM
94	Common Greenshank	*Tringa nebularia*	LC	PM
95	Green Sandpiper	*Tringa ochropus*	LC	PM
96	Wood Sandpiper	*Tringa glareola*	LC	PM
97	Common Sandpiper	*Actitis hypoleucos*	LC	PM
98	Little Stint	*Calidris minuta*	LC	PM
99	Temminck's Stint	*Calidris temminckii*	LC	PM
100	Curlew Sandpiper	*Calidris ferruginea*	NT	PM
101	Ruff	*Philomachus pugnax*	LC	PM
Glareolidae: Egyptian Plover, coursers and pratincoles				
102	Collared Pratincole	*Glareola pratincola*	LC	am
Laridae: gulls, terns and skimmers				
103	Grey-headed Gull	*Chroicocephaus cirrocephalus*	LC	
104	Black-headed Gull	*Chroicocephalus ridibundus*	LC	PM
105	Gull-billed Tern	*Gelochelidon nilotica*	LC	PM
106	Little Tern	*Sterna albifrons*	LC	PM
107	Whiskered Tern	*Chlidonias hybrida*	LC	(pm)
108	White-winged Black Tern	*Chlidonias leucopterus*	LC	PM
Columbidae: pigeons and doves				
109	Speckled Pigeon	*Columba guinea*	LC	
110	Dusky Turtle Dove	*Streptopelia lugens*	LC	
111	Red-eyed Dove	*Streptopelia semitorquata*	LC	
112	Ring-necked Dove	*Streptopelia capicola*	LC	
Cuculidae: cuckoos and coucals				
113	Red-chested Cuckoo	*Cuculus solitarius*	LC	am
114	Klaas's Cuckoo	*Chrysococcyx klaas*	LC	

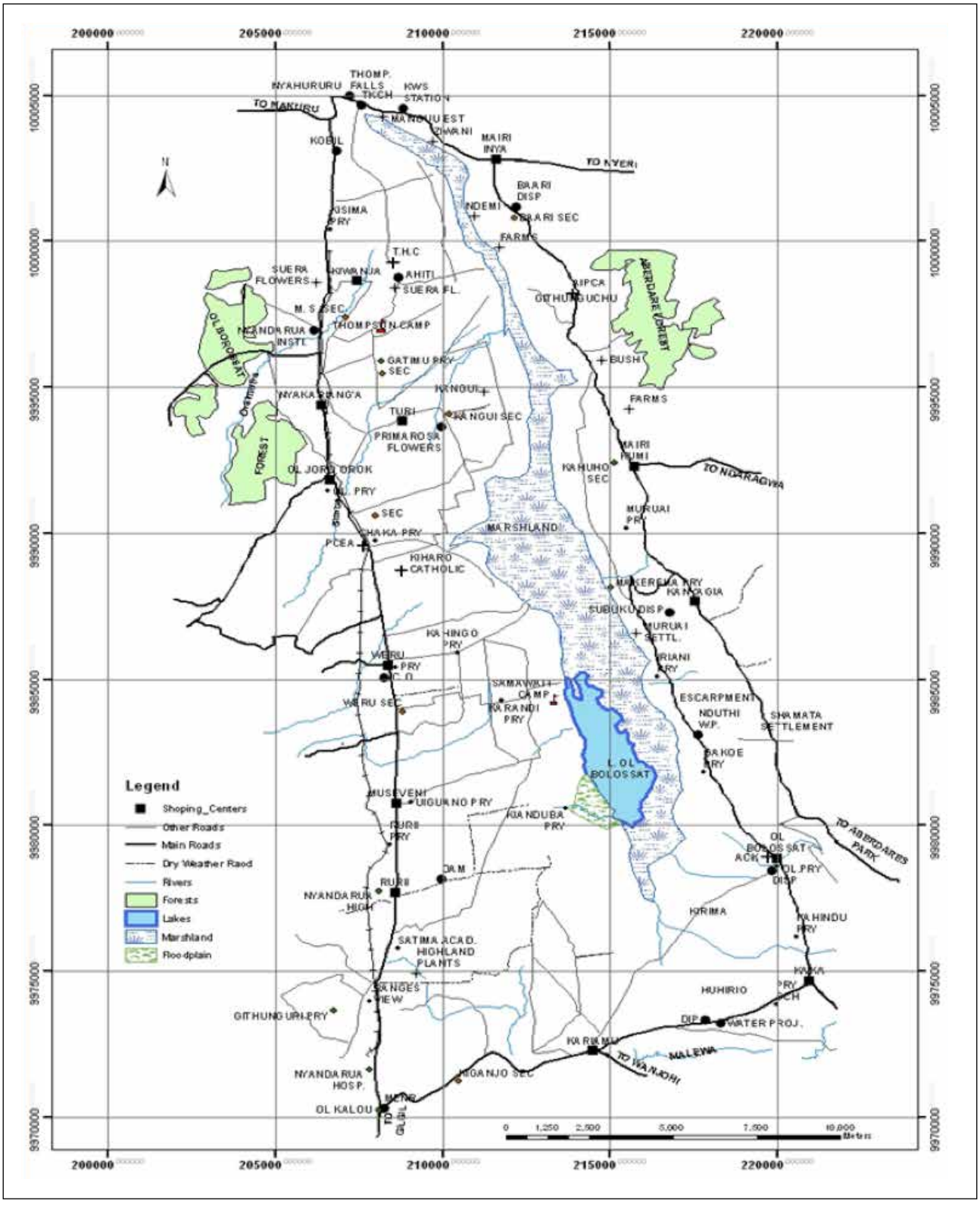
Family	Species common name	Species scientific name	IUCN Red List Category	Migration Status
Cuculidae: cuckoos and coucals				
115	Diederik Cuckoo	*Chrysococcyx caprius*	LC	am
Caprimulgidae: nightjars				
116	Montane Nightjar	*Caprimulqus poliocephalus*	LC	
Caprimulgidae: nightjars				
117	Speckled Mousebird	*Colius striatus*	LC	
Alcedinidae: kingfishers				
118	Malachite Kingfisher	*Alcedo cristata*	LC	
119	Giant Kingfisher	*Megaceryle maxima*	LC	
120	Pied Kingfisher	*Ceryle rudis*	LC	
Meropidae: bee-eaters				
121	Cinnamon-chested Bee-eater	*Merops oreobates*	LC	
122	Eurasian Bee-eater	*Merops apiaster*	LC	PM
Bucerotidae: hornbills				
123	Crowned Hornbill	*Tockus alboterminatus*	LC	
Malaconotidae: Malaconotidae: helmetshrikes, bushshrikes, tchagras & puffbacks				
124	Tropical Boubou	*Laniarius aethiopicus*	LC	
Laniidae: shrikes				
125	Common Fiscal	*Lanius collaris*	LC	
Monarchidae: monarch flycatchers				
126	African Paradise Flycatcher	*Terpsiphone viridis*	LC	am
Corvidae: crows and allies				
127	Cape Rook	*Corvus capensis*	LC	
128	Pied Crow	*Corvus albus*	LC	
Hirundinidae: saw-wings, swallows and martins				
129	Black Saw-wing	*Psalidoprocne pristoptera*	LC	
130	Barn Swallow	*Hirundo rustica*	LC	PM
131	Red-rumped Swallow	*Cecropis daurica*	LC	
Alaudidae: larks				
132	Rufous-naped Lark	*Mirafra africana*	LC	
133	Red-capped Lark	*Calandrella cinerea*	LC	
Cisticolidae: cisticolas and allies				
134	Hunter's Cisticola	*Cisticola hunteri*	LC	
135	Winding Cisticola	*Cisticola galactotes*	LC	
136	Levaillant's Cisticola	*Cisticola tinniens*	LC	
137	Pectoral-patch Cisticola	*Cisticola brunnescens*	LC	
138	Wing-snapping Cisticola	*Cisticola ayresii*	LC	
139	Tawny-flanked Prinia	*Prinia subflava*	LC	

Family	Species common name	Species scientific name	IUCN Red List Category	Migration Status
Cisticolidae: cisticolas and allies				
140	Grey-backed Camaroptera	*Camaroptera brachyura*	LC	
Pycnonotidae: bulbuls				
141	Common Bulbul	*Pycnonotus barbatus*	LC	
142	Yellow-whiskered Greenbul	*Andropadus latirostris*		
Sylviidae: Old World warblers				
143	Little Rush Warbler	*Bradypterus baboecala*	LC	
144	Lesser Swamp Warbler	*Acrocephalus gracilirostris*	LC	
Zosteropidae: white-eyes				
145	Montane White-eye	*Zosterops poliogaster*	LC	
Sturnidae: starlings and oxpeckers				
146	Greater Blue-eared Starling	*Lamprotornis chalybaeus*	LC	
147	Superb Starling	*Lamprotornis superbus*	LC	
Turdidae: thrushes				
148	Olive Thrush	*Turdus olivaceus*	LC	
Muscicapidae: chats, wheatears and Old World flycatchers				
149	White-starred Robin	*Pogonocichla stellata*	LC	
150	Cape Robin-Chat	*Cossypha caffra*	LC	
151	Common Stonechat	*Saxicola torquata*	LC	
152	Northern Anteater Chat	*Myrmecocichla aethiops*	LC	PM
153	White-eyed Slaty Flycatcher	*Melaenornis fischeri*	LC	
154	African Dusky Flycatcher	*Muscicapa adusta*	LC	
Nectariniidae: sunbirds				
155	Tacazze Sunbird	*Nectarinia tacazze*	LC	
156	Bronze Sunbird	*Nectarinia kilimensis*	LC	
157	Malachite Sunbird	*Nectarinia famosa*	LC	
158	Golden-winged Sunbird	*Drepanorhynchus reichenowi*	LC	
Passeridae: sparrow weavers, Old World sparrows and petronias				
159	House Sparrow	*Passer domesticus*	LC	
160	Kenya Rufous Sparrow	*Passer rufocinctus*	LC	
161	Grey-headed Sparrow	*Passer griseus*	LC	
Ploceidae: weavers, bishops and widowbirds				
162	Grosbeak Weaver	*Amblyospiza albifrons*	LC	
163	Baglafecht Weaver	*Ploceus baglafect*	LC	am
164	Speke's Weaver	*Ploceus spekei*	LC	
165	Chestnut Weaver	*Ploceus rubiginosus*	LC	
166	Red-billed Quelea	*Quelea quelea*	LC	am
167	Long-tailed Widowbird	*Euplectes progne*	LC	

Family	Species common name	Species scientific name	IUCN Red List Category	Migration Status
Ploceidae: weavers, bishops and widowbirds				
168	Jackson's Widowbird	*Euplectes jacksoni*	NT	
Estrildidae: waxbills				
169	Abyssinian Crimsonwing	*Cryptospiza salvadorii*	LC	
170	Common Waxbill	*Estrilda astrild*	LC	
171	Red-billed Firefinch	*Lagonosticta senegala*	LC	
172	African Quailfinch	*Ortygospiza fuscocrissa*	LC	
Viduinae: Parasitic Weaver, indigobirds and whydahs				
173	Pin-tailed Whydah	*Vidua macroura*	LC	
Motacillidae: wagtails, longclaws and pipits				
174	Yellow Wagtail	*Motacilla flava*	LC	PM
175	Cape Wagtail	*Motacilla capensis*	LC	
176	Mountain Wagtail	*Motacilla clara*	LC	
177	African Pied Wagtail	*Motacilla aguimp*	LC	
178	Sharpe's Longclaw	*Macronyx sharpei*	EN	
179	Yellow-throated Longclaw	*Macronyx croceus*	LC	
180	Grassland Pipit	*Anthus cinnamomeus*	LC	
181	Tree Pipit	*Anthus trivialis*	LC	PM
182	Red-throated Pipit	*Anthus cervinus*	LC	PM
Fringillidae: canaries, citrils, seedeaters and relatives				
183	Yellow-crowned Canary	*Serinus flavivetex*	LC	
184	African Citril	*Crithagra citrinelloides*	LC	PM
185	Reichnow's Seedeater	*Crithagra reichenowi*	LC	
186	Brimstone Canary	*Crithagra sulphurata*	LC	
187	Streaky Seedeater	*Crithagra striolata*	LC	

Source: Compiled by Jabes Okumu, EAWLS, 2017 from various sources (African Waterfowl Census reports (National Museums of Kenya; Wamiti (2010)

Annex 2: Map of Lake Ol Bolossat



Source: Wetlands Department, Kenya Wildlife Service

Annex 3: Information collection template

INFORMATION/DATA	SOURCE/STAKEHOLDERS
Size and geographical location of the lake: • Description • Map (location of Lake Ol Bolossat in the world and Kenyan map, and site specific map)	• NEMA • RCMRD • KWS
Conservation status of the lake	• NEMA • KWS • County Government
Biodiversity (flora and fauna) • Inventory of vegetation within the lake and its catchment • Inventory of animals found within the lake (mammals, birds, reptiles, amphibians, invertebrates, fish) • Biodiversity threats	• Kenya Wildlife Service (KWS) • Nyahururu Bird Club, • Nature Kenya • Birdlife International • National Museums of Kenya (NMK) • Kenya Forest Service (KFS) • Min. of agriculture, fisheries and livestock, • Universities & other research institutions
Soils, topography and geology	• Online materials • Min of water and irrigation • Dept. of water, environment and natural resources • NEMA
Hydrological characteristics • Water flow (recharge and discharge) • Lake volume fluctuations • Water quality	• Dept. of Water, Environment and Natural Resources, Nyandarua County • Water resource Management Authority (WRMA) • Ewaso Nyiro River Basin Authority • Online materials
Climate	• Kenya Meteorological department • Online materials
Existing and potential land uses in, within and around the lake: • Socio-economic and cultural activities • Lake resources ranking as per the usage	• Online materials • Nyahururu Bird Club • EAWLS • NEMA • WRMA • Research papers • Project report

INFORMATION/DATA	SOURCE/STAKEHOLDERS
Human population density and trends within the lake catchment (socio-demographic characteristics of the lake dependants)	• RCMD • Online materials
Land tenure system in the lake catchment	• Department of land and physical planning- Nyandarua county • NEMA Nyahururu office • NLC
Threats and challenges facing the lake	• Online materials • EAWLS • KWS • KFS • WRMA
Landsat imageries and aerial photos • Land use changes • Trends in the size of the lake	• RCMRD • Department of resource survey and remote sensing (DRSRS) • Research papers
Camera photos • General photographs of the lake landscape and its resources.	• EAWLS • Birdlife International • Nyahururu Bird Club (NBC)

Annex 4: List of Key institutions consulted

1. National Environment Management Authority (NEMA) – Nyandarua
2. Water Resources Management Authority (WRMA)
3. County Government of Nyandarua
4. Kenya Wildlife Service – Nyahuru Station
5. Nyahururu Bird Club
6. National Museums of Kenya (NMK)
7. Nature Kenya
8. Birdlife International
9. Kenya Forest Service

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