بسم الله الرحمن الرحيم

SUDAN UNIVERSITY OF SCIENCES AND TECHNOLOGY

COLLEGE OF GRADUATE STUDIES

A Study on Some Zoos in the Sudan and their Role in Wild Animals conservation with Emphasis on Kuku Zoo

دراسة عن بعض حدائق الحيوانات في السودان ودورها في المحافظة على الحيوانات البرية بالتركيز على حديقة الحيوان بكوكو

By: Ahmed Adam Salih Mohammed

(B.Sc. hon.SUST, 2007)

A dissertation submitted in partial fulfillment for the requirements of the degree of Master of Science in wildlife management

Supervisor: Prof. Ali Saad Mohamed

Sudan University of Science and Technology

Aug. 2019

الإستهلال

قال تعالى:

﴿ إِنَّ لِلْمُتَّقِينَ مَفَازًا ﴿ 31 ﴾ حَدَائِقَ وَأَعْنَابًا ﴿ 32 ﴾

صدق الله العظيم

سورة النبأ (الآيتان 31 – 32)

DECLARATION

I declare that this research project is my original work .it is being submitted in partial fulfillment of the degree of Master of Science in Wildlife Management to the Sudan University of Science and Technology. It has not been submitted for award of degree or for any similar purpose to any other University.

Candidate: Ahmed Adam Salih Mohammed

Signature:…… Date: Aug. 2019

Dedication

THIS RESEARCH IS DEDICATED TO:

SOUL OF MY FATHER AND MY BROTHER ALI

MY MOTHER

MY BROTHERS AND SISTERS

MY SMALL FAMILY

MY TEACHERS

MY COLLEAGUES AND FRIENDS

Acknowledgements

Praise in the first place to my lord (Allah) for enabling me to complete this work. I am grateful to my supervisor ***prof. Ali Saad Mohamed*** for encouragement and guidance. Great thanks to *my brother Yagoub Adam* for encouragement and funding this research**.** Also thanks go to family and administration of the following Zoos (Kuku,Alqurashi, Elbasigat, Kassala, andNyala) for their fruitful addition to this research. Furthermore, I am grateful to my colleagues in the wildlife field, especial thanks go to *Prof. Ibrahim Hashim* (SWS), *Prof. HamedAgab* (SUST), *Mr. Badreldin Adam* (WRC), *Mr. Ahmed Babay* (SUST) ,Waleed Musa SUST and *Adam Ahmed* (NU) for their advice, helping and encouragement. I am thankful to *prof. Mohammed Tag Eldeen&Dr. Abu baker Said* for their great help in data analysis.Finally my thanks go to all persons who helped me to fulfill this research.

LIST OF CONTENTS

LIST OF TABLES

LIST OF APPENDIXES

ABSTRACT

This study was undertaken to establish data on wild animals and aimed to keeping and breeding them in Zoological gardens in the Sudan and assesses their role in wild animal conservation and challenges facing the Zoos. The present study was conducted in the Sudan on five selected Zoos: Kuku, Alqurashi and Basigat zoos in Khartoum state as the main locality of the study with reference to Kuku zoo and the center for wild animal's trade, Kassala Zoo is located near Dinder Biosphere reserve and Nyala Zoo located near Radom National Park. This study was conducted during (Oct.2018 – Aug.2019). This study adopted direct observation, direct contact and questionnaire survey methods. Results of study showed the diversity of wild animals kept in zoos including; (324) wild animals belonging to (33) species; (123) mammals; (125); Reptiles and (76) Birds, of these zoos; Kuku Zoo shows the highest diversity and abundance of wild animals. Common problems were; predators, competitors, difficulties. Foreign body, wounds, management problems and diseases; (Parasites, viral, Bacterial, and Fungal).The results of the questionnaire in kuku zoo showed that (87.5%) of respondents said most successful breeders are primates, (50.0%) said that the highest mortality which occurred in the Zoo was in avian species. Common diseases in kuku Zoo varies, the highest was digestive system diseases (43.8%). Diseases are the main cause of most mortality cases (50%) Disease frequency at all season in Kuku zoo(46.9%), most attractive feature in Kuku Zoo was wild animals (46.9%), most attractive animals for visitors in Kuku zoo was the Lions with percent (90.6%), The highest one was educational role (56.3%), that the highest recommendations to develop the Zoo is Retrieving Endangered Species (84.4%). Moreover the responders of Kuku Zoo agree that the animals housing and display are suitable (3.69± 1.03),chi.^{2} significant level (0.000),

the feed quantity is adequate (3.97±0.93) Significant chi²level (0.010),the feeding frequency is enough (3.69± 1.12) Significant chi.² level (0.475), clean supply of water is available, (3.78± 1.29) Significant chi.² level (0.09), The interaction between the wild animal and visitor is safe (3.41± 1.58) Significant chi.² level (0.117), The wild animals were good breeders in Kuku zoo (3.66± 1.18) Significant chi.² level (0.626), The wild animals increasing (3.50± 1.22) Significant chi.² level (0.170), There is provision of opportunity to express most normal behaviors (3.84± 1.11) Significant chi.² level (0.040). However The responders in Kuku zoo strongly agree that the feed quality are good (4.09±0.93) Significant chi.² level (0.050), Kuku zoo play a good role in wild animal conservation (4.22± 0.83) Significant level (0.000), Quality of service the in zoo is good (4.16± 0.77) Significant level (0.380) and Neutral (2.50± 1.34) Significant chi.² level(0.020).

المستخلص

هدفت الدراسة الي تاسيس بيانات عن الحيوانات البرية الموجودة في الحدائق والمساعدة في حفظها وتربيتها وتقيم دور الحدائق في المحافظةعلي الحيوانات البرية.أُجريت هذه الدراسة في السودان في الفترة خلال (اكتوبر 2018– اغسطس 2019) حيث اختيرت خمسة حدائق (كوكو،القرشى،الباسقات) الموجودة في ولاية الخرطوم والخرطوم وتمثل المقر الرئيسى للدراسة و مرجعية حديقة حيوان كوكو وبالاضافة وهى مركز لتجارة الحيوانات البرية .وحديقة كسلا لموقعها القريب من محمية المحيط الحيوى (الدندر).ونيالا القريبة من محمية الردوم.إعتمدت الدراسة علي الملاحظات المباشرة والمقابلات الشخصية والتقارير السنوية والشهرية ' بالاضافة الي استبيانات للعاملين في حديقة حيوان كوكو.

أظهرت هذة الدراسة تنوع الحيوانات البرية التي تحفظ في حدائق الحيوانات ويبلغ عددها (23) نوعاً و(324) حيوان تقسم علي نحو التالي (123) ثديات و(125)زواحف و (76) طيور. وتعتبر حديقة حيوان كوكو اكثر تنوعاًووفرةً في الحيوانات البرية. ومن اكبر المشاكل التي تواجه الحيوانات بالجدائق هيالافتراس والمنافسة ومشاكل تصميم الاقفاص والامراض (الفيروسية والبكترية والطفيلية والفطرية).كما اظهرت نتائج الاستبيانبحديقة حيوان كوكو (87.5%) من المسبينن يرون بان القرود اكثر توالداً في و(50%) يرون ان الطيور اكثر نفوقاًو(43.8) يرون أمراض الجهاز الهضمي اكثرشيوعاً في الحديقة. بينما(50.0%) يعتبرون بان الامراض هي المسبب الرئيسى لنفوق الحيوانات و(46.9%) يرون بان الامراض موجودة في كل مواسم السنة والحيوانات البرية الاكثر جزباً للزوار ,(46.9%و(90.6%) يرون بان الاسد اكثر جذباً للزوار من بين حيوانات الحديقة و(56.3%) يرون ان دور الحديقة تعليمي و(84.4%)منهم يعترون اضافة حيوانات مهددة بالانقراض اهم توصياتهم لتطوير الحديقة.

كما يوافقون بان طريقة عرض وتسكين الحيوانات بالحديقة مناسبة (1.03 ±3.69)،بمستوي معنوية مربع كاي(0.000)،كما يرون بان كمية الاغذية التي تقدم للحيوانات بالحديقة مناسبة (0.93±3.97) بمستوي معنوية مربع كاي(0.010)عدد مرات التغذية الحيوانات المختلفة كافية'(1.12 ±3.69)بمستوي معنوية مربع كاي (0.475)،المياة متواجدة ونظيفة بالحديقة (1.29 ±3.78)بمستوي معنوية مربع كاي (0.09)،.كما بوافقون بشدة بأن الحديقة بوضعها الحالي يمكن ان تحافظ علي الحيوانات البرية من الانقراض (0.83 ±4.22) بمستوي معنوية مربع كاي(0.000) ونوعية الاغذية التي تقدم للحيوانات بالحديقة جيدة(0.93±4.09)بمستوي معنوية مربع كاي(0.050) ،الخدمات داخل الحديقة جيدة ±4.16) (0.77بمستوي معنوية مربع كاي (0.380). ومحايدين عدد الزكور والاناث للحيوانات مناسب (15.6%) وبمستوي معنوية مربع كاي (0.020)

CHAPTER I

1. INTRODUCTION

Wild animal's diversity is globally rapidly declining. Out of the 61,898 taxa listed by the International Union for Conservation of Nature and Natural Resources (IUCN), 35.9% are either existing in the wild; (0.1%), critically endangered; (7.4%), endangered; (11.0%), vulnerable; (17.4%), are referred to as threatened species (IUCN, 2014). Of these threatened animals, 22.1% are mammals, including large herbivorous species as the most endangered species due to overexploitation, habitat loss, invasive species and the synergistic effects of these factors (Seddon,2010).

Thus the ex situ conservation of wild animals in many forms such as Zoos and Aquariums must be necessary, they play a great role in conservation of the wild animals and human services. However the community of zoos personnel considers animal welfare be of great importance provided that animals must be accommodated under good conditions which satisfy the conservation and biological requirements of the individual species (EC Regulation, 2005).

In the Sudan, many factors are contributing to the decline of population sizes of wildlife, including; natural factors and human activities, especially after political separation of South Sudan in 2011 and evacuation of Khartoum zoo in 1993 which led to loss of most species of wildlife. There are no available documents about Khartoum Zoo in the Wildlife Conservation General Administrations (W.C.G.A). Therefore no standards for modern zoo in the Sudan are existing so no research conducted on zoological gardens in the Sudan and their role in conservation of wild animals to the present and future generations. Beside that there is little information and no adequate data available about zoos in the Sudan.

1.2. Overall Objective:

This study aimed to throw light on the importance of keeping and breeding wild animals in Zoological gardens in the Sudan and assess their role in wild animal conservation and the challenges facing them

1. 3. Specific Objectives:

1.3.1. To establish baseline information about Zoos in the Sudan and Wild animals that they keep.

1.3.2. To evaluate the role of Zoos in Wild animals conservation in the Sudan.

1.4. Research hypothesis:

The hypothesis of the study tended to test:

1. Zoos play magnificent role on conservations of wild animal's issues in the Sudan (H0: $\mu 1 = \mu 2$).

2. Zoos do not play magnificent role on conservations of wild animal's issues in the Sudan (H0: $\mu 1 \neq \mu 2$).

CHAPTER II

2. LITERATURE REVIEW

2.1. Background about the Zoological Gardens

European Association of Zoos and Aquariums (2014) defined Zoos to refer to all establishments open to and administered for the public, to promote nature conservation and to provide education, information and recreation through the presentation and conservation of wildlife.

Karen (2004) Reported that the zoos are the oldest form of wildlife tourism; Efforts to tame and keep wild animals in captivity are nearly as old as human society itself. The first documented were the animal collections associated with places of worship in Ancient Egypt around 2,500 BC. The history of the modern zoo began in the late 18th and early 19th centuries with the formation of the first public zoo open to all. The first zoo was opened in Paris in 1793.

The wild animals breeding in captivity in the Sudan was started in the public zoo. A notable example was the Khartoum zoo (1902-1993). It was established almost for the purpose of recreation. The zoo was rather not proportional to Sudan's resources of wildlife; it was in step with the pace of development of national capital. Consequently it was evacuated and the wildlife it used to contain were shifted by qualified Sudanese to other locations (Sudanow, 1993)

2.2. Zoos Design:

The development of zoos and zoo design runs in parallel with one another and so rapidly that it is barely possible to obtain an overview. New ideas that come up again and again to reinvent the zoos of the 21st century – entirely as intended by animal rights activists – as substitute "electronic zoos" will remain on the fringes, because nothing can truly replace the

experience of coming eye-to-eye with a living being, to hear, smell, observe and maybe even touch it. Also, spectacular design approaches – such as the 2014 master plan for Givskud Zoo as a cage-less zoo Topic Park without enclosures, in which the visitor is intended to be a guest with the animals – must still be put to the test, with respect to their potential to be realized. Visitor participation will increase; following the example of Bronx Zoo's Congo Gorilla Forest, where at the end of their visit, visitors can individually decide on touch screen monitors which in situ projects the (separately charged) admission fee should be used for. However, in order to obtain the moral legitimacy at all, those zoo representatives of their nonspecific in nature must find a habitat that is – uncompromisingly – designed according to the latest knowledge of zoo biology and is continuously adapted and developed(Rasbach, 2016). Saeed (2019) mentioned that the designs of wild animal's cages in Kuku Zoo are safety for both animals and visitors.

2.2.1. Housing of Zoo animals:

Enclosures must be managed so as to:

Avoid animals within herds or groups being unduly dominated by individuals; avoid the risk of persistent and unresolved conflict between herd or group members, or between different species or age groups in mixed exhibits; Ensure that the physical carrying capacity of the enclosure and/or system is not over-burdened; prevent an uncontrolled build-up or spread of parasites and other pathogens; Remove any refuse and allow drainage of waste water. Trees within or near animal enclosures must be regularly inspected and lopped or felled as necessary to avoid animals being harmed by falling branches, toxicity or trauma. Trees and climbing plants must be pruned to prevent aiding animal escape. Distance or barriers between animals and between enclosures and visitors must be sufficient to

minimize transmission of disease or of potential pathogens (wildlife, 2012). Patricia (2015) reported that good zoo management should be reflected in enclosure design that mimics as far as possible the wild state of the animals concerned. Knowledge of species' behavior both innate and those that are able to be learned should be a fundamental requirement however, application of that knowledge is the primary evidence of good zoo management Shepherdson *et al.* (2004) reported that stresses naturally occur during the reproductive process, foraging and feeding in normal day-to-day interactions. Evolutionary processes provide adaptations for coping with such stresses. Measuring psychological stress within the zoo environment is attempted by observation, noninvasive and invasive processes. A primary analytic is corticoid, a product of adrenal activity and when measurements are gathered amongst several institutions, comparisons and safer conclusions can be made as to improvements in captive welfare. The same author recommended that studies need to take place of course, at a working zoo as captive where animals experience the attendant disruptions and stresses associated with a zoo environment. Saeed (2019) reported that the housing for each animal species in Kuku Zoo is Suitable.

2.2.2. Protection of public:

Every person licensed to use a firearm must undergo formal training by a suitably qualified person. Every trained operator should undergo periodic refresher training and practice. Such training should be recorded and available for inspection where a zoo holds any primate, carnivore, or hoofed mammal, appropriate firearms must be available, unless a risk assessment has shown that a firearm would not provide the most appropriate means of protection to the public from that animal, and other arrangements have been made. Firearms, ammunition and darting equipment, where provided, must be: Available for immediate use by

licensed and trained operators; Cleaned and maintained as recommended by the manufacturer; Kept securely when not in use or under maintenance; Appropriate staff must be trained in medicines handling: its risks; side effects; human risks if misused; and emergency protocols; Where used to contain animals, must be surrounded by a stand-off e.g. fences, walls, hedges or shrubbery, sufficient to prevent the public from approaching too close to the edge. Consideration should be given to whether rescue equipment such as lifebuoys should be provided; Barbed, razor wire or electrified fences should be beyond the reach of members of the public; Stand-off barriers must be provided and be designed, where necessary, to ensure public safety particularly to prevent direct contact with; Safety barriers should be designed to prevent children from getting through, under or over them. They should also be designed to discourage visitors from sitting on them (Wildlife, 2012).

Situations; for example, whether daytime staff is on duty, whether visitors are present, and whether more than one animal has escaped; What needs to be done in the event of an escape; including recapturing the animal, protecting visitors, alerting the police and, where necessary, the licensing authority; The control of visitors, including reassurance, ushering into buildings, closing doors and windows, evacuating the zoo; The security of the perimeter barrier; involving the closure of all points of access to, exit from the Zoo(Wildlife, 2012), the provision of firearms and darting equipment to tranquillize or kill escaped animals, precise details of which are to be discussed and agreed by the zoo operator and the local police (regular training with firearms and darting equipment should be conducted and documented); The provision of adequate equipment for members of any recapture party, including, where necessary, vehicle protection. A member of staff should be readily available at all times to take decisions regarding euthanasia of escaped animals. The zoo must establish a clear

chain of responsibility, which must be written and up to date. It must be notified to all staff, and posted on notice-boards in staff areas. The zoo must be responsible for the selection of the appropriate firearm or darting equipment to deal with escaped animals (Wildlife, 2012).

2.2.3. Free-ranging spaces:

- Zoos must prevent the deliberate release or permitting to escape into the wild of non-indigenous species. This is particularly relevant if free-ranging species are kept within the zoo grounds but not confined in enclosures.
- Zoos are required to be active in preventing the escape of animals in order to avoid possible ecological threats to indigenous species.

-Zoos must take into account the Wildlife and Countryside Act 1981 where there are free-flying psittacine birds or birds of prey in flying displays.

- Zoos must be aware of the legislation and take every precaution to prevent escapes. Particular points to note are:

Bird of prey centers which use birds in flying demonstrations should train birds sufficiently to ensure their return; Where possible, transmitters should be used to help zoo staff to locate birds which have strayed; Zoos which allow birds to free-fly should encourage them to remain on site by providing roosting areas, nest boxes, and feeding points; and enough staff should be available to retrieve birds when lost. The perimeter boundary, including access points, should be designed, constructed and maintained to discourage unauthorized entry and, so far as is reasonably practicable, as an aid to the confinement of all the animals within the zoo (Wildlife, 2012)..

Zoos must have systems in place to minimize the risks of theft, malicious damage or release of animals by intruders entering the grounds out of hours. Zoo operators must assess whether any danger may arise in the event of an animal escaping from its enclosure, and consider the possible or likely attempted escape route from the zoo if this were to happen. Every

effort must be made, so far as it is reasonably practicable, to affect the recovery, live or dead, of any escaped animals. The procedures to be adopted in the event of escapes within or from the zoo of any animal should be brought to the attention of, and available to, all members of staff, and other relevant personnel as considered necessary, in a written document. Procedures relating to escapes of animals should be established and include the following: The reporting of every escape by the quickest possible means to the most senior member of staff available; the response to an escape in all (Wildlife, 2012).

2.3. Provision of a suitable environment:

The temperature, ventilation, lighting and noise levels of enclosures must be suitable for the comfort and well-being of the particular species of animal at all times. Consideration must be given to the special needs of pregnant and newly-born animals;

Newly-arrived imported animals should be allowed to become fully acclimatized into their new environment. In some cases, this may be a gradual process; Tanks for aquatic animals need to be adequately aerated, according to the number kept in each tank, and must be heated or cooled according to the needs of the species. Environmental parameters must be suitable for the species; Indoor housing must protect against extremes of sunlight, heat, draughts and cold, and provide appropriate humidity, (Wildlife, 2012).

2.4. Provision of Food and Water:

Susan (2001) reported that providing an appropriate diet to the wide array of animal in zoos remains challenging, although the tremendous expansion in the science of zoo nutrition and diet management in the past 20 years. Significant advances have been possible because of a number of interested scientists. provided food must be presented in an appropriate

manner and must be of the nutritive value, quantity, quality and variety appropriate for the species, and for the condition, size and physiological, reproductive and health status of the individual animals. Sufficient fresh, clean drinking water must be available at all times for all animals requiring it. Supplies of food and drink must be kept and prepared under hygienic conditions, in particular: food and drink must be protected against dampness, deterioration, mould or from contamination by insects, birds, vermin or other pests; supplies of perishable food and drink, other than those brought into the premises fresh on a daily basis, should be kept, where appropriate, under refrigeration; preparation of food and, where appropriate, drink should be undertaken in a separate area suitably designed and constructed; staff should be instructed to observe strict standards of personal hygiene and should conform to good hygiene practice in the preparation of food, having due regard to the risk of cross contamination between equipment, utensils and surfaces; receptacles for food and drink must not be used for any other purposes. The natural behavior of the animals, particularly social aspects, should be considered when offering food and drink. Feeding and drinking receptacles, when used, should be of appropriate design and placed so as to be accessible and available to every animal kept in an enclosure. Feeding methods must be safe for animals and staff. Live feeding of vertebrate prey is to be discouraged .Although the Animal Welfare Act 2006 does not prohibit the feeding of animals with live prey, the live feeding of vertebrate prey should be avoided save under exceptional circumstances, and only under veterinary advice. Where it has to be undertaken, a written justification and ethical review process must have been undertaken and agreed by senior staff weighing up the welfare of predator and prey; feeding must be observed and live prey not left in the enclosure. Such feeding should not take place in the presence of the public.

Food and drink, and feeding and drinking receptacles when used, must be placed in positions which minimize the risks of contamination from soiling by the animals, wild birds, rodents or other pests. Food, water and other drinking receptacles, where used, must be regularly cleaned. Self-feeders, where used, should be inspected twice daily to ensure that they are working effectively and do not contain caked or unfit food. Water lines should also be checked twice a day. Uncontrolled feeding of animals by visitors must not be permitted. Where controlled feeding occurs, it should be on a selective basis only, with suitable food sold, provided or approved by the operator. The quantity supplied per day must be managed to avoid over-feeding. Uneaten food must be removed as appropriate to maintain hygiene. Veterinary or other specialist advice in all aspects of nutrition must be obtained and followed. A record of all diets and dietary changes must be maintained (Wildlife, 2012). Adequacy quality, quantity of food were given to animals in Kuku Zoo (Saeed, 2019)

2.5. Reproduction:

Reproduction is an integral part of the quality of life and natural behaviour of each living animal. However offspring of zoo animals were not life without suitable house condition. The following measures can be considered to limit undesired reproduction; temporary separation, or unlike in some cases the continued holding together if not group housing , of males and females, holding of all-male or all-female groups, extension of birth period, removal, shaking or freezing of egg clutches, hormone injections, oral medication, or implants in females. Female's vaccinations, Sterilization of both males and females, including vasectomy and castration (EAZA, 2014; Gonja 2003), reported that the major factors that led to the unsustainable management of the captive included dependence of the ranchers on dorcas gazelle as a single species of animal, inadequacy of

male to female stocking ratio, collection of the wild animals from only one site, lack of awareness and expertise within the management personnel and inadequate number of trained laborer, lack of comprehensive and technical guidelines on captive management, no monitoring and advisory body to assist the farmers, poor feasibility studies, no veterinary supervision, the committees formed to report on the status of the farms were confined to the officers of the Wildlife Conservations General Administration (W.C.G.A) only, no ownership certificates, and low economic benefits. Different species require different management plans, and population requires keeping track of individuals knowing how many animals there are and who is related to whom, animal's birth, death, lineage, sex, and reproductive history.

2.6. Environmental Threats and Loss of Wild Animals:

Zoos and Aquariums now operate in a world of accelerating environmental threats and reduction in biodiversity. In the last decades climatic changes, overexploitation of natural resources, increases in the negative impact of invasive species and overall environmental degradation have all continued. The value of species and vulnerability and ecosystems and their influence on humans have been poorly reflected in the media; public perception has focused on crises of conflict, drought, famine and migration rather than root causes linked to the unsustainable use of natural resources. Similarly human development and demands on sustainability, and concerns about globalization and corporatism, dominate international political agendas. Underlying everything is the continuing essential fact that there are too many human beings consuming far too great a proportion of the Earth's natural resources therefore allow non-human species to share that secures their future. The predicted increase in human population and the pronounced inequality in distribution of wealth among and within

nations are two of the major problems facing human kind both affect, directly and indirectly, the conservation of species and habitats (David, 2004). The most threatening factors of wildlife in the Sudan were poaching, trafficking, fire, and over grazing (Mohammed, 2019)

2.7. The Role of Zoos and Aquariums:

In several countries historical and social perceptions of zoos as recreationally, menageries still persist, and in some cases are justified. A sector frequently hostile to zoos is the growing animal-rights and animal-welfare lobby, which emphasizes the interests of individual animals, rather than the conservation of species or eco-systems; further opposition comes from that part of the conservation movement which doubts the justification for removing animals from the wild. If zoos and aquariums are to play an active part in conservation they must face opposition head-on, by understanding criticisms, adapting where necessary and explaining their actions in a way that gains public support. They must also make clear to the general public that their mission is one of conservation, which is conducted in the highest welfare standards (Wilson, 2002).

2.8. Definition of Conservation:

Conservation is the securing of long-term populations of species in natural ecosystems and habitats wherever possible. Definitions of conservation are many and varied. It is important to have a common and straightforward definition that everyone understands and uses. In addition these wild populations must be able to develop and evolve. From this it follows that we must continually assess and review how successful zoo and aquarium supported conservation programs are. Within these wider contexts and alongside major trends, zoos and aquariums have to achieve and promote a clearer view of their unique role and the contribution they

can make as part of a global conservation coalition. More coordination of activities are focus of resources towards high priorities need to be coupled with a wider application of good management practices, in particular; continuous evaluation of the impact of key projects. The major goal of zoos and aquariums will be to integrate all aspects of their work with conservation activities. The fundamental elements of each organization's culture will be the values of sustainability and conservation, and social and environmental responsibility (Rasbch, 2016)

2.8.1. Qualitative measures to achievement successful conservation:

Increasingly secure populations of species in the wild, increasing areas/volumes of secure, sustainable habitat, greater knowledge and application of species biology, ecology and conservation science, More political awareness of environmental issues with better environmentally-friendly decision making and increasingly higher conservation priorities, increasing capacity in habitat areas through training, education and public awareness, Individual zoos and aquariums, and the zoo community, are pre-eminently suited to emphasize the global aspects of conservation. Scientific knowledge of the interconnections of all life systems and habitats has greatly increased in the last few years and it is becoming increasingly evident that conservation is not only a matter of saving species and habitats but, to be successful, also needs cooperation and a global approach. Zoos and aquariums, because they care for, and have expertise in collections of living animals from around the world, and because of their global network, can play a major role in promoting conservation cooperation on a global scale.

Only zoos, aquariums and botanic gardens can operate across the whole spectrum of conservation activities, from ex situ breeding of threatened species, research, public education, training and influencing and advocacy,

through to in situ support of species, populations and their habitats; they uniquely have a massive ‘captive audience’ of visitors whose knowledge, understanding, attitude, behavior and involvement can all be positively influenced and harnessed. They have a huge resource of technical skills and dedicated people. As habitats shrink and collection-managed populations grow, the definition of what is a zoo, what is a botanic garden, what is a reserve, and who is a collection-based conservationist, who is a field-based conservationist, will inevitably blur.

Zoos, aquariums and botanic gardens have an opportunity to establish themselves as models of ‘integrated conservation’ and the means of achieving this in a collective fashion for zoos and aquariums are through the World Zoos and Aquariums Conservations Strategy (WZACS). Other bodies, such as conservation bodies and governmental departments, can use the WZACS and the integrated conservation approach, and this will bring benefits to all concerned with conservation (Rasbach, 2016).

2.8.2. Elements of design that facilitate the best animal care:

Designers focus on the public experience, but without good support spaces and infrastructure, zoos and aquariums cannot function. Animal holding spaces, life support systems, propagation spaces are just a few of the necessary programmatic needs, which can be facilitated by good design. We need to consider space for propagation and Partnerships with other zoos and aquariums can provide shared resources of space, scientific expertise (Rasbach, 2016). Commonly recommended strategies for preventing the loss of critically endangered species include ex situ approaches and in situ approaches, or a combination of both strategies by reintroducing captive bred animals to suitable habitats and to restore and connect populations (Seddon, *et al.,* 2012; 2009; 1995).Although reintroductions involve many logistical and financial challenges (Kareiva,

*et a*l,and Marvirs 2011).They have been successfully carried out numerous times (Seddon, 2010). Examples include the Alpine ibex (*Capra ibex ibex*) in the European Alps (Stüwe, and Nievergelt,1991).Przewalski's horses (*Equusferus przewalskii*) in Mongolia (Wakefield *et al.*,2002).The Arabian Oryx (*Oryx leucoryx*) in Saudi Arabia and Israel(Ostrowski, *et al*.1998).The European bison (*Bison bonasus*) in several eastern countries (Pucek, *et al*.2004; 2007; 2013), The Black bear (*Ursusameri canus*) in Arkansas (Smith,*et al*., 1991).

the Bearded vulture (*Gypaetus barbatus*) in the European alps(Hirzel, *et al.*,2004).Because species considered for reintroduction may lack their original habitat types or lack unaltered habitat it is essential for successful reintroductions to find suitable environments that can meet a species' habitat requirements (Osborne and Seddon, 2012).

2.8.3. Conservation measures within and beyond the zoo:

The directive requires that zoos undertake conservation measures and gives a number of options for doing so. The options given are:

Participating in research from which conservation benefits accrue to the species, training in relevant conservation skills, the exchange of information relating to species conservation; Where appropriate, captive breeding, where appropriate, repopulation or reintroduction of species into the wild(Leader, 2007)

Zoos must therefore undertake, as a minimum, at least one of these options. The measures required should be proportionate to the size and type of zoo. Where the relevant species are held, a zoo must be an active participant in recognized species management program. Zoos must be able to demonstrate their conservation measures, including research if undertaken. Areas to be considered should include overall conservation policy, and how this relates to the World Zoo and Aquarium Conservation

Strategy, and type and level of input into international conservation programs. Zoos should generally be able to demonstrate that they encourage research. Research can be developed through forging links with Higher Education Institutions. In any research carried out, care must be taken to comply with all relevant legislation and be subject to ethical review (Leader, 2007)

2.9. Wildlife Utilization:

Wild animals are utilized in three principal ways: first as food, second as non-edible products and the third as sport hunting (Eltringham, 1984; Awad, 1990).

As zoo specimens, there was a time not so long ago, when the demands for wild animals supported the profession of animal trade. Regarding their qualities, some products of wildlife have no equivalents with which to compare. Ivory, for example, is found only on elephants. White plastic can be made and molded into ornaments that look like ivory carvings, but they are not mistaken for original ivory, Rhino horns come into the same category, (Awad,1990). Sayed (1994), reported that there are many wild mammals species in Khartoum Zoo included; Giraffe, Elephant, African buffalo, Lions, Leopard, Serval cat , Black bear, Spotted hyaena, Striped hyaena, Black backed Jackal, Egyptian mongoose, Hippopotamus, Greater kudu, White eared Kob, Dorcas gazelle, Red-fronted gazelle, Nubian Ibex, Roan antelope, Warthog, River hog , Porcupines, Giant forest Hog , Bennette kangaroo , Grivet Monkeys, chimpanzee, Patas Monkeys and Domestic goats.

2.10. Provision of animal Health care and Routine observation:

The condition, health and behavior of all animals should be checked at least twice daily by the person(s) in direct charge of their care consistent with avoiding unnecessary stress or disturbance. Any animals which give

cause for concern must be thoroughly assessed as to whether they are unduly distressed, sick or injured. Where necessary they must receive immediate attention and treatment. A daily record must be kept by the person(s) in direct charge of the animals, indicating changes to the prescribed diet, health checks carried out, any unusual behavior or activity or other problems, and remedial actions taken (Wildlife, 2012). Routine examinations, should be administered by a veterinary surgeon or practitioner including vaccination, preventive medicine, and parasite checks (EAZA, 2014)

2.11. Veterinary care:

Comprehensive programmers of care must be established and maintained under the supervision of a veterinary surgeon that is familiar with current practice in the care of zoo animals, particularly in the types maintained in the collection. They must make arrangements to meet the ethical responsibilities of veterinary cover, where a zoo uses a local veterinary practice for basic cover, supported by a specialist adequate advance arrangements must be made to allow early contact and discussion between all parties whenever necessary, and particularly for emergency cases. The veterinary surgeon should be responsible for, or actively involved in, the following: Routine inspections of the collection; Directing or carrying out treatment of all sick animals; Administration of vaccines, worming and other aspects of preventive medicine; Health monitoring of animals including submission of blood and other samples for laboratory examination; Safe and proper collection, preparation and dispatch of diagnostic and other samples. Training of zoo personnel in health and hygiene; Ensuring that post-mortem examinations of animals are carried out where necessary; Supervision of quarantine premises and other such tasks required by law or as part of good zoo veterinary practice; The

nutrition and the design of diets; Planning and exhibit design; The establishment of written procedures to be followed in the event of the accidental use of dangerous drugs.

The level of veterinary facilities must be consistent with the welfare needs of the animals. Comprehensive records must be kept – where possible on computer – and be made available to inspectors covering the following:

Preventive medicine; Clinical medicine and surgery; Pathological findings from ante-mortem and post-mortem testing examination.

There must be systems for regular review, by the relevant veterinary and curatorial staff, of clinical, behavioral and pathological records and mortality. Husbandry and preventive medical practices must be reviewed where problems become apparent. Zoo management must ensure that the Zoo, or a local hospital, or their veterinarian has readily available antidotes to potentially toxic veterinary products used at the Zoo (Wildlife, 2012). Member of staff must be readily available at all times to take decisions regarding the euthanasia of sick animals on veterinary advice. There must be provision of an effective humane method of euthanasia and standard written protocols should be set down. Adequate facilities must be available either at the Zoo or within a reasonable distance for the post-mortem examination of all species held at the zoo.

Dead animals must be handled in a way which minimizes the risk of transmission of infection. Animals that die at the zoo should be examined post-mortem in accordance with veterinary advice. Where appropriate, samples for diagnosis or health monitoring should be taken for laboratory examination. Retained samples must be stored in conditions advised by the veterinary surgeon and away from animal feeding substances. The establishment of a reference collection should be encouraged (Wildlife, 2012)

2.11.1. Isolation and containment:

Wildlife (2012) reported that the accommodation, off-show where necessary, should be available for the isolation and examination of newly arrived animals, and for the quarantine and care of unduly distressed, sick or injured animals. Facilities should be available for hand-rearing and nursing animals. Newly arrived animals should be kept isolated for as long as is necessary to ensure proper examination, acclimatization and quarantine before introduction to other animals in the collection. Particular attention must be paid to hygiene in the quarters where isolated or quarantined animals are kept. Protective clothing and utensils used by staff in the isolation area must be used, cleaned and stored only in that area

2.11.2. Sanitation and Control of Diseases:

Clinical waste and refuse must be regularly removed and disposed of in a manner approved by the local authority, A safe and effective programme for the control or deterrence of pests and vermin and where necessary predators, must be established and maintained throughout the zoo. Health risks posed by the use of power houses on animal waste must be minimized. Staff should be instructed to report in confidence any medical condition or disability which might affect their capacity to manage the animals in a safe and competent manner (Wildlife, 2012).

Specialist techniques used on animals to make them safe for exhibit or to allow them to be exhibited in a particular way must be kept under continual review. Current legislation or codes of practice must be followed (Wildlife, 2012).

2.11.3. Health problems facing captive animals in the Sudan:

The commonest problems encountered during the gestation and post parturient periods were pneumonias, tick and/or lice infections, wounds and or fractures, helminithiasis, toxicity, septicemia, abs cessation, lactic

acidosis, possible viral infections, shipment stress, alopecia, conjunctivitis, cerebral hemorrhage, ilio-caecal valve paresis, simple Indigestion, bloat and other miscellaneous conditions, Abortion and retained placenta (Sayed, 1994; Gonja, 2003).

2.12. Provision of opportunity to express most natural behavior:

Captive breeding should be encouraged where appropriate and a policy should exist covering all species kept, and be subject to continual review. Appropriate control measures should be put in place to prevent overpopulation. Zoos must keep up-to-date with information on biology and husbandry, especially when considering the keeping of species that they have not housed before, or when planning new housing for species already kept. Accommodation must take account of the natural habitat of the species and seek to meet the physiological and psychological needs of the animal. Enclosures must be equipped in accordance with the needs of the animals with bedding material, branch work, burrows, nesting boxes, pools, substrates and vegetation and other enrichment materials designed to aid and encourage normal behavior patterns and minimize any abnormal behavior. Facilities must take into account growth of animals and must be capable of satisfactorily providing for their needs at all stages of their growth and development. Animals of social species should normally be maintained in compatible social groups. They should only be kept isolated for the benefit of the conservation and welfare needs of the group, and where this is not detrimental to the individual specimen. Animals of different taxa should not normally be allowed to inter-breed. Where practiced for justifiable reasons, it should never compromise the genetic integrity of animals within a managed conservation breeding programmer (Wildlife, 2012).

2.13. Provision of protection from fear and distress:

Animals must be handled and managed only by, or under the supervision of appropriately qualified and experienced staff. Handling must be done with care, in order to protect the animals‟ well-being, and avoid unnecessary discomfort, stress or physical harm. Any direct physical contact between animals and the visiting public must only be for restricted periods of time and under conditions consistent with animals‟ welfare, and not likely to lead to their discomfort. Animals must not be provoked for the benefit of the viewing public. Animals which may interact in an excessively stressful way must not be maintained in close proximity. Suitable, separate if appropriate, accommodation for pregnant animals and animals with young should be available in order to minimize unnecessary stress. Animals temporarily accommodated away from others should not be separated for such a period of time that there would be difficulties in their re-introduction to the group. Animals destined for rehabilitation must not be on public display if this is likely to cause stress or compromise their eventual release. Smoking by zoo staff must be prohibited except in designated areas. In open-air collections smoking by visitors must be prohibited where the health and welfare of animals will be compromised (Wildlife, 2012).

2.14. Transportation and movement of live animals:

Surplus zoo stock should only be passed on to responsible persons who have the appropriate facilities, resources and expertise to ensure the welfare of the animals. Where necessary, the appropriate licenses for the keeping and management of the species must be held. Facilities suitable for lifting, crating and transportation of all the types of animals kept within the zoo to destinations both inside and outside the zoo should be readily available (Wildlife, 2012).

Zoos must ensure that they comply fully with the requirements of the Convention on International Trade in Endangered Species (CITES) which governs the import, export, sale and other commercial use – including display of species listed in its Appendices. CITES is implemented within the EU by way of two regulations which in many respects are stricter than CITES. Other considerations to be taken into account when animals are moved to accommodation outside the zoo include: Catching and transportation techniques must take account of the animal's temperament and escape behavior in order to minimize injury, damage and distress. Any animal taken outside the zoo must be in the personal possession of the operator of the zoo, or of competent persons acting on his/her behalf, and adequate provision must be made for its and the public's safety and well-being. All animals taken outside the zoo must be kept securely at all times. Animals should be kept away from direct contact with persons other than the zoo operator or competent persons acting on his/her behalf, unless the zoo operator is satisfied that the animal is not likely, when under control, to suffer distress or cause injury or to transmit or contract disease. Zoo operators should exercise caution and discretion in the case of the removal of all animals from the zoo, since their behavior may become less predictable when away from their usual enclosures (Wildlife, 2012).

2.15. Education measures:

The Directive requires that zoos must promote public education and awareness in relation to the conservation of biodiversity, particularly by providing information about the species exhibited and their natural habitats. The measures required should be proportionate to the size and type of the zoo. A zoo must have a written education strategy and an active education program. Suitable facilities, commensurate to the size of the zoo, should be available for education purposes. Accurate information about the species

exhibited must be available. Generally, this should include, as a minimum, the species name (both scientific and common), its natural habitat and some of its biological characteristics and details of its conservation status. The zoo should be able to demonstrate: the educational role of the zoo as set out in any mission statement; how the written education plan applies to different types of people who visit the Zoo.

Zoos should keep records of their conservation and education activities and should be encouraged to evaluate the effectiveness of their contribution to these activities by collecting appropriate evidence and/or engaging in research projects to do this. In addition to statutory requirements, as a general principle zoos should establish ethical review processes and, where appropriate, seek appropriate help in planning and implementing their conservation and education strategies (Wildlife, 2012).

2.16. Public safety in the zoo:

The Act states authority shall not attach to a license a condition which relates only or primarily to the health, safety or welfare of persons working in the zoo. Points regarding the containment of hazardous animals are particularly important to the animal's welfare, as actions following escapes may result in the injury or death of the animal in order to guard public safety. Risk assessments relating to public safety must be undertaken where appropriate and significant findings should be available for examination by the Inspector (Wildlife, 2012).

2.17. Zoos Insurance:

Zoo operators must have insurance which covers them and every other person under a contract of service or acting on their behalf, against liability for any damage or injury which may be caused by any of the animals or by other factors, whether inside or outside the zoo, including during

transportation to other premises. Any upper limit on the sum insured must be set at an adequate but realistic level (Wildlife, 2012).

2.18. Signs to Entrance and Exits:

Exits should be suitably located and adequately signed. Each main exit must be kept clear and be capable of being easily opened from inside to allow the release of visitors from the zoo. All such gates should be capable of being closed and secured to prevent the escape of animals (Wildlife, 2012).

Suitable warning signs and information should be provided where animals and visitors may come into contact. An adequate number of safeties signs and, where appropriate, the Health and Safe Regulations, giving warning of the hazard either by symbol or a combination of symbol and words, should be provided on any electrified fence. Warning should be given of all edges where a person might fall. Such edges must be guarded by a barrier capable of preventing children from falling. Any buildings where a hazard exists should be kept locked. Warning notices should be displayed to indicate that access is either unsafe or not permitted. Other areas should be clearly defined, e.g. by means of barriers and warning notices; or, where access is allowed to vehicles operated by zoo staff, by notices and road markings. Zoos should consider the use of symbol-based signs wherever practicable to assist, for example, foreign visitors and children. Safety signs on any electrified section of perimeter fence should face outwards and inwards (Wildlife, 2012).

2.19. Stock records:

Records must be kept and maintained of all individually recognizable animals and groups of animals in the zoo. Where possible, animals should be individually identifiable; the records must be kept either on a card index or computer, or other type of retrieval system from which

information can be quickly examined, to update and be available on site for six years. Provision should be made for long-term archiving in a secure format (Wildlife, 2012).

The records must provide the following information: Identification and scientific name; Dates of entry into and disposal from, the collection and from and to whom; Date or estimated date, of birth or hatching; Sex; Any distinctive markings, including tattoos, freeze-brands, rings or microchips; Clinical data, including details of and dates of any treatment given; Behavioral and life history data; date of death and the result of any post-mortem examination and laboratory investigations; where an escape has taken place, or damage or injury has been caused to, or by, an animal to persons or property, the reason for such escape, damage or injury must be recorded and a summary of remedial measures taken to prevent recurrence should be provided; Food and diets(Wildlife, 2012).

In addition to the individual records, an annual stock record of all animals must be kept. Common and scientific names of the species; Number of arrivals into the collection from all outside sources during the year; Number of births or hatchings within the collection during the year; Number that died including culls (Wildlife, 2012)

CHAPTER III

3. MATERIALS AND METHODS

3.1. **Study Area**:

This study was conducted in five selected Zoological gardens namely (Kuku, Alqurashi, Elbasigat, Kassala and Nyala); these Zoos are located in three States in the Sudan .For details see table (1)

3.2. Materials:

1. GPS device (Global Position System), in appendix (8)
2. Digital and Telephone Camera.
3. Scales, Tapes.
4. Pen, Pencil and Information sheets.
5. Birds of Africa South of the Sahara (a field guide), in appendix (8)

3.3. Methods:

In this study two types of data were used namely primary and secondary data. The ***Primary data*** was collected through various methods including:

3.3.1. Field Visits

During the period from Oct. 2018 to Aug.2019, five Zoos were visited, currently operating zoos (Three zoos in Khartoum State, Kassala and Nyala States) were chosen. During the visits, the labourers were met, introductory meetings were held with direct observations of wild animals and Zoos owners and appointments were scheduled for detailed discussions on the subject matter with technical supervisors. Direct observation of zoos status was also made in data collection. The operating Zoos were photographed.

3.3.2. Questionnaire survey

Through the meetings information were gathered on different aspects of the Zoos and the questionnaires were completed. Total of 32 questionnaire

forms were randomly distributed among Kuku Zoo personnel (Appendix 13).

3.3.3. Personal contact and interviews

The ***Secondary data*** was obtained from different relevant sources like Wildlife Conservation General Administration, annual and monthly reports (Head quarter &Zoos Offices), studied zoos reports, Wildlife Research Center reports, and various published and unpublished literature related to the topic were reviewed.

3.4. Statistical Analysis

All quantitative data were analysed using the statistical software SPSS, version (23) (Statistical Package for Social Science). Data analysis included comparative and descriptive statistical analysis to determine the coefficient of variation between Zoos to conserve wild animals, and annual natality, monthly expenditure and the number of the wild animals kept.

Following, formulas were used for calculating mean, standard deviation and coefficient of variation as follows:

$$\text{I-}\ \mu = \Sigma X/n \qquad \text{II-}\ \sigma = \sqrt{\Sigma/n - x2}$$

Where:

μ = mean

X = values assumed by variables

n = number of zoos/ Respondent

σ = standard deviation

The data was analysed statistically (Sendecor and Cochran, 1967), frequents and Chi square test for significance χ^2 (k)

P>0.05= Non significance

P<0.05=Significance

Table (1) 1shows: The studied Zoological gardens according to Date of establishment, Total Area, State, ownership and ordinates

No.	The Zoos	Date of establishment	Zoos Area (Acre)	States	Ownership	Ordinates
1	**Kuku**	2008	10	Khartoum	Governmental SUST	Long (32, 59ºE) Lat. (15,623ºN).
2	**Elbasigat**	2009	10	Khartoum	Private	Long (32. 67ºE) Lat. (15.69ºN).
3	**Alqurashi**	1993	1	Khartoum	Governmental WCGA	Long (32.53ºE) Lat. (15.58ºN).
4	Kassala	1982	2	Kassala	Governmental WCGA	Long(34 -37º E) Lat. (14-17º N)
5	**Nyala**	1972	2	S. Darfur	Governmental WCGA	Long (15-27º, 0-28º E Lat(9-30,13º N)

WCGA = Wildlife Conservation General Administration

SUST= Sudan University of Sciences and Technology

CHAPTER IV

4. RESULTS

Table (2) shows that the total number of Wild mammals in the five Zoos was (123) animals belonging to (15) species and (4) orders. The highest number was in Kuku, followed by Kassala, Qurashi, Basigat and Nyala consequently, Moreover the Striped hyeana was of the highest frequency (100%). While the Chimpanze**e**, Reed buck and Genets were the lowest frequency and abundance. The Grivet Monkeys were the highest relative abundance.

Table 2: Number of Wild Mammals according to five Zoos during the study period (2018)

Animals Species				**Number in each location**					
No.	**English Name**	**Scientific Name**	**Arabic Name**	**Kuku**	**Qurashi**	**Basigat**	**Kassala**	**Nyala**	**Total (%)**
1	Lions	*Panther aleo*	الأسد	11	6	2	3		**22 (17.89%)**
2	Striped hyaena	*Hyaena hyaena*	الضع المخطط	2	6	1	2	3	**14 (11.40%)**
3	Black Backed Jackal	*Canis mesomelas*	الثعلب	4	1		1		**6 (4.90%)**
4	Genets	*Viverra genetta*	قط العلية	1					**1 (0.81%)**
5	Egyptian Mongoose	*Mungosspp*	النمس	1			1		**2 (1.62%)**
6	Baboons	*Papio Anubis*	قرد البابون	8		2	1		**11 (8.94%)**
7	Patas Monkeys	*Erythrocebu spatas*	نسناس الأحمر	6		4	2		**12 (9.76%)**
8	Grivet Monkeys	*Chlorocebus aethiops*	نسناس الأخضر	18	2			3	**23 (18.70%)**
9	Chimpanzee	*Pan troglodytes*	الشمبانزي				1		**1 (0.81%)**
10	Hamadryasbaboon	*Bapio hamadryas*	القرد الحبشي	1			2		**3 (2.44%)**
11	Red-fronted gazelle	*Eudorcas rufifrons*	غزال أم سير	1			1		**2 (1.62%)**
12	Reed buck	*Redunca redunca*	البشمات				1		**1(0.81%)**
13	Dorcas gazelle	*Gazella dorcas*	غزال العادة	7		3			**10 (8.13%)**
14	Warthog	*Phacochoerus africanu*	الحلوف				2		**2 (1.62%)**
15	Crested Porcupines	*Hystrix galeata*	أب شوك	9	2		1	1	**13 (10.56%)**
Total				**69(56.1%)**	**17(13.82%)**	**12 (9.76%)**	**18(14.63%)**	**7 (5.69%)**	**123 (100%)**

Table (3) shows that the total number of Reptiles in the five zoos were (125), while the highest number was in, Qurashi, followed by Kassla Kuku, Basigat and Nyala respectively. Moreover the Tortoises were highest frequency (100%) and relative abundance (78.4%). While the Turtles were of the lowest (20%) frequency and abundances (0.8%)

Table 3: Number of Reptiles according to five Zoos during the study period (2018)

Animals Species				**Number in each location**					
No.	**English Name**	**Scientific Name**	**Arabic Name**	**Kuku**	**Qurashi**	**Basigat**	**Kassala**	**Nyala**	**Total%**
1	Tortoises	*Centrochelyssulcata*	السلاحف البرية	8	43	12	33	2	**98 (78.4%)**
2	Turtles	*Aldabrachelys gigantean*	السلاحف البحرية		1				**1(0.8%)**
3	Nile Crocodiles	*Corcodilusniloticus*	التمساح النيلي	3		1	3	2	**9 (7.2%)**
4	Nile monitor	*Varanusniloticus*	الورل		1		1		**2 (1.6%)**
5	Pythons	*Python sebae*	الأصلة	4	3	1	7		**15 (12%)**
Total				**15 (12%)**	**48 (38.4%)**	**14 (11.2%)**	**44 (35.2%)**	**4 (3.5%)**	**125 (100%)**

Table (4) shows that the
Total number of avian species in the five zoos was (76), the highest number was in, Kuku, followed by Kassla, qurashi, and Basigat respectively. While no avian species was reported in Nyala Zoo, Moreover the Toulouse geese were of the highest frequency and relative abundances. While the Red- necked ostrich was of the lowest frequency and abundance.

Table 4: Number of Avifauna according to five Zoos during the study period (2018).

Animals Species				**Number in each location**				
No.	English Name	**Scientific Name**	**Arabic Name**	**Kuku**	**Qurashi**	**Basigat**	**Kassala**	**Total**
1	Red necked ostrich	*Struthio camelus*	نعام أحمر الرقبة	1				**1(1.32%)**
2	Peacock	*Pavo cristatus*	الطاؤوس	7			1	**8** (10.53%)
3	Marabou stork	*Leptoptilscrumeniferus*	أبو السعن	1	2			**3 (3.95%)**
4	Toulouse geese	*Anser anser*	الوز	10		4		**14 (18.4%)**
5	Muscovy ducks	*Cairinamos chata*	البط المسكوفي	10				**10 (13.2%)**
6	Tufted Guinea fowl	*Numidameleagris*	دجاج الوادي	2			2	**4 (5.3%)**
7	Domicile crane	*Grus virgo*	الرهو	5				**5 (6.6%)**
8	Crowned crane	*Balearica povonina*	الغرنوق	2	1			**3 (3.95%)**
9	Bateleur	*Terathopius ecaudatus*	العقاب الحكيم	2	5			**7 (9.2%)**
10	Turkeys	*Meleagris gallopavo*	الدجاج الرومي			3		**3(3.95%)**
11	White-back vulture	*Gyps africanus*	الرخمة				5	**5(6.6%)**
12	Budgerigar	*Melopsittacus undulatus*	الدر				7	**7 (9.2%)**
13	yellow canary	*Serinusflaviventris*	كناري أصفر				6	**6(7.9%)**
Total				**40 (52.6%)**	**8 (10.5%)**	**7 (9.2%)**	**21(27.63)**	**76(100%)**

Table (5) shows that the highest birth rate was in kuku zoo. While Nyala was the lowest, Basigat Zoo was the highest of mortality rate. While the Nyala zoo was the lowest of mortality rate

Table (5) Birth and mortality rate in five Zoos

Zoo	Total of Birth Rate	Total of Mortality Rate
Kuku	79 (71.82%)	22 (29.33%)
Qurashi	13 (11.82%)	10 (13.33%)
Basigat	10 (9.1%)	35 (46.67%)
Kassala	6 (5.45%)	6 (8.00%)
Nyala	2 (1.82%)	2 (2.67%)
Total	110 (100%)	75 (100%)

Table (6) shows that the respondents´ jobs in five levels, the employees in Kuku zoo showed highest percentages (34.4%) whereas managers´ percentage was (3.1%) of the total jobs for same zoo.

Table 6:Numbers &percentage of the jobs in Kuku zoo

Jobs	**N**	**(%)**
WCGA	7	(21.9%)
Labor	7	(21.9%)
Employee	11	(34.4%)
Supervisors	6	(18.8%)
Manager	1	(3.1%)
Total	**32**	**(100%)**

WCGA=Wildlife Conservation General Administration

Table (7) Shows that 40.6 % of respondents´ age was over 45 years while 28.1% of them were between 35-45 years, while the two groups (25-35) and (15-25) were equals as (15.6%).

Table 7. Age of interviewers in Kuku Zoo

Age (years)	N	%)
15-25	5	(15.6%)
25-35	5	(15.6%)
35-45	9	(28.1%)
Above 45	13	(40.6%)
Total	**32**	**(100.0%)**

Table (8) Shows that the highest percentage of experiences of interviewers of less than 10 years was (90.7%) while the least one (3.1%) was above 20yrs.

Table8. Experiences of interviewers in Kuku Zoo

Experiences (yrs.)	**N**	**%**
Less than 10 yrs.	29	(90.7%)
10-20 yrs.	2	(6.3%)
Above than 20 yrs.	1	(3.1%)
Total	**32**	**(100%)**

Table (9) Shows that the ratio of male/female of respondents in Kuku Zoo was (78.1%), (21.9%) respectively

Table9. Sex of interviewers in Kuku Zoo

Sex	**No**	**(%)**
Male	25	(78.1%)
Female	7	(21.9%)
Total	**32**	**(100.0%)**

Table (10) Shows that highest educational level of interviewers was the secondary School level (40.6%) followed by undergraduate (25.0%) while the lowest level was for the technical level (3.1%).

Table 10. Education level of respondents in Kuku Zoo

Education level	**N**	**Percentage (%)**
Illiterate or khalwa	6	(18.8%)
Secondary	13	(40.6%)
Under graduate	8	(25.0%)
Post graduate	4	(12.5%)
Technical	1	(3.1%)
Total	**32**	**(100.0%)**

Table (11) Shows that (87.5%) of respondents said that highest fecundity was in the primates. While (3.1%) said that avian were the most reproducing animals.

Table11. % of fecundity in Kuku zoo

Most reproduced animals	**N**	**Percentage (%)**
Primates	28	(87.5%)
Carnivorous	2	(6.3%)
Avian	1	(3.1%)
Monkeys +Carnivorous	1	(3.1%)
Total	**32**	**(100.0%**)

Table (12) the questionnaire shows that the highest proportion of respondents (50.0%) said that most mortality in Kuku Zoo was in avian and the lowest was in herbivores (3.1%).

Table 12. frequency and Percentage mortality of wild animals in Kuku zoo

Mortality	**Frequency**	**Percentage (%)**
Avian	16	(50.0%)
Primates	8	(25.0%)
Carnivorous	5	(15.6%)
Herbivorous	1	(3.1%)
Reptiles	2	(6.3%)
Total	**32**	**(100.0%)**

Table (13) shows that the Veterinarians (n=3) visited the Zoo frequently (53.1%). Respondents said that least Veterinarians visit to the Zoo was twice and three times weekly (3.1%)

Table 13. Veterinarians visits in Kuku zoo

Vet visitor	**Frequency**	**Percentage (%)**
Weekly	17	(53.1%)
Every 3 month	2	(6.3%)
None	4	(12.5%)
Daily	7	(21.9%)
Twice weekly	1	(3.1%)
Trice weekly	1	(3.1%)
Total	**32**	**(100.0**%)

Table (14) shows that the incidence of common diseases in the Zoo varies, the highest was digestive system diseases (43.8%) and the lowest was foreign body and Senility (6.3%)

Table14. Common Diseases in Kuku zoo

Common Diseases	**Frequency**	**Percentage (%)**
Respiratory system diseases	6	(18.8%)
Digestive system diseases	14	(43.8%)
Foreign body	2	(6.3%)
Injuries	8	(25.0%)
Senility	2	(6.3%)
Total	**32**	**(100.0**%)

Table (15) shows the seasonal diseases increase, the highest increase was in all seasons (46.9%) and the lowest was in winter (3.1%).

Table15. Disease frequency according to season in Kuku zoo

Season	**Frequency**	**Percentage (%)**
Summer	9	(28.1%)
Autumn	7	(21.9%)
Winter	1	(3.1%)
All	15	(46.9%)
Total	**32**	**(100.0%)**

Table (16) shows that diseases were the main cause of mortality (50%).While senility was the lowest (6.3%).

Table16. Mortality Causes in Kuku zoo

Mortality Causes	**Frequency**	**Percent (%)**
Diseases	16	(50.0%)
Bad housing	8	(25.0%)
Injuries	6	(18.8%)
Senility	2	(6.3%)
Total	**32**	**(100.0%)**

Table (17) shows that the number of daily visitors in the Kuku Zoo varies, the highest was between 200 – 300 Visitors (43.8%) and the lowest was between 100 – 200 visitors (9.4%).

Table17. Size of average daily visitor in Kuku zoo

Daily visitors	**Frequency**	**Percentage (%)**
less than 100	4	(12.5%)
100 – 200	3	(9.4%)
200 – 300	14	(43.8%)
More than 300	11	(34.4%)
Total	**32**	**(100.0%)**

Table (18) shows that most zoo visitors were during Occasions (68.8%) and the lowest were during holidays and whole year (15.6%).

Table18. Visitor frequency according to season Kuku zoo

Most visitor season	**Frequency**	**Percentage (%)**
Whole year	5	(15.6%)
Occasions	22	(68.8%)
Holidays	5	(15.6%)
Total	**32**	**(100.0%)**

Table (19) shows that the most attractive feature in Kuku Zoo was wild animals (46.9%) and the lowest was toys and recreations (9.4%)

Table19. Most attractive feature in Kuku zoo

Most attractive	**No.**	**Percentage (%)**
Toys	3	(9.4%)
Wild animals	15	(46.9%)
Recreations	3	(9.4%)
All	11	(34.4%)
Total	**32**	**(100.0**%)

Table (20) shows that the most attractive animals for visitors in Kuku zoo were Lions (90.6). While the Reptiles and Ostrich were lowest (15.6)

Table (20) Most attractive animals zoo in Kuku zoo

Most attractive animals	Responses		% Cases
	N	Percent	
Lions	29	35.4	(90.6%)
Monkeys	21	25.6	(65.6%)
Gazelle	12	14.6	(37.5%)
Reptiles	10	12.2	(31.3%)
Ostrich	5	6.1	(15.6%)
Peacock	5	6.1	(15.6%)
Total	82	100.0	(264.5)

Table (21) shows the main role of Kuku Zoo, the highest one was educational role (56.3%) and the lowest was conservational role (3.1%)

Table21. Main Role of Kuku zoo

Mean role of Kuku zoo	No.	Percentage (%)
Educational	18	(56.3%)
Recreational	9	(28.1%)
Conservational	1	(3.1%)
All	2	(6.3%)
Educational, Recreational	1	(3.1%)
Educational & conservational	1	(3.1%)
Total	32	(100.0%)

Table (22) shows the Problems facing Kuku Zoo, the highest one was collection of wild animals (78.1%) and the lowest was management problems (3.1%)

Table 22. Problems of Kuku Zoo

Mean problems	**N**	**(%)**
Collect wild animals	25	(78.1%)
Management problems	1	(3.1%)
Food sufficient	3	(9.4%)
Collection of wild animals &Management problem	3	(9.4%)
Total	**32**	**(100.0**%)

Table (23) shows that the highest recommendation to develop the Zoo was Retrieving Endangered Spp. (84.4%) while improvement of administration system, mating singles and endangered Spp. and Toys were the least (3.1%).

Table23. Recommendation to develop of Kuku Zoo

Recommendation to development of Zoo	**N**	**(%)**
Retrieving Endangered Spp.	27	(84.4%
Toys	1	(3.1%)
Improvement of administration	1	(3.1%)
Mating Single and endangered Spp.	1	(3.1%)
Additions of endangers Spp. Toys	2	(6.3%)
Total	**32**	**(100.0**%)

Table (24) percentages and frequencies of some different management practices in Kuku zoo showed that (50%) of respondents' agree that housing and display of wild animals were suitable, while the strongly disagree were lowest (3.1%). Moreover the highest percentage of responds (53.1%) said that the feed quantity is adequate, while disagree were lowest percentage (12.5%). The highest percentage of respondents' agree that the feed quality are good (43.8%), while the neutral and disagree were equal (9.4%). The highest percentage of respondents' agrees that the Feeding frequency is enough (34.4%), While disagree were lowest (21.9%). The highest percentage of respondents' strong agree a clean supply of water is available (40.6%), while the strong disagree lowest were (3.1%), the highest percentage of respondents' strong agree The interaction between wild animals and visitors is safe (34.4%). the percentage of neutral and disagree were equal (9.4%), the highest percentage of respondents'

disagree the ratio of male to female are suitable (46.9%).While the lowest percentage was neutral (3.1%), the highest percentage of respondents' strong agree the wild animals were good breeding in Kuku Zoo (31.3%), while the lowest percentage were neutral (15.6%), the highest percentage of respondents' agree The wild animals increasing (43.8%). While the disagree were lowest percentage (12.5%), the highest percentage of respondents' agree Kuku zoo play role in wild animal conservation (46.9%), while the percentage of neutral and disagree were equal (6.3%), the highest percentage of respondents' agree the Quality of service in Zoo are good (40.6%).While the percentage were neutral (21.9%), and the highest percentage of respondents' agree there is provision of opportunity to express most normal behaviors (40.6%), while the strong disagree was lowest percentage (3.1%).

Table 24. Percentage and frequencies of some different management practices in Kuku Zoo

Statement	Strong agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strong disagree n (%)
The animals housing and display are suitable	6 (18.8%)	16 (50.0%)	5 (15.6%)	4 (12.5%)	1 (3.1%)
The feed quantity is adequate	9 (28.1%)	17 (53.1%)	2 (6.3%)	4 (12.5%	
The feed quality are good	12 (37%)	14 (43.8%)	3 (9.4%)	3 (9.4%)	
The Feeding frequency is enough	9 (28.1%)	11 (34.4%)	5 (15.6%)	7 (21.9%)	
a clean supply of water is available	13 (40.6%)	8 (25.0%)	3 (9.4%)	7 (21.9%)	1 (3.1%)
The interaction between the wild animal and visitor is safe	11 (34.4%)	8 (25.0%)	3 (9.4%)	3 (9.4%)	7 (21.9%)
The ratio of male to female are suitable	4 (12.5%)	5 (15.6%)	1 (3.1%)	15 (46.9%)	7 (21.9%)
The wild animals were good breeding in Kuku zoo	10 (31.3%)	9 (28.1%)	5 (15.6%)	8 (25.0%)	
The wild animals increasing	6 (18.8%)	14 (43.8%)	5 (15.6%)	4 (12.5%)	3 (9.4%)
Kuku zoo play role in wild animal conservation	13 (40.6%)	15 (46.9%)	2 (6.3%)	2 (6.3%)	
Quality of service in zoo are good	12 (37.5%)	13 (40.6%)	7 (21.9%)		
There is provision of opportunity to express natural behaviors	10 (31.3%)	13 (40.6%)	4 (12.5%)	4 (12.5%)	1 (3.1%)

Table (25) shows that (50%) were significant (Accept the sentence). While the other (50%) were non-significant (Reject the sentence) on descriptive statistics of some different management practices in Kuku zoo

Table (25) Descriptive statistics of some different management practices in Kuku zoo

Statement	X^2 value	Df	Significant level	Decision
The animals housing and display are suitable	20.188	4	(0.000)	Accept the sentence
The feed quantity is adequate	16.750	3	(0.010)	Accept the sentence
The feed quality are good	12.750	3	(0.050)	Accept the sentence
The feeding frequency is enough	2.500	3	(0.475)	Reject the sentence
a clean supply of water is available	13.625	4	(0.09)	Reject the sentence
The interaction between the wild animal and visitor is safe.	7.375	4	(0.117)	Reject the sentence
The ratio of male to female are suitable	17.375	4	(0.020)	Accept the sentence
The wild animals were good breeding in Kuku zoo	1.750	3	(0.626)	Reject the sentence
The wild animals increasing	12.063	4	(0.170)	Reject the sentence
Kuku zoo play role in wild animal conservation	18.250	3	(0.000)	Accept the sentence
Quality of services in zoo are good	1.938	2	(0.380)	Reject the sentence
There is provision of opportunity to express most normal behaviors	15.188	4	(0.040)	Accept the sentence

Table (26) shows that the highest were Agree (66.67%), strongly agree (25%), Neutral (8.33%) respectively.

Table (26) Chi square test of some different management practices in Kuku zoo

Statement	(Mean ± SD)	Result
The animals housing and display are suitable	(3.69± 1.03)	Agree
The feed quantity is adequate	(3.97±0.93)	Agree
The feed quality are good	(4.09±0.93)	Strong agree
The feeding frequency is enough	(3.69± 1.12)	Agree
a clean supply of water is available	(3.78± 1.29)	Agree
The interaction between the wild animal and visitor is safe.	(3.41± 1.58)	Agree
The ratio of male to female are suitable	(2.50± 1.34)	Neutral
The wild animals were good breeding in Kuku zoo	(3.66± 1.18)	Agree
The wild animals increasing	(3.50± 1.22)	Agree
Kuku zoo play role in wild animal conservation	(4.22± 0.83)	Strong agree
Quality of service in zoo are good	(4.16± 0.77)	Strong agree
There is provision of opportunity to express most normal behaviors	(3.84± 1.11)	Agree

- Strongly agree (> 4)

- Agree (>3)

-Neutral (<3)

Chapter V

5. Discussion

Globally, there is rapid decline of wild animal populations, which necessitates ex-situ conservation of wild animal species. Zoos and aquariums play a greater role in wild animal's conservation.

In the Sudan many factors are contributing to the decline of population sizes of wildlife; including natural factors and human activities, especially after political separation of South Sudan in 2011, and evacuation of Khartoum zoo in 1993 which resulted in loss of most of species of wildlife. The main objective of this study was to shed light on the role of keeping and breeding wild animals in zoological gardens as a conservational tool.

The methods used in the present study consisted of describing the study which included Khartoum Kassala and South Darfur states. Khartoum was chosen as the main locality of the study with reference to Kuku zoo, Kassala located near Dinder Biosphere reserve and Nyala located near Radom National Park. The methods included, using GPS for the geographical locality of research. In addition to those equipments like digital Camera and phone camera, scales, tapes and pen and information sheet, a questionnaire form was constructed and distributed among 32 enquirees of kuku zoo personnel.

The diversity of wild animals in zoos is a primary factor for attracting visitors because the conservation issue goes through display of zoo animals. This study show that (3) class of wildlife encounter in zoos including Mammals, Reptiles and Birds it lacks of amphibious and Pisces this refer Zoos have not aquariums. Kuku zoo is more diversified compared to the four other zoos. Besides that there is successful breeding, births constitute72% of

the zoo animals and that they were adapted perfectly to the prevailing conditions, the Nyala Zoo was with the lowest mortality, this refered to few numbers of animals, Basigat Zoo has the highest mortality, this refereed to poor Free-ranging spaces (barriers), direct interaction between visitor and wild animals as well as no wildlife specialist and Wildlife Conservation General Administrations. represented carnivores (lions, Striped hyena) and primates as the most numerous wild animals in zoos of the present study which means that they are adapted to captive environment, this is consistent with answer of questionnaire about the most breeding wild animals in Kuku zoo, Same results were reported by (Sayed, 1994), as in nature like Dinder National Park (D.N.P) the primates are highly abundant. There are few numbers or single of some wild animals species in zoos such as chimpanzee, Reed-Buck, Red fronted gazelle, Warthog, Genet Cat and Hamadryas Baboon which refer to either the wild animals are single, , as well as more single wild animals were male. This refers to lesser mortality rate among males than female lowest than female shown in (Gonia, 2003) Appendix1and.The Reptiles were represented in studied Zoos. The Tortoise has the highest frequency and abundance reptiles have no success of breeding but they have low mortality, that refer to ease of collection, transport, distribution form natural habitat, and adaptation to factors that threaten, captive animals. In studied Zoos; Qurashi has diversities considered as a center for collection of wild animals for export this is shown .The Sudan is considered being a high bird diversified country, showed that the Kuku Zoo has highest diversities of Bird species. Nyala Zoo lacks of the bird species due to miss management. Prey Birds didn't reproduce in Studied Zoos, shows that some avian species are very sensitive to environment as well as chicks were more vulnerable for predation by Nile Monitor, and cats, this leading to high mortality rates as personnel questionnaire is (50%).Moreover passive visitors behavior, poor

housing condition and negative impacts bird behavior, (Saeed 2019), the employee, has highest frequency of kuku zoo jobs, this was due to the fact that kuku Zoo has different departments (counter, ticket, vet, supervision etc). Age of interviewed were more than 45 years (35%), most of them are rankers .Table 8: showed that 91% of respondents experiences were less than 10 years because Kuku Zoo was established not more than 11years ago and sometimes it depends on temporary workers like students. Table 10; showed that the education level secondary also Kuku Zoo has low female gender (22%) of workers and they are frightened to enter the cages to remove the waste material thrown by the kids . However, respondents said that kuku zoo has veterinary service that agrees (Wild life, 2012). Moreover the common ailment noted in the five zoos was; in the carnivores; Parasitic, predators by parental (abnormal behavior) fight within species and some nervous signs in lioness. Primate suffered from competitions and prolapsed uterus in green monkey this refer dominant behaviors , and current capacity of cages, miss Management , Visitor injury, Fungal, Bacterial, Predatory, Competitive, viral disease, Red Necked Ostrich and Nile crocodile suffer from foreign body thrown by visitor such as plastic iron i.e. found through post-mortem in Kuku Zoo. And Cages difficulties' according to their food habit, the highest common diseases in kuku Zoo were mostly digestive disturbance (43%) this agrees with result, (Gonja, 2003; Sayed 1994), this was attributed to zoo managers avoidance of Zoo nutrition high cost of feed, animals inedible food stated lead's to GIT disorders as well as that diseases caused the majority of mortalities in wild animals in kuku Zoo. Therefore answers of questionnaire that diseases occur in all season (47%) but summer was the highest (28%) high temperature, structure of wild animals housing (metal roof, iron, and concrete floor, this caused stress which lead to occurrence of diseases. the daily visitor of kuku were (200-300 persons) according to respondents

answers, About (43%) said that this was due to the fact that kuku Zoos has a variety of wild animals, as well as the fact that the lion were most attractive animals and that wild animals were rare in the area,, as far as researcher, as well as during occasions zoo would be most crowded. The Zoo under study has different purpose such as educational and recreational (European Association of Zoos and Aquariums, 2014; Saeed, 2019) and economic. Alternative activities/income sources: were entry tickets, Excoriation tools, sale of breeding animals, general services (restaurant, Plaything, ballroom and beyond contributor). Collections of wild animals were the highest percentage (78%) the main problems facing kuku Zoo according to personnel questionnaire of kuku Zoo, this refers to decline of wild life diversity globally (IUCN, 2014). Answer of interviewers in kuku Zoo statement agrees that animals housing and display are suitable as reported by (Patricia 2015; Wild life, 2012,) and also agree the feed quantity, frequency is adequate, clean supply of water, safe interaction between the wild animal and visitor and strongly agree that the food quality were good. This refer to provision of different food items were given including fresh meat for carnivores and prey bird, live pigeons given for python, (vegetable, fruits, groundnut and dates for primates and crested porcupine) Sorghum, Alfa-Alfa, Abo-sabaen and vegetables for antelope (Wildlife, 2012), interviewers agreed that wild animals were of good breeding at Kuku Zoo, which meant that wild animals in kuku Zoo were healthy and breeding well. Thus they strongly agree that Kuku zoo played a role in wild animal conservation (David, 2004; Rasbach, 2016), strongly agreed that it provided opportunity to express most normal behaviors (Wildlife, 2012).

The author is of the opinion that Kuku Zoo could be considered as a good representation of recreation, education and could act as conservational tool after making more effort to improve its situation. It needs the addition of more wild animal species, and improving the housing and feeding and health care of the wild animals.

Chapter VI

6. Conclusion and Recommendations:

6.1. Conclusion:

Zoological gardens and aquariums serve many purposes as public entertainment, education and source of income for owner or governmental body. There are other functions of Zoos as rehabilitation of threatened and endangered animals by providing good conditions for breeding in Zoos. Besides that Zoos, can satisfy the request of international and local demand, so by securing this service, pressure on wild animals in the wild will be reduced. We can conclude that the most important function of Zoos is conservation of endangered animal species.

6.2. Recommendations:

1. Periodic research studies should be conducted on the status of Zoo with regard to wild animal's conservations, animals breeding behaviors and housing conditions in zoos.
2. Improvement of management program systems should collaborate with Wildlife Conservations General Administrations (WCGA), Wildlife Research Center (WRC), universities, NGOS, GOS and owner of zoos to establish standard and modern zoos and how to manage them as well as reintroduction of wild animals to natural habitat.
3. Separate keeping of domestic animals from wild animals.
4. Zoos should adopt quarantine and bio-security measurements and isolation of pregnant females to avoid spread of diseases; competition and aggressive behaviors' of males.

5. Wild animals in Zoos should have a detailed record (date of entry, parents, date of birth, health record, feeding record….etc) as well as having indentifying marks or tags.

6. Collaboration of zoos within and out of Sudan for mating single wild animals, retrieving endangered species, increase biodiversity and to avoidance of in- breeding in zoos.

7. Increase of green area and cage arrangement of animal taxa according to the order of wild animals or feeding habit.

8. Establish breeding area beside each zoo which will be away from inconvenience.

9. Establish Museums in zoos as an educational tool.

REFERANCES

Awad, N.M. (1990).Wildlife Utilization (Unpublished). Lecture Notes, CNRES, University of Juba reived by Gonia (2003)

David A, (2004). Today more and more of us live in cities and lose any real connection with wild animals and plants. world association of zoos and aquariums, 2005, chapter 1, 7 – 8p

EC Regulation (2005). on the protection of animals during transport and related operations.http://europa.eu.int/eurlex/

Eltringham, S.K. (1984). Wildlife Resources and Economic Development. John Wiley and Sons Ltd. Chichester New York, Brisbane,Toronto,Singapore. p 1-23,57- 69.

European Association of Zoos and Aquaria (2014): EAZA Standards for the Accommodation and Care of Animals in Zoos and Aquaria, P1 – 15 http: //www.crctourism .com. au

Gonja, M. J. (2003): ASSESSMENT OF WILD ANIMALS Farming System In The Sudan With Emphasis on Dorcas Gazelle, (Gazella dorcas,Linnaeus,1758) IN KHARTOUM STATE, A *M*.Sc. Thesis, U.Kh., P-3

Hirzel, AH., Posse , B, Oggier, P- A, Crettenand ,Y, Glenz, C and Arlettaz, R (2004) Ecological requirements of reintroduced species and the implications for release policy: the case of the Bearded vulture. J ApplEcol 41(6): 1103–1116.

IUCN (2014). The IUCN Red List of Threatened Species. Version

2013.1. Available: www.iucnredlist. org. Assessed 30 June 2014.

Kareiva, PM. and Marvier, M (2011). Conservation science: balancing the needs of people and nature. Roberts and Company Greenwood Village, Colorado, USA.576 p.

Karen, (2004). Wildlife Tourism impacts, management and planning , National library of Australia, Bib.ISBN 1863355480 P.35-38.

Leader et al. (2007) Leader -Williams, Nigel &Balmford, N.P. &Linkie, Matthew & Mace, Georgina & Smith, Robert & Stevenson, Miranda & Walter, Olivia & West, C.D. & Zimmermann, Alexandra. . Beyond the ark: conservation biologists' views of the achievements of zoos in conservation.

lex/LexUriServ/site/en/oj/2005/l_003/l_00320050105en00010044.pdf

Mohammed, .S.A, (2019), Impact of Some Wildlife Offenses on Wild Animals and Their Habitats in Selected States in Sudan and Dinder Biosphere Reserve during (2013-2017), *M*.sc.adissertation, SUST.p 14.

Osborne, PE,and Seddon, PJ. (2012). Selecting suitable habitats for reintroductions: variation, change and the role of species distribution modelling. In: Ewen JG, Armstrong DP, Parker KA, Seddon PJ, editors. Reintroduction Biology.Integrating Science and Management.Wiley-Blackwell. pp. 73–104.

Ostrowski ,S, Bedin, E, Lenain, DM,and Abuzinada, AH (1998) Ten years of Arabian oryx conservation breeding in Saudi Arabia-achievements and regional perspectives. Oryx 32: 209–222.

Patricia, (2015): Unit 1 Zoo Animal Enclosure Design, Intellectual property of Animal Biology & Care Ltd., DOI: 10.13140/RG.2.1.3435.7924,

Pucek, Z, Belousova, I, Krasińska, M, Krasiński, Z, Olech,W. (2004). Status survey and conservation action plan. European bison. In: Pucek Z, editor. IUCN/SSC Bison Specialist Group (IUCN, Gland, Switzerland and Cambridge, UK. 54 p..

Rasbach (2016): WAZA, WORLD ASSOCIATION OF ZOOS AND AQUARIUMS Future of Zoo and Aquarium Design, Zoo and Aquarium Design – Yesterday, Today and (the Day after) Tomorrow Vol.17 2016 **http//www.waza.org.**ISSN: 2074-4528

Saeed, N.k,Kh, (2019). A preliminary Study on Administrative Performance, animals Care and Visitors interest Satisfaction in Kuku Zoo, M.Sc. Thesis, SUST.P 26-36.

Seddon, P.J. (2010). from reintroduction to assisted colonization: moving along the conservation translocation spectrum. Restoration Ecology 18: 796–802.

Sendecor,GW and Cochran, WD.(1967).Statistical methods.6th Eduition Ames, lowa, the lowa State University**.**

Shepherdson, D. J., Carlsterad, K. C. and Wielebnowski, N. (2004): Cross-institutional assessment of stress responses in zoo animals using longitudinal monitoring of faecal corticoids and behaviour. Animal Welfare, 13: S105-113 Availablewww.federalcircusbill.org/wpcontent/uploads/2014/04/Shepherdson2004.pdf 1.04.15

Smith, K.G, Clark, J, and Gipson, P. (1991) History of black bears in Arkansas: over-exploitation, near elimination,and successful reintroduction. Eastern Workshop on Black Bear Research and Management10: 5–13.

Stüwe, M, and Nievergelt B (1991) Recovery of alpine ibex from near extinction: the result of effective protection, captive breeding, and reintroductions. ApplAnimBehavSci 29(1): 379–387.

UNITED FOR CONSERVATION Building a Future for Wildlife - The World Zoo and Aquarium Conservation Strategy ISBN 3-033-00427-X http://www.waza.org

Sudanow Magazine (1993). Interview with the Director of Wildlife General Administration (1976).Office P.Box 2651, 7 Jaomhouriya Avenue, Khartoum, Sudan.Vol 21, No 4 June, p18

Susan, D. C. (2001): The History of Zoo Nutrition, Daniel F. and Ada L. Rice Conservation Biology and Research Center, Chicago Zoological Society, Brookfield Zoo, Brookfield, Illinois USA

Wakefield, S, Knowles, J, Zimmermann, W, and Van Dierendonck, M. (2002) Status and action plan for the Przewalski's horse (Equusferusprzewalskii). In: Moehlman PD, editor. Equids: Zebras, Asses and Horses: Status survey and conservation action plan. IUCN/SSC Equid Specialist Group. pp. 82–92.

Wildlife. S.C. (2012): Secretary of State's Standards of Modern Zoo Practice, Department for Environment, Food and Rural Affairs Zone, PB13806, http://www.defra.gov.uk p.

Wilson, O. E. (2002). At current levels of consumption of natural resources humanity needs three earth-sized planets to survive, *WORLD ASSOCIATION OF ZOOS AND AQUARIUMS*, 2005, chapter 1 8 – 8p

Yayed , A.S.A (1994): Diseases of Captive Wild Mammals in Khartoum zoo with emphasis on *Toxascarisleanina*, *M*.Sc. Thesis, U.Kh.

Appendices

Appendix(1) Status of wild animals in Kuku zoo

Wild animals	Total	Six		Adult	Non adult	Source	Cage /M	Feeding Type	Feeding. Frequently	Birth rate	Mortality rate	Common ailment
		M	F.M									
Lions	11	5	6	5	6	E. Sudan	384	Meat	Trice weekly	4	1	Parasite
Striped Hyeana	2	1	1	2		S. Darfur	90	Meat	Trice weekly		0.1	Predation & Competition
Black Backed Jackal	4	2	2	4		WhiteNile	90	Meat	Trice weekly	4	3	Predation &Competition
Genet Cat	1	1		1		Dinder	18	Meat	Trice weekly			
Egyptian Mongoose	1	1		1		Khartoum	18	Meat	Trice weekly		0.4	Predation & Competition
Baboon	8	4	4	4	4	E. Sudan	216	Veg& fruits	Daily	2	0.2	Competition
Patas Monkey	6	2	4	4	2	S. Darfur	216	Veg& fruits	Daily	0.1	0.2	
Grivet Monkey	18	5	13	6	12	S. Sudan	132	Veg& fruits	Daily	6	0.5	
Hamadarys baboon	1	1		1		E.Sudan	90	Vegt& fruits	Twice daily			
Dorcas Gazelle	7	4	3	5	2	S. Darfur	270	Herbs	Twice daily	2	0.25	Cages difficulties
Red-fronted gazelle	1	1		1		Kordofan	90	Herbs	Twice daily		0.1	Bacterial
Crested Porcupine	9	6	3	7	2	S. Darfur	50	Vegt& fruits	Daily	4		
Tortoises	8	5	3	7	1	Khartoum	32	Herbs	Daily			
Nile Crocodiles	3	2	1	1	2	S. Sudan	280	Meat	Twice weekly		0.2	Foreign body
Python	4	2	2	4		S. Sudan	72	Meat	Weekly		0.3	Parasite
Red Necked Ostrich	1	1		1		Khartoum	500	Herbs	Twice daily		0.3	Foreign body
Peacock	7	4	3	5	2	Khartoum	90	Herbs	Twice daily.	5	2	viral disease
Marabou Stork	1	1		1		S.Sudan	90	Meat	Trice weekly		1	Bacterial
Toulouse Geese	10	4	6	4	6	Khartoum	280	Herbs	Twice daily	30	5	Fungal
Muscovy duck	10	2	8	10		Khartoum	280	Herbs	Twice daily	20	6	Predation &Competition
Tufted Guinea Fowl	2	1	1	2		Khartoum	6	Herbs	Twice daily		0.4	
Domicile Crane	5	2	3	5		Jazeera	90	Herbs	Twice daily			
Crowned Crane	2	1	1	2		S.Darfur	25	Herbs	Twice daily	1	1	
Bateleur	2	1	1	2		S.Darfur	90	Meat	Trice weekly			

Appendix (2) Status of Wild animals in Alqurahi Zoo

Wild animals	Total	Six		Adult	Non adult	Source	Cage /M	Feeding Type	Feeding. frequently	Birth rate	Mortality rate	Common ailment
		M	Fm									
Lions	6	2	4	4	2	Khartoum	252	Meat	Trice Weekly	3	1	
Striped Hyeana	6	3	3	6		S. Darfur	96	Meat	Trice Weekly.	2	2	Predation &Competitions
Black Backed Jackal	1		1	1		Sinar	12	Meat	Trice Weekly	1	2	Predation & Competitions
Grivet Monkey	2	2		2		Sinar	18.5	Vegtables	Daily	2	5	Predation & Competition
Crested Porcupine	2	2		2		S. Darfur	9	Herbs	Daily	2		
Tortoises	43	26	17	23	20	Kassala	120	Herbs	Daily	3		
Turtles	1	1		1		Red Sea	5,4	Meat	Trice weekly.			
Nile Monitor	1	1		1		Khartoum	15	Meat	Trice weekly			
Python	3		3	3		Khartoum	27	Meat	Twice weekly			
Marabou Stork	2	1	1	2		S. Darfur	12	Meat	Trice weekly			
Crowned Crane	1	1		1		S. Darfur	22	Herbs	Twice daily.			
Bateleur	5	3	2	3	2	S .Darfur	27	Meat	Trice weekly.		3	
Egyptian Goose	1		1	1		S. Darfur	7,5	Herbs	Daily			

Appendix (3) Status of wild animals in Basigat Zoo

Wild animals	Total	Six		Adult	Non adult	Source	Cage /M	Feeding Type	Feeding. frequently	Birth rate	Mortality rate	Common ailment
		M	f.m									
Striped Hyeana	1	1		1		Unknown	27	Meat	Twice Weekly.		1	Fungal
Baboon	2	2		2		Unknown	30	Vegt& fruits	Twice Daily	1	1	Bacterial
Patas Monkey	4	2	2	3	1	Khartoum	24	Vegt& fruit	Twice Daily	4	4	Management Problems
Dorcas Gazelle	3	2	1	2	1	Khartoum	15	Herbs	Twice Daily		1	Cages difficulties
Tortoises	12	3	9	12		Khartoum	36	vegta& Herb	Twice Daily	5	3	Visitor injury
Nile Crocodiles	1	1		1		Khartoum	12	Meat	Twice weekly		3	Visitor injury
Python	1	1			1	Khartoum	6	Meat	Daily		3	Visitor injury
Toulouse Geese	4	2	2	4		Khartoum	12	Herbs	Daily		12	Parasite
Turkeys	3	2	1	3		Khartoum	15	Herbs	Daily		7	Management Problems

Appendix (4)Status of wild animals in Kassala Zoo

Wild animals	Total	Six		Adult	Non adult	Source	Cage /M	Feeding Type	Feeding. frequently	Birth rate	Mortality rate	Common ailment
		M	Fm									
Lions	3	1	2	1	2	Kassala	180	Meat	Daily	**2**	**1**	Parasite
Striped Hyeana	2	1	1	2		Kassala	45	Meat	Daily			
Black Backed Jackal	1	1		1		Kassala	8	Meat	Daily	1	1	Parasite
Egyptian Mongoos	1	1		1		Kassala	8	Meat	Daily			
Baboon	1		1	1		Elfawo	16	Vegetables	Daily			
Patas Monkey	2	2		2		Qadarif	12	Vegetables	Daily			
Hamadarys baboon	2	2		2		Red Sea	36	Vegetables	Daily			
Chimpanzee	1		1	1		Dinder	27	Vegetables	Daily			
Red-fronted gazlle	1		1	1		Dinder	18	Herbs	Daily	1	1	Parasite
Reed Buck	1	1		1		Dinder	18	Herbs	Daily			
Warthog	2	1	1	1	1	Kassala	30	Herbs	Daily			
Crested Porcupine	1	1		1		Kassala	12	Vegetables	Daily			
Tortoises	33	15	18	25	8	Red Sea	12	Herbs	Daily	2	3	
Nile Crocodiles	3	2	1	2	1	Blue Nile	48	Meat	Daily			
Nile Monitor	1	1		1		Kassala	8	Meat	Daily			
Python	7	4	3	7		Kassala	18	Meat	Daily			
Peacock	1		1		1	Khartoum	24	Herbs	Daily			
Tufted Guinea Fowl	2	1	1	2		Kassala	8	Herbs	Daily			
White -Back Vulture	5	3	2	5		Kassala	12	Meat	Daily			
Bud Gerigar	7	4	3		7	Khartoum		Herbs	Daily			
Yellow Canary	6	3	3		6	Khartoum	24	Herbs	Daily			

Appendix (5) Status of wild animals in Nyala Zoo:

Wild animals	Total	Six		Adult	Non Adult	Sources	Cage/ M	Feeding Type	Feeding. frequentl y	Birth rate	Mortali ty rate	Common ailment
		M	f. m									
Crested Porcupine	1	1		1		Radou m	30	Herb	Daily	2	4	Parasite
Grivet Monkey	3	1	2	1	2	Radou m	30	Vegetabl es	Daily			
Striped Hyeana	3	2	1	1	2	Radou m	30	Meat	Trice weekly			
Nile Crocodiles	2	1	1		2	S.Darfu r	18	Meat	Twice weekly.			
Tortoises	2	1	1	1	1	S.Darfu r	200	Vegetabl es	Daily			

Appendix (6)

Sales of wild animals in Kuku zoo during (2018)

No.	Species	Total
1	Lions,	8
2	Black Backed Jackal	2
3	Baboons	2
4	Grivet Monkeys,	5
5	Dorcas gazelle,	1
6	Crested Porcupines	4
7	Tortoises	6
8	Peacock	2
9	Toulouse geese	20
10	Muscovy ducks	12
11	Domicile crane	2

Appendix (7)

Monthly feeding of animals in Kuku zoo

Amount of food	Type of feeding	نوع الغذاء
kg600	Banana	موز
600kg	Green melon	عجور
kg300	Pumpkin	قرع
150kg	Sweet potato	بامبي
90kg	Carrot	جزر
kg150	Water –cress	جرجير
150kg	Purslane	رجلة
kg150	Alfa- Alfa	برسيم
450kg	Abo sabeen	قصب
225kg	Sorghums	فتريتة
kg225	Concentrated feed	علف بياض
112kg	Concentrated feed	علف مركز
30كيلة	Wheat brawn	ردة قمح
kg920	Meats	لحوم
36 kg	Pigeons	حمام
On demand	Date	بلح
225 on demand	Groundnut	فول سوداني

Appendix (8) Tools GPS device and BIRDS field guide

Appendix (9) Image of wild animal in Kuku Zoo

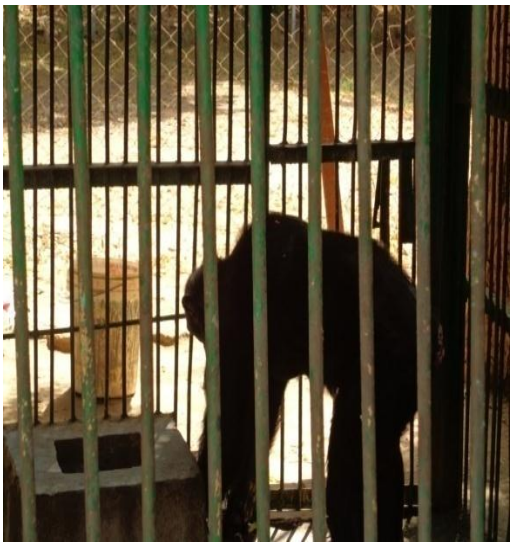
Appendix (10) Image of Alqurashi Zoo

Appendix (11)

Image of Basigat zoo

Appendix (12)

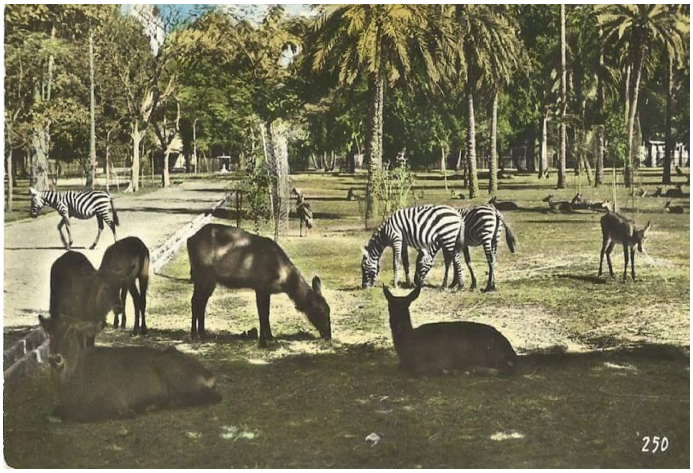
Image of wild animals in Kassala Zoo



Appendix (13) Image of Nyala Zoo

Appendix (14)

Image of some Wild animals in Khartoum Zoo (1902-1993)



حديقه الحيوان _الخرطوم المقرن

Appendix (15)
Questionnaire of Kuku Zoo personnel:

جامعة السودان للعلوم والتكنولوجيا
كلية الدراسات العليا

إستبانة العاملين بحديقة حيوان كوكو

الاخ الكريم بين يديك مجموعة من الاسئلة تدور حول دور حديقة حيوان كوكو في المحافظة علي الحيوانات البرية في السودان نرجو شاكرين الاجابة عليها بدقة دون تحيز علماً هي لغرض البحث العلمي .

(1)**الوظيفة:** .....

(2)العمر: 15 – 25 ☐ 25 – 35 ☐ 3 – 45 ☐ اكثر ☐

(3)الجنس: ذكر ☐ أنثى ☐

(4)المستوى التعليمي: خلوة ☐ أساس ☐ ثانوي ☐ جامعي ☐ فوق الجامعي ☐ أخرى ☐

- الحيوانات

(5)اكثر الحيوانات توالدا ؟

القرود ☐ الطيور ☐ اكلات اللحوم ☐ عاشبات ☐ الزواحف ☐

(6)اكثر الحيوانات نفوقا ؟

القرود ☐ الطيور ☐ اكلات اللحوم ☐ عاشبات ☐ الزواحف ☐

(7) الزيارات البيطرية ؟

كل اسبوع ☐ كل شهر ☐ كل 3 شهور ☐ غير موجود ☐ اخري ☐

(8) اسباب الوفيات؟

الامراض ☐ عدم كفاية الاكل ☐ الاصابات ☐

(9) التعامل مع الامراض ؟

طبيب بيطري ☐ ممرض ☐ العمال ☐

(10) اكثر الامراض الملاحظة ؟

امراض الجهاز التنفسي ☐ امراض الجهاز الهضمي ☐ اخري ☐

(11) عدد الزوار في اليوم ؟

(أ) 50-100 ☐ (ب) 100-200 ☐ (ج) اكثر ☐

(12) موسم ارتفاع الزيارات ؟

طول العام ☐ خلال الاعياد ☐ الاجازات ☐

(13) الاكثر جزباً للزوار هي

الالعاب ☐ الحيوانات ☐ الترفية ☐

(14)من وجه نظرك ما هو الدور الأساسي لحدائق حيوان كوكو؟

(أ) تعليمي ☐ (ب) تسلية وترفيه ☐ (ج) الحفاظ على الحيوانات ☐ (د) أخرى ☐

إذا كانت (د) أذكرها .....

(15)أكتر الحيوانات جذباً بالحديق؟. ولماذا؟

(أ).....(ب).....(ج).....

(16)مشاكل تواجة الحديقة ؟

(أ) الحصول علي الحيوانات البرية

(ب) الامراض

(ج) مشاكل ادارية

(18)بماذا توصي لتحسين الأداء والتطوير الحديقة ؟

(أ) اضافة حيوانات النادرة

(ب) اضافة العاب

(ج) تحسين الاداء الاداري

الرقم	السؤال	اوافق بشدة	اوافق	محايد	لا اوافق	لا اوافق بشدة
19	طريقة عرض وتسكين الحيوانات بالحديقة مناسبة					
20	كمية الغذاءات التي تقدم للحيوانات الحديقة مناسبة					
21	نوغية الغذاءات التي تقدم للحيوانات الحديقة جيدة					
22	عدد مرات التغذية الحيوانات المختلفة كافية					
23	المياة متواجدة ونظيفة بالحديقة					
24	التفاعل بين الحيوانات و الزوار امين					
25	عدد الزكور والاناث للحيوانات مناسب					
26	تتوالد حيوانات بالحديقة بصورة جيدة					
27	الحيوانات بالحديقة متذايدة					
28	الحديقة بوضعها الحالي يمكن ان تحافظ علي الحيوانات البرية من الانقراض					
29	الخدمات داخل الحديقة جيدة					