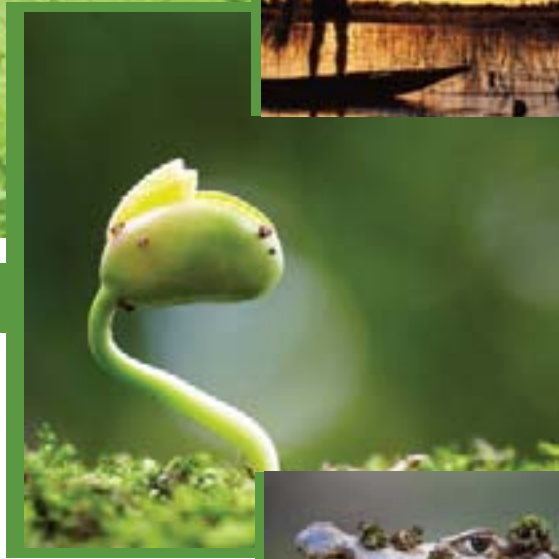
Botswana Symposium on Wetlands and Wildlife 2015

Natural resource research: implications for management and conservation



Book of Abstracts

Moseki Ronald Motsholapheko, PhD,
Olekae Tsompi Thakadu, PhD (Eds)

Contact details
Okavango Research Institute University of Botswana
Private Bag 285 Maun Botswana

BOTSWANA SYMPOSIUM ON WETLANDS AND WILDLIFE 2015

Acknowledgements

The organizing committee would like to express their sincere gratitude to all sponsors of the Botswana Symposium on Wetlands and Wildlife 2015 without whose generous support, this symposium would not have taken place.

Organising Committee

Dr M. Flyman	Ms T. Komazenge
Prof. J.E Mbaiwa	Ms. P. Dijeng
Mr M. Nthomiwa	Ms T. kgaditswe
Mrs M. Somolekae	Ms G. Sechele
Mrs M.G Mojalemotho	Mr B. Nduchwa
Dr O. T Thakadu	Ms A. O Keitsile
Dr L.P Rutina	Ms D. Keithome
Dr M. Gondwe	Mr J. Dekoker
Dr M.R Motsholapheko	Ms C. Leutlwetse
Dr G.S Masunga	Mr M. Othomile
Mr E. Mosimanyana	Mr M. Batshabang
Mr S. Nengu	Mr T. Nyakane
Mr B. Batsile	Ms G. Moetse
Mr P. Sandawana	Mr L. Leepile
Mr K.C Rathipana	Mr B. Thupe
Mr K. Charleson	Mr. J Mhongovoyo

Sponsors

Government of Botswana
Department Of Wildlife and National Parks
Okavango Research Institute
United Nations Development Programme (UNDP)
World Bank
Ecoexist Foundation
Wilderness Safaris

Table of Contents

Table of Contents

Table Of Contents

Background

Natural resources research should inform action, conservation and management, and as such studies should seek to produce knowledge that is applicable outside of the research setting, with implications for policy and project implementation. Botswana is a large country with low human population densities. Extensive wilderness areas support high densities of natural resources, and Botswana is one of the last refuges of species requiring open range. As a result Botswana still remains a stronghold for some of the world's globally threatened species, such as the African elephant, wild dog and others. While the distribution of natural resources in Botswana is fairly well documented, there are still knowledge gaps in their management and conservation status, including threats and challenges. It is therefore important for research and planning, in Botswana and other countries with similar conditions, to draw attention to the importance,and the sustainable use, of natural resources.

Aim

The symposium aims at improving our understanding of natural resources dynamics by exploring all facets of variability and change in ecosystems as well as their management and conservation around the world. Furthermore, the Symposium will review existing knowledge and present the most recent research findings on ecosystem dynamics and management options. The general objective of the Symposium is to provide an open forum for the exchange of views among natural resources professionals, academics and practitioners regarding the implication of research findings on management and conservation of natural resources.

Specific objectives are:

- To understand flora and fauna responses to the dynamics and heterogeneity of biogeochemical processes and primary production.
- To determine appropriate management and conservation regimes of natural re sources for sustainable utilization.
- To assess the economic and ecological value of natural resources to inform policy and planning.
- To assess the linkages between the dynamics of ecosystem services and human well-being.
- To examine how human activities (e.g. mining, agriculture, water diversion/ abstraction) affect ecosystem processes and functions
- To explore how research findings can effectively influence management and con servation of natural resources

Symposium sub-themes

1. Ecosystem dynamics (Wetlands Hydrology, Biogeochemical cycling, Vegetation and wildlife ecology, Energy flow)

2. Managing Ecosystems (Trans Frontier conservation, Managing natural resources, Governance, Monitoring of natural resources, Evaluation of management practices such as translocation, compensation, fire, waterholes)

3. Peopleand Ecosystems(Ecosystem services and human wellbeing, Economic values of ecosystem services, CBNRM, Sustainable Tourism, Human Wildlife Interactions, Anthropogenic impacts on ecosystems)

4. Game Ranching: A conservation tool or threat? (Management, Contribution to endangered species conservation, Conservation risks, Genetics , Tourism)

Host Institutions

The symposium is co-hosted by the Department of Wildlife and National Parks and the Okavango Research Institute, University of Botswana.

Scientific Committee

Dr. L.P Rutina
Dr. M. R. Motsholapheko
Dr. M. Gondwe
Dr. M. Stone
Dr G. Masunga
Mr. C. Winterbach
Mr. J Mhongovoyo
Mr. S. Nengu
Mr. A. Piutahija
Mr. K. Mosepele
Mr. K.T. Kgaditswe
Mr M. Nthomiwa
Mr E. Mosimanyana
Mr A. Hijamakutu
Mr P. Sandawana

The socio-cultural impacts of tourism on community people's quality of life: a structural equation analysis

O.I. Kolawole [1*], J.E.Mbaiwa,G. Mmopelwa[2]
[1]Okavango Research Institute,University of Botswana,P/Bag 285 Maun, Botswana
*Corresponding author: kolawoleid@gmail.com
[2]Department of Environmental Science,University of Botswana, Botswana

Abstract

Tourism in destination areas has socio-cultural impacts on host communities. The impacts can either improve the quality of life or degrade it. The objective of this paper therefore is to examine the relationship between socio-cultural impacts of tourism and Community People's Quality of Life (CPQoL) in Maun Village, Botswana. The theory underpinning this study was social exchange theory (SET). A self-administered questionnairewas used to collect primary data from 400 households heads or their representatives who were 18 years or older and have stayed in Maun for at least a year at the time of the study.The analysis was carried out using the Analysis of moment structure (AMOS)software version 16.0. The Cronbach's alpha reliability analysis, Explanatory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were performed to measure internal consistency and construct and content validity to explicate the robustness of the factor structure analysis. The model tests were based on the covariance matrix using maximum likelihood estimation. The result of the study revealed a significant positive relationship between tourism socio-cultural impacts and the community people's quality of life (CPQoL). This means that the community people's quality of life in Mainisinfluenced by the potential socio-cultural benefits that may accrue to their community. In conclusion, these results indicate that if tourism is to meaningfully benefit host communities and improve their quality of life, it must create employment and business opportunities for host communities. This is somehow different from the enclave tourism approach happening in most developing countries where tourism development does not benefit host populations but outsiders and foreign tourism companies.

Keywords: Socio-cultural impacts, quality of life, structural equation modeling, Botswana

Cascading effects of the Okavango floods on human-lion conflict along the Boteti River, Botswana.

K. Ngaka[1,2], L. Rutina[1], G. Maude[2], G. Hemson[3]
[1]Okavango Research Institute, Private Bag 285, Maun, Botswana
[2]CKGR Research Group, P.O. Box HA 33 HAK, Maun, Botswana

Abstract

The flowing of the Boteti River due to floods from the Okavango Delta has implications for human-wildlife conflict because of its influence on the spatio-temporal distribution of wildlife, which may influence carnivore predation on livestock. The aim of this study was to assess the spatio-temporal change in incidents of lion predation on livestock following the flowing of the Boteti River. Livestock predation incidents data was collected from the Department of Wildlife and National Parks. The data was then divided into three periods: Before (before fence was erected and river flowing), Fence (when fence was intact), and River (when river was flowing and fence has holes). Semi-structured interviews were conducted covering 99 households to assess farmers' perception on changes on human lion conflict among the three periods. Movement of collared lion in relation to cattle-posts were compared for the periods. Generally, the numbers of PAC reports were higher before the fence was erected and after the flowing of the river ($P < 0.05$) and differed significantly between seasons ($P< 0.001$). Lion accounted for 75% of the attacks.Farmers reported that lion conflict was worse before the erection of the fence and during the flowing of the River (68.8%) and better when the fence was intact (69%). There was a significant difference between distance travelled by lions before and during the flowing of the River ($P<0.005$). This results shows that the flowing of the Boteti River increased lion predation on livestock in the Boteti area.

Keywords: Botetiriver, livestock predation, farmers, human-wildlife conflict

Strategic partnerships for wetland management: Lessons from Uganda

R.Bagyenda, R. Mbeche*
The International Union for Conservation of Nature (IUCN), Uganda Country Office.
P.O Box 10950 Kampala, Uganda
*Corresponding author: robertmbeche@gmail.com or Robert.BAGYENDA@iucn.org

Abstract

Approximately 11,268km2 of Uganda's wetlands were lost between 1994 and 2008, representing a 4.7% loss in only 14 years. This has had serious consequences including but not limited to decreased water quantity and deteriorating water quality, adverse impact on fisheries, and flooding among others. As part of its response, the Government working with civil society actors put in place and tested a unique governance arrangement that included a strategic partnership with civil society, local governments and communities. The uniqueness sought to address capacity gaps, representation, accountability and sustainability at both local and national level for wetland policy implementation.These were lacking in previous wetland conservation initiatives in the country. Six new wetland Community Conservation Areas (CCAs) were established as a new form of wetlands Protected Areas in the Ugandan context, protecting 13,184ha of highly bio-diverse wetlands. Six Community Based Organisations have been established, officially registered and recognised by local governments to manage the sites. Their management roles and responsibilities are clear, including management of revenue from eco-tourism, fishing and a Community Environment Conservation Fund (CECF) that has been established to sustainably catalyse functionality of the local governance arrangements and adoption and replication of wise use activities. Killing of birds has been halted and catching immature fish has drastically reduced at these Ramsar Sites and Important Bird Areas (IBAs) because communities do self-policing with technical guidance from local government staff. The implication is that strategic partnerships between state, non-state actors and communities with clear roles, responsibilities and benefits enhances conservation and access to these resources.

Keywords: Wetland management, Community Conservation Areas, Important Bird Areas

Commitment to public access and sustainable utilization of Peter Smith's University of Botswana Herbarium collection data

J .Madome*, F. Murray-Hudson, K.Kashe
Okavango Research Institute, University of Botswana,Private Bag 285, Maun, Botswana
*Corresponding author: madome@ori.ub.bw

Abstract

The Peter Smith University of Botswana Herbarium (PSUB) of the Okavango Research Institute houses well over 13 000 specimens representing over 1700 species from in and around the Okavango Delta, a World Heritage site. The main purpose of the collection is to support botanical research of this unique habitat. Sharing and facilitating access to information is central for maintaining the relevance of the herbarium to ORI's mission of undertaking engaged wetland research and training on wetland ecosystems. Here we indicate PSUB's commitment to facilitating access and sustainable utilization of the PSUB collection. We highlight the availability of a checklist of all the plants housed in PSUB and their respective taxa, use and benefits of the adopted Botanical Research and Herbarium Management System (BRAHMS) database and ongoing digitization of the P.A Smith collection specimens. The targeted scanning of the collection through the Herbscan and the high resolution images generated, contribute to the PSUB Virtual herbarium linkable to P.A Smith annotated maps legacy housed in the ORI library. The BRAHMS database and the virtual herbarium information will be accessible through the Okavango Delta Information System (ODIS) and Okavango Basin Information System (OBIS) websites.

Keywords: Herbarium, Peter Smith, public access

An analysis of rural livelihood and community-level risk of malaria in the Okavango Delta, Botswana

D. Maphane*, B.N.Ngwenya, M.R.Motsholapheko
Okavango Research Institute, Private Bag 285, Maun, Botswana.
*Corresponding author: dirontshomaphane@rocketmail.com

Abstract

The Okavango Delta in north-western Botswana, is a malaria endemic area and major source of rural livelihoods for different social groups in the area. This study analyses the relationship between water related livelihood activities and malaria risk in the Okavango River Panhandle. Data were collected through participatory rural appraisal (PRA) tools, including livelihood ranking and disease calendar. The PRA was held in Shakawe village with a total of 34 participants from Ngarange and Shakawe villages. Data were analysed through constant comparison and thematic analysis. The results of livelihood ranking indicate that fishing (basket and hook line fishing) was ranked first out of all livelihood activities listed in relation to malaria risk. The disease and livelihood calendar showed that fishing had the longest duration (12 months), therefore coinciding with malaria season (October-April) in a year compared to other activities. Livelihood ranking results also showed that, boys are the most exposed to malaria transmission, as they take part in most livelihood activities. From the results, it can be concluded that exposure to malaria transmission varies with social group and livelihood activity, and that activities that take place at the river present high risk to malaria. Activities that take longer duration lead to higher exposure to mosquito (malaria vector) bites compared to those with less duration within a year. It can therefore be suggested that policy makers need to aggressively consider public health education as the main strategy, to sensitize people on the dangers of indulging in those activities.

Keywords: Exposure, livelihood, malaria, Okavango Delta

In search of greener pastures: using satellite images to predict the effects of environmental change on zebra migration

H.L.A. Bartlam-Brooks[1*], P.S.A. Beck[2], G. Bohrer[3] and S. Harris[1]
[1]School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, UK,
*Corresponding author:E-mail: hattiebartlam@gmail.com
[2]Woods Hole Research Center, 149 Woods Hole Road, Falmouth, MA 02540-1644, USA,
[3]Department of Civil, Environmental and Geodetic Engineering, The Ohio State University, Columbus, OH 43210, USA.

Abstract

Historically, ungulate migrations occurred in most grassland ecosystems, but many have been lost due to increasing habitat loss and fragmentation. Understanding the cues that drive long-distance animal movements is critical to predicting the fate of migrations under different environmental change scenarios and helpful in prioritizing migration routes for conservation. We used individual-based modelling approach to investigate the influence of environmental conditions, monitored using satellite data, on departure date and movement speed of migrating zebras in Botswana. Daily zebra movements between dry- and rainy-season ranges were annotated with coincident observations of precipitation from the Tropical Rainfall Measuring Mission dataset and MODIS-derived normalized difference vegetation index (NDVI). The best and most justified model predicted daily zebra movement as two linear functions of precipitation rate and NDVI, and included a modeled departure date as a function of cumulative precipitation. The model was highly successful at replicating both the timing and pace of seven actual migrations observed using GPS telemetry (R2=0.914). It shows how zebra rapidly adjust their movement to changing environmental conditions during migration, and are able to reverse migration to avoid adverse conditions or exploit resources, a nomadic behavior which should lend them a degree of resilience to climate and environmental change.Our results demonstrate how individual-based models, informed by freely-available satellite data, can be used to increase understanding on the use of environmental cues in animal movement. This modelling framework can be applied to quantify how animals adapt their movements to prevailing environmental conditions and to forecast migratory movements under alternative environmental scenarios.

Keywords: Zebra, migration, habitat loss

An assessment of community knowledge, practices and perceptions regarding Schitosomiasis in the context of climate variability: a case study of Okavango River Panhandle in Botswana

K.M. Malela[1*], B.N.Ngwenya[1], O.T.Thakadu[1]
[1]Okavango Research Institute, University of Botswana; P/Bag 285, Maun, Botswana,
*Corresponding author: kaimalela@yahoo.com

Abstract

Bilharzia (Schistosomiasis) is an endemic parasitic water-borne disease with a significant socio-economic impact and one of the most neglected tropical diseases in the world. The Okavango Delta has experienced an epidemic increase in transmission in the 1970s and 80s.Although a nationwide community based control program reduced prevalence significantly, there have been limited campaigns since 1993 when the community-based control program ended.This study assessed knowledge, practices and perceptions of Schitosomiasis among the two Pan Handle communities in the Okavango Delta. Forty key informants (40), purposively sampled, were interviewed using a semi-structured questionnaire. Data werecoded thematically and using SPSS software. Findings indicate that 20% linked climatic variables (drought, floods, rainfall and temperature) to changing disease patterns, 38% did not consider Bilharzia as a public health concern, whereas30% indicated that the disease has been eliminated. Majority of respondents (52%) identifiedbloody urine as a sign of Schitosomiasis and 82% did not know genital bilharzia, 10% associated it with a sexually transmitted infection, in particular thosola(syphilis) and 8% as a gynaecological problem manifested by erratic menstruation. About 15% regarded primary school going children as the most vulnerable group and that public health facilities had the capacity to diagnose and treat Schitosomiasis. However, 43% indicated that patients consult the hospital immediately, 3% stated that they go to traditional medicine practitioners (TMPs) and 10% stated that patints used both healthcare systems. Community perceptions of the risk of re-emergence are low. The results highlight the need to take into account the community behavioural patterns in designing Schistosomiasis control programmes.

Keywords: Schistosomiasis, neglected tropical disease, community knowledge and practices,

Analysis of community perceptions of vulnerability to water-borne diseases in the Okavango Delta, Botswana

M.R. Motsholapheko*, B.N. Ngwenya, L. Magole
University of Botswana, Okavango Research Institute
*Corresponding author: rmoseki@ori.ub.bw

Abstract

Wetland systems in different parts of the world, including the Okavango Delta in Botswana, determine public health and human well-being as they serve as sources of diverse livelihood activities. Water-borne diseases, which are commonly endemic in wetlands, such as malaria and schistosomiasis, adversely impact on human health in communities that depend on water-related livelihood sources. There is a need to understand community perceptions of vulnerabilities to these diseases in order to promote effective prevention and treatment. This paper assesses community perceptions of the link between access to water resources in the Okavango Panhandle, and vulnerability of individuals and social groups to malaria and bilharzia in the study villages of Shakawe and Ngarange. Data were obtained from three participatory rural appraisal (PRA) workshop focus group discussions (FGDs). The FGDs were on social analysis of disease patterns and livelihoods; livelihood activity rankings, and livelihood-disease calendars. Six livelihood sources were selected and mapped against risk of disease at different times of the year. The results indicate that river-based livelihood activities present high risk of being exposed to both malaria and bilharzia. Livelihoods and disease calendars also indicated that changes in weather and environmental factors (floods and rainfall) potentially increase vectors (mosquitos and snails). Community members perceive that there is a relationship between engagement in water-based livelihood activities, vulnerability and exposure to malaria and schistosomiasis in the Okavango Delta, and this relationship varies by specific social groups (gender and age) involved.

Keywords: Vulnerability, water-borne diseases, vector-borne diseases, wetlands.

Wetlands, people and cultural heritage: Okavango Delta world heritage site, Botswana

S.O. Keitumetse
Okavango Research Institute, University of Botswana, P/Bag 285, Maun, Botswana
Corresponding author: skeitumetse@ori.ub.bw

Abstract

Wetlands all over the world have been documented to have had various relationships with people in the past. Therefore wetlands are storages of both tangible and intangible cultural heritage. They provide cultural ecosystem services that are linked to concepts of landscape, heritage and identity. More common examples include the former lakeshore wetlands of the African Rift Valley (East Africa) and the Sterkfontein caves (Southern Africa) that has yielded hominid sites dating as far back as two million years old. In Botswana, archaeological studies in Tsodilo World Heritage site have also yielded past lakeshore evidence of stone-age technologies used by prehistoric communities to conquer and interact with past wetlands. While more prehistoric studies are necessary, to achieve sustainable development of wetlands, there is need to reconstruct historical wetland heritage that is much closer, and of direct utility to contemporary populations living within wetlands. This will enhance communities' sense of identity and belonging to the landscape, consequently leading to sustainable conservation measures. This research highlights various approaches through which the dormant cultural heritage of the Okavango Delta wetland can be unearthed to balance its natural and cultural heritage identities. In order to bring out the cultural heritage of the Okavango Delta wetland, archival research, historical archaeology, ethnographic research are illustrated as some of the approaches that need to be considered.

Keywords: Cultural, heritage, Okavango Delta, world heritage site

Trans-boundary and landscape conservation of lions in the KAZA-TFCA

D.T. Bauer*, M.K.Kesch, A.J. Loveridge
Wildlife Conservation Research Unit, Recanati Kaplan Centre
Department of Zoology, University of Oxford, UK
*Corresponding author: zimlions@gmail.com

Abstract

Fragmentation of natural habitat and isolation of populations is one of the biggest challenges faced by conservationists in modern times; a particularly damaging process for wild species that range widely such as carnivores, preventing genetic flow between animal populations and increasing the risk of inbreeding. Within the southern Kavango-Zambezi Trans-frontier Conservation Area (KAZA-TFCA), the University of Oxford´s Wildlife Conservation Research Unit investigates the potential for the habitat between Hwange National Park in Zimbabwe and Chobe National Park, Makgadikgadi/Nxai Pans National Parks and the Okavango Delta in Botswana to function as trans-boundary corridors for lions and other wildlife. To assess the carnivore occupancy in the corridor area, nine predator spoor surveys were undertaken in Botswana. Furthermore, a total of 61 lions have been collared with GPS satellite collars in Botswana and Zimbabwe, in order to assess movement patterns and levels of population connectivity within the southern KAZA-TFCA. Carnivore occupancy data will be presented separately for different parts of the study area. Furthermore, the GPS data from radio-collared lions show clearly that there is a contiguous lion population, reaching from north-western Zimbabwe throughout north-eastern Botswana. Therefore, rather than dealing with habitat connectivity between protected areas, the study population may represent one of the largest intact lion populations in Africa.

Keywords: KAZA-TFCA, lions, landscape conservation,trans-boundary

Inscription of the Okavango Delta on the World Heritage List: implications for research, conservation and management

G.M. Matswiri
Archaeology & Heritage Management, Department of National Museum & Monuments
Corresponding author: gertymatswiri@gmail.com; gmmatswiri@gov.bw

Abstract

This paper will assess the implications of the inscription of the Okavango Delta on the World Heritage List on research, conservation and management. The paper will also provide a description and relevance of the World Heritage Convention of 1972. This Convention is the basis for the inscription of World Heritage sites. It provides the requirements and expectations for inscription in terms of conservation and management of these sites. The paper will also explain the values and attributes and criteria which formed the bases upon which the inscription of the Okavango Delta was made. Once a site is inscribed on the World Heritage List, expectation by UNESCO is that the State Party should be able to maintain its integrity and protect the values for which the site was inscribed for. This could only be done through focused research, conservation strategies and management interventions that speak to those values. This paper, therefore, will discuss areas of focus in terms of research, conservation and management. This will assist the State Party to ensure protection of the integrity of the site and it's Outstanding Universal Values (UOV). Inscription of a site further requires the State Party to provide State of Conservation Reports and Periodic reports regarding the site. In addition, when inscribing a site, the World Heritage Committee made recommendations that the State Party should address. For the Okavango Delta WHS, the State Party is expected to submit its first report of the State of Conservation by 1st December 2015. These recommendations have implication on the focus of research, conservation strategies and management interventions of the site. This paper is therefore aimed at influencing decisions on research, conservation and management interventions that will contribute to protecting the integrity of the site and its outstanding universal values. It is however important to note that World Heritage values of the site are in line with the values of the site as a Ramsar site and this approach should not be seen as separating the two, nor does it come up with new conservation and management approaches, but it requests the consideration of these values and attributes in the research agenda, conservation strategies and management interventions.

Keywords: Conservation, Research, Okavango Delta,World Heritage Site,

Okavango Crocodile Monitoring Program: past, present and future

S. Bourquin*, V. Shacks
Okavango Crocodile Monitoring Program, P.O.Box HA 146 HAK, Maun, Botswana
*Corresponding author: Sbourquin@gmail.com

Abstract

The Okavango Crocodile Monitoring Program (OCMP) has been running since the Okavango Crocodile Research Group from the University of Stellenbosch ended their project in 2006.The complete database for both research projects is held by the OCMP and continually updated as new crocodiles are captured. To date the database contains over 2000 crocodiles, each of which has the corresponding GPS location and detailed morphological data. This is one of the largest databases of wild captured Nile crocodiles in the world and provides an excellent platform from which a number of current scientific studies are running, including reassessment of population status and health including recruitment and nesting patterns, long-term growth rates in the wild, isotope and urine analysis to assess heavy metal content, and assessment of farm-release successes. The OCMP has also captured crocodiles in the Okavango catchment area in Angola and has discovered what appears to be a fairly healthy recruitment upstream from the Okavango River. While current capture efforts are not as intensive as they were in the past, the strategy of targeting specific size classes will certainly improve our understanding of growth rates and movements of sub-adult and adult crocodiles. This presentation will summarize the research findings to date, discuss present work being conducted and touch on future expectations, including addressing issues of Human/crocodile conflict.

Keywords: Crocodile, human-crocodile conflict, Okavango

Application of Geospatial Information Technology for Collaborative Fisheries Resources Mapping and Management in the Okavango Delta World Heritage Site

M. Dhliwayo, K.B. Mfundisi*, K. Mosepele
University of Botswana, Okavango Research Institute, P/Bag 285 Maun, Botswana
*Corresponding author: kmfundisi@ori.ub.bw or kmfundisi@daad-alumni.de

Abstract

Modern information technology tools can play an important role in enabling meaningful community participation for sustainable fisheries resources management. The objective of this research was to use geospatial information technology to engage communities in the Okavango panhandle area to map and hysic ze habitats for fisheries resources with an ultimate goal of maintaining ecosystem services. Teams consisting of the local fisheries community, tourist service operators and researchers from University of Botswana and Department of Wildlife and National Parks (Fisheries division) undertook a field expedition along the Okavango River by boat and air. Handheld GPS units were used to mark locations of lagoons, river channel blockages and other features of interest. Afterwards the teams were engaged in collaborative mapping and demarcation of lagoons for selection of 'fishing-free zone'.The information obtained from field expedition consisted of GPS points, attribute information and identified features as well as photography and video. The projected GPS points were overlaid onto a Google Earth globe and lagoon areas around them hysic ze as polygons. Other features such as river channels and lagoons that were previously not captured were also identified and mapped.The collaborative mapping exercise resulted indesignation of one lagoon as a fisheries resources reserve whereby existing fisheries resources would be allowed to thrive and possibly replenish the fishing stocks in other fishing areas. A Story Map was created using the geospatial information generated for visualization and easy dissemination of the results. The study set a premise for future evaluation and monitoring of the area.

Keywords: Collaborative mapping, online GIS, fisheries resources reserve, Okavango Delta

Stakeholder perspectives on the ecological impacts of wildlife-based tourism in the Chobe National Park River Front in northern Botswana

E. Mogende1, Naomi Moswete[2*]
[1]Okavango Research Institute, University of Botswana, P/Bag 285 Maun, Botswana
[2*]Department of Environmental Science, University of Botswana,
P/Bag 00704, Gaborone, Botswana,
*Corresponding author: nomsamoatshe@yahoo.com or moatshen@mopipi.ub.bw

Abstract

Botswana is one of the best wildlife-based tourism/holiday destinations in southern Africa owing to its unspoilt wilderness and species diversity. There has been significant increase in local and international tourist numbers to protected areas that include wetlands of the Okavango Delta, Chobe National Park and Moremi Game Reserve in the north. Thus, nearly 90% of tourists who come to Botswana visit national parks and nature reserves, and tend to list wild animals and associated habitats as the main motivation to visit. Developments such as safari lodges and campsites are situated along waterfronts of the Okavango and the Linyanti/Chobe River. Consequently, wild animal lovers tend to concentrate along the scenic Chobe River. Therefore, the purpose of this study was to assess stakeholder perspectives on the ecological impacts of wildlife-based tourism development in the Chobe National Park (CNP) River Front. Sampling was conducted on site (tourist/visitors) and work place for other stakeholders. Data were collected by means of structured self-completion questionnaires among tourists who visited the study site and other key informants from May to July 2012 in Kasane. Additional information was collected by participant observation in December 2012. The research findings reveal that the development of tourism in the Chobe region has stimulated growth of infrastructure such as safari lodges, developed camp sites, especially along the Chobe River. This has improved employment opportunities and income for local communities. However, there were general perceptions that wildlife tourism has begun to cause negative effects on the ecology of the park. Increased levels of congestion of visitor/tourists' boats and vehicles have led to visible deterioration in the quality of natural resources of CNP, especially the riverfront. Thus this study finds management of park activities and the ecological sustainability of the CNP River front being compromised. Recommendations are spelled out to include sustainable management and marketing coupled with increased monitoring of tourism activities.

Keywords: Ecological impacts, Chobe River Front, Stakeholder, tourism

Sustainability of community-based natural resource management programme in marginal wildlife areas: a case study of Mekgatshi Community Trust in the Kalahari, Botswana

L.H. Gabolemogwe1, G.S. Masunga[2*], K.S. Thibedi[3]
[1]Estates Management Division, Department of Wildlife & National Parks,
P.O. Box 22 Mabutsane,Botswana
[2]Okavango Research Institute, University of Botswana, P/Bag 285, Maun, Botswana
3Botswana Wildlife Training Institute, Department of Wildlife and National Parks,
P.O. Box 376 Maun, Botswana
*Corresponding author: gsmasunga@ori.ub.bw

Abstract

Community-based natural resource management (CBNRM) is widely hysic zed as noble approach to wildlife conservation, especially in developing countries where poverty inrural communities residing near wildlife protected areas is very high. To engage local communities in wildlife conservation and ensure that they benefit from their conservation efforts, the Botswana Government introduced the CBNRM concept and supported its implementation throughout the country in many wildlife areas, including those in marginal areas. First, areas with wildlife were set aside as wildlife management areas (WMAs) to facilitate the implementation of CBNRM. Given that CBNRM is an innovation; its acceptance by communities is likely to experience challenges, depending on how the innovation is delivered by extension workers. This study was undertaken to determine the perceptions of the Mabutsane and Kokong communities on Mekgatshi Community Trust (MCT) which was one of the first trusts to be formed in Botswana. The MCT was formed to manage WMA SO2. Formal interviews were conducted in 2013 and responses showed that the two communities had negative perceptions on MCT and CBNRM.The communities stated that the trust had not made any positive impact to their livelihoods. Consequently, the two communities suggested the re-designation of area SO2 as a mixeduse to accommodatelivestock grazing. The study further established that thorough consultations with the communities were not done hence their resistance. This resistance brings into challenge the implementation of CBNRM in the area, especially when one considers the marginality of the area in terms of wildlife numbers and diversity.

Keywords: CBNRM, community based, Mekgatshi Community Trust, wildlife conservation

What is in the fragment size? Landscape heterogeneity and resource availability in reserve selection

G.S.Masunga
Okavango Research Institute, University of Botswana,P/Bag 285, Maun. Botswana
Corresponding author:gsmasunga@ori.ub.bw

Abstract

A close relationship between abiotic and biotic landscape elements is critical in influencing ecosystem processes and determining spatio-temporal patterns within a given area, and further important in determining the areal size ideal for biodiversity conservation and protection. This paper sets out to determine how abiotic heterogeneity in a landscape can influence decisions on the choice of the area size appropriate for biodiversity conservation, and whether heterogeneity and resource availability are closely related to the extent that they can be used for identifying potential wildlife reserves. I reviewed the literature and selected two countries as case studies for in-depth discussion and elaboration of the concepts of heterogeneity, resource availability and reserve selection. Case 1 explored the degree to which heterogeneity and resource availability in Botswana can be used to influence management decisions when selecting an area for a biodiversity reserve. Case 2 presented an example of a country where heterogeneity was used to determine the size ofa reserve, and this country is one of world's biodiversity hotspots.Literature indicates a close link between heterogeneity in abiotic elements and in biotic communities and such variations have important implications on resource availability. The review further indicates that heterogeneity increases with a fragment size and it enhances biodiversity. The review suggests that less heterogeneous landscapes are resource-poor and need to be large enough to account for resource complementation and supplementation, and where it is not feasible small isolated reserves can be established to capture high biodiversity hotspots, with possible connectivity among reserves considered.

Keywords: Biodiversity, heterogeneity, patch size, reserve selection, resource availability

The influence of stump diameter and height on coppicing ability of selected woody species of Shorobe, Botswana

J.Neelo[1*], D.T.Fanta[2], K.Kashe[1],W.Masamba[1]
[1]University of Botswana, Okavango Research Institute, P/Bag 285, Maun, Botswana
[2]Botswana College of Agriculture, Department of Crop Science and Production, P/Bag 0027, Gaborone, Botswana
*Corresponding author:jneelo@tati.ub.bw or njohncap@gmail.com

Abstract

Fencing native vegetation has become a widespread activity for arresting declines in biodiversity in agricultural landscapes. This approach was investigated using the short-term effects of fencing to exclude livestock and human disturbance on woody species recruitment and the influence of stump diameter and stump height on the coppice effectiveness in relation to interspecific variation in the north western Botswana. The objective was to provide an understanding of the coppicing ability of the selected woody species in order to provide a basis for sustainable management of the species. A total of 162 stumps (50% fenced and 50% left unfenced as control) were observed for a period of twelve months. Coppice effectiveness results varied among the key tree species and between the fenced and unfenced species. Acacia tortilis and Acacia erioloba hadthe highest number of coppice shoots of 8.20 ± 1.48 and 4.57 ± 1.12 respectively and the least being Colophospermum mopane(3.52 ± 1.32) in the fenced, while in the unfenced all the species had on average less than three coppice shoots. High coppice effectiveness indicates a greater recruitment potential for these woody species and coppicing ability of the species is species dependent and fencing them enhances recruitment. The results therefore suggest that management of woody vegetation of Shorobe should be species specific rather than holistic and also browsing and human disturbance should be minimized for better regeneration. The study has also provided a model for cutting of the aforementioned species for various purposes.It thus suggests the optimum diameter class time (10 to 20 cm) that may be utilized for various purposes including fuel wood and construction.

Keywords: Coppice effectiveness, sustainable management, regeneration.

Vegetation heterogeneity in the Savuti-Mababe-Linyanti ecosystem (SMLE) of northern Botswana

K.Sianga*,R.W.S.Fynn
Okavango Research Institute, University of Botswana, P. Bag 285, Maun, Botswana.
*Corresponding author: keosianga@gmail.com

Abstract

The Savuti-Mababe-Linyanti ecosystem (northern Botswana) is an extremely dynamic, complex and heterogeneous system. This ecosystem comprises of variable vegetation types involving permanent swamps, floodplains- and dry grasslands and woodlands. The spatial heterogeneity of the SMLE is driven largely by the trade-off between fire, herbivory, soils and annual flooding prompted by rainfall from the Okavango River catchments in Angola and Cuando River (Angola-Namibia). While there are some useful spatial information for the region, few efforts were invested in the generation of systematic and comprehensive spatial datasets to cover the entire region of northern Botswana. Vegetation composition (woody species, grasses and forbs) rooted within >600 40 x 20m plots sampled during the 2013-2014 and 2014-2015 wet seasons were subjected to hierarchical cluster analysis in PC-ORD to identify the defined classes. These vegetation classes were mapped using the Landsat Enhanced Thematic Mapper (ETM+) image, which was subjected to Supervised Image Classification (maximum likelihood classifier) in ENVI to identify the spatial distribution of the classified land-cover classes. Soil analyses will be conducted in each vegetation class to determine key aspects of functional heterogeneity. This classification and vegetation map will produce a key output for Botswana that will contribute to our understanding of the functional heterogeneity in the SMLE, will provide a detailed habitat map for herbivore research and for conservation planning.

Keywords: Northern Botswana,SMLE, Vegetation, heterogeneity,

Attitude of local communities towards forest management and conservation in Botswana: case study of Chobe Forest Reserve

Garekae. Hesekia[1*], Thakadu Olekae[1], Lepetu Joyce[2]
[1]Okavango Research Institute, University of Botswana, P/Bag 285, Maun, Botswana
[2] Botswana College of Agriculture, P/Bag 0027, Gaborone, Botswana
*Corresponding author: Tel: +267-6817286 / +267-74585883, email: garekae@yahoo.com

Abstract

Understanding conservation attitudes of local communities is essential to the long-term sustainable management of natural resources, forests included. This paper, guided by the Social exchange theory (SET), examined attitudes of local communities towards management and conservation of Chobe Forest Reserve (CFR) and assessed key factors which influence communities to develop certain attitudes towards conservation of CFR. Secondary data sources were reviewed and in-depth interviews with key informants were held with Chobe Enclave communities and government officials. This paper made use of thematic analysis technique for analyzing the data. Findings revealed that communities generally have positive attitudes towards forest conservation, though at varying degrees, whilst others were negative. The development of positive attitudes is influenced by various factors which among them include socio-economic and demographic factors. Conversely, negative attitudes are attributed to community's disenfranchisement in decision making and resource use and relations between communities and forestry department. For sustainable forest management and conservation to be achieved, it is vital that community's needs and aspirations, their attitudes and perceptions regarding conservation are considered and factored into strategies and approaches.

Keywords: sustainable management, natural resources, forest management, conservation, local communities, attitudes, Chobe Forest Reserve

Applying System Thinking Approach in Understanding Protected Areas, Tourism and Community Livelihood Linkages and Dynamics

M.T. Stone
University of Botswana, Okavango Research Institute, P/Bag 285, Maun, Botswana.
Corresponding author: moren.stone@ori.ub.bw

Abstract

In the context of this study, the community capital framework is used to understand the stock and flow among community capitals as a result of the interaction between protected areas, tourism and community livelihoods in a wetland environment, and how the impacts of these stock and flow affect the system. The study assesses how enhancements in community capitals through tourism have influenced changes in community needs that in turn have influenced the character of protected areas (PAs). The investigation is exploratory in nature and uses qualitative data collected through semi-structured interviews and secondary data sources. Results suggest that participation in conservation efforts through wildlife-based tourism brings mixed results on biodiversity conservation and community livelihoods. In exploring changes in community needs that have the potential to alter the character of PAs and community livelihoods, four overarching themes emerged: community capitals dynamics, prevalence of cash-flows, transformation of agriculture, and infrastructural development. The Chobe Enclave Conservation Trust, a community living adjacent to Chobe National Park in Botswana provides the context on which this study's discussion focuses. Overall, the enhancement of community capitals through tourism has brought multiple and multi-scalar drivers of change in community needs at both community and household levels. These changes define the relationship of PAs, tourism and community livelihoods. Tourism has introduced a model where natural resources are exchanged in an exploitative manner for financial and physical capitals gain which in future may not resonate with conservation undertakings. The findings provide insights into the dynamics of biodiversity conservation, tourism and community livelihoods which are essential to planners and policy makers in their quest to devise adaptability measures in PAs.

Keywords: Protected areas, community livelihoods, community capital framework, wildlife-based tourism, system thinking approach

Challenges influencing biodiversity conservation in community-based natural resource management in Khwai and Sankuyo communities, northern Botswana

K. G.Thebe, G. S.Masunga*
Okavango Research Institute, University of Botswana, P/Bag 285, Maun
*Corresponding author: gsmasunga@ori.ub.bw

Abstract

Biodiversity conservation is vital for sustenance of livelihoods, particularly in rural communities that live in and around protected areas. CBNRM is being introduced across the world to motivate communities to conserve and at the same time benefit from their efforts. However, concerns are raised that the increasing focus of the communities practicing CBNRM is on financial benefits at the expense of conservation. This study analyzes the status and challenges affecting the implementation of the biodiversity conservation projects by communities engaged in CBNRM programs in the Okavango Delta, Botswana. Khwai and Sankuyo communities have been engaged in CBNRM for over two decades and were selected for this study. Interviews were conducted to gather the perceptions of the community members and other stakeholders. Management plans were reviewed to verify the proportion of completed versus planned projects. We found out that both Khwai and Sankuyo communities were aware of the projects proposed in the management plans and knew those that have been implemented. Although the two communities raised a concern about the complexity of the implementation process, the implementation success rate of their projects was over 80%. The communities were satisfied with the success rate and the impact of the projects on conservation. One such impact is the decrease in incidences of poaching and illegal tourism operations. The positive perceptions of the local communities towards biodiversity conservation are vital for the realization of the CBNRM goals, and efforts should be directed to making the implementation phases simpler and standardized for sustainable landscape management.

Keywords: biodiversity conservation, Botswana, CBNRM, Okavango Delta,

Collaborative management of an ecosystem: A case study of elephant-human interaction in the eastern part of the Okavango Delta, Botswana

O. Kontle
Kalahari Conservation Society, Gaborone
Corresponding author: okontle@kcs.org.bw or konosmanic@yahoo.com

Abstract

The Okavango Delta has continued to be popular across the global sphere due to its rich ecosystem wildlife resource base, among them being elephants, which need to be conserved collectively by all stakeholders. The ecosystem is an interaction of all living organism in conjunction with their instantaneous environment within which they live. As a result, therefore, collaborative management (co-management) of an ecosystem strives for the advancement of mutually shared accountability amongst stakeholders aimed at conserving a given ecosystem. The top-down approach has continued to undermine the true intentions of the co-management of an ecosystem in elephant-human interaction. In order to combat this phenomenon this study, specifically is set to explore the implementation of co-management of an ecosystem in elephant-human interaction in the eastern part of the Okavango Delta panhandle, Botswana. This thesis evolved around one main research question supported by four specific questions that correspond to the objectives through which four thematic areas were achieved. In order to contribute to the body of hysic ze knowledge in co-management of an ecosystem in elephant-human interaction, I employed a qualitative approach, an emergent research design aimed at adjusting the methods, as well as encompassing a combination of data sources such as interviews, observations and relevant documents. In addition, to the aforementioned, I also employed snowball technique as a variant of purposive sampling for the selection of respondents or participants for this study. This thesis concludes that co-management of an ecosystem in elephant-human interaction is vital and there is a need to embrace adaptive management in a continuum.

Keywords: Collaborative management, ecosystem, wildlife resource, elephant-human interaction, stakeholders, Okavango Delta, adaptive management,

Tourists' preferences and sustainable tourism management in the Okavango delta, Botswana

D.M. Matlhola[1*], G. Mmopelwa.[2], D.L. Kgathi.[1]
[1]Okavango Research Institute, University of Botswana, P/Bag 285, Maun
[2] Department of Environmental Science, University of Botswana
*Corresponding author: dmatlhola@ori.ub.bw

Abstract

Tourism has a key role to play in confronting the challenges of sustainable use of wetlands. Its rapid growth has fuelled the high rates of population increase in wetlands such as the Okavango Delta, causing wetlands degradation thus loss of their landscape for locals and deterioration of scenes for sightseeing tourists. However, tourists' preferences on aesthetic quality and the place of recreational activities are considered as means to achieve sustainable wetlands management. The goal is to illustrate the importance of assessing tourists' preferences when designing programs and policies central to the sustainable development of the Okavango Delta, Botswana. With this goal in mind, 180 international tourists were interviewed as they were coming from the Delta from mokoro excursions. Through choice experiment, tourists' preferences were determined using three attributes of the ecotourism; management of community tourism enterprises, landscape of the Delta, wildlife species and mokoro price as the payment vehicle. Results indicate that most tourists prefer wildlife-viewing during the flooding season of the Delta as they partake in mokoro excursions. Tourists also prefer to use community tourism enterprises that are managed in joint venture. The study results suggest the importance of tourists' preferences for programs central to sustainable management of the Okavango Delta to managers since these preferences can drive them to develop management decisions in a more sustainable direction. The results also illustrate the importance of these preferences in sustainable development as a means to conserve natural resources and the environment.

Keywords: Tourists' preferences, sustainable tourism, choice experiment, ecosystem services, wetlands management

Spatial variability of the water quality of the Okavango-Boro-Thamalakane-Lake Ngami system, Botswana

M.J. Gondwe[1*], W.R.L. Masamba[1] and M. Murray-Hudson[1]
[1]Okavango Research Institute, University of Botswana, P/Bag 285, Maun, Botswana.
Corresponding author: mgondwe@ori.ub.bw

Abstract

The Okavango Delta is a wetland of international significance. It is an oasis in the middle of the Kalahari Desert providing a habitat for various plants and animals. It is also an important tourism destination in Botswana. The Delta depends on both water quantity and water quality for sustaining ecosystem services. Whereas many studies have been carried out on hydrology, few have been carried out on water quality. Surface water quality of the Okavango Delta was monitored approximately every fortnight from June 2008 to June 2009 at eight sites along the Okavango-Boro-Thamalakane River system to Lake Ngami by measuring several hysic-chemical parameters. The following means and ranges (in brackets) were determined for the eight sites: Ph-mean 6.98 (4.18-9.23), electrical conductivity 95.10 µS/cm (23.00-384.0), dissolved oxygen 4.04 mg/l (0.03-11.25), turbidity 34 NTU (0.34-745), temperature 24.1 °C (12.0-34.7), sodium 6.72 mg/l (1.00- 55.0), potassium 3.83 mg/l (0.80-30.0), calcium 7.58 mg/l (2.19-22.4) and magnesium 2.50 mg/l (0.31-9.10), carbonates 0.53 mg/l (0.00-33.83), bicarbonates 88.8 mg/l (21.4-355.0), chloride 0.97 mg/l (0.05-11.08), sulphate 0.46 (0.01-12.3) and nitrate 0.55 mg/l (0.00-21.60). There was a general increase from the inlet to the outlet of the Delta for electrical conductivity, sodium, potassium, calcium, magnesium, chloride and bicarbonate. There was an initial decrease followed by an increase in Ph and concentrations of dissolved oxygen, turbidity, sulphate and iron from the inlet to the outlet. This shows that the Okavango Delta wetland acts as both a sink and a source depending on the water quality parameter.

Keywords: water quality, Okavango Delta wetland, spatial variability

Modelling of flood pulse using extreme value models: acase study of the Okavango River, Botswana

T.R. Mothobi[1*], W.M. Thupeng[2], E. Mosimanyana[1]
[1]Okavango Research Institute, University of Botswana, P/Bag Maun, Botswana
[2]Department of Statistics, University of Botswana. Gaborone
*Corresponding author:rmothobi@ori.ub.bw

Abstract

Floods in the Okavango Delta are mostly as a result of heavy inflow of water into the Okavango River at Mohembo with little input from local rainfall. Several hydrological models have been developed for the flow system of the Okavango Delta (OD). However, most of these models are deterministic in nature, focusing primarily on mimicking the hydrological processes in the Delta. This study uses a statistical approach based on extreme value theory to model water-inflow into the OD at Mohembo. To the best of the authors' knowledge, very little research work has been done on modelling extreme events like floods in the OD using a statistical approach. The study models annual and monthly maximum inflows using both the Block maxima and Peaks over threshold (POT) methods. Block maxima are modeled using the Generalized Extreme Value distribution while the POT are modeled using the Generalized pareto. The parameters of the models are estimated using the maximum likelihood method, while the goodness-of-fit of the models is assessed through the quantile-quantile plots and numerical measures like the relative Nash-Sutcliffe efficiency measure. We also estimate T-year return levels for the maximum inflows at Mohembo. Such information can be used by policy makers, such as the National Disaster Management Committee and residents of flood prone areas to raise awareness for flooding possibility for every hydrological year.

Keywords: Extreme values, floods, Block maxima, Peaks over threshold, Generalized extreme value, Generalised Pareto

The seasonal impact of shared grazing by wildlife and livestock on gastrointestinal nematode transmission in Botswana

J.G. Walker[1,2,3*], H. R.[1,2,] K.Evans[3], J.Wyk[4], E.R. Morgan[2,5]
[1]School of Biological Sciences, University of Bristol, Bristol Life Sciences Building, [24], Tyndall Avenue, Bristol, BS8 1TQ, UK
[2]Cabot Institute, University of Bristol, BS8 1UJ, UK
[3]Elephants for Africa, Maun, Botswana
[4]Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, 0110 Onderstepoort, South Africa
5School of Veterinary Science, University of Bristol, Langford House, Langford, North Somerset, BS40 5DU
*Corresponding author: J.G.Walker@bristol.ac.uk

Abstract

In the Makgadikgadi Pans of Botswana, wild and domestic ungulates share grazing land, leading to the potential for transmission of generalist gastrointestinal parasites between them. However, wild species which are not susceptible to the same parasites as livestock will have the opposite effect, removing infective larvae from the pasture, thus reducing the transmission risk for livestock. This area hosts one of Africa's largest seasonal migrations of herbivores. Also, rainfall in the region is highly seasonal, and climate has a strong effect on survival of infectious stages of gastrointestinal nematodes on pasture. We trained farmers in four villages with varying contact with wildlife to look for signs of GIN in small ruminants using a targeted selective treatment method modified from Bath and van Wyk's Five-Point-Check©. These data, in combination with a well validated climate-based model of nematode transmission, were used to assess seasonal patterns of nematode transmission in livestock in the villages. We extend the model in order to assess the role that wildlife could play in contributing to or mitigating nematode transmission within the ecosystem, as well as the relative impact of management strategies including targeted selective treatment of livestock. We aim to build resilience to wildlife conflict through a better understanding of the potential benefits of shared grazing land, and through improved livestock health by empowering farmers to treat their livestock in a low-cost, sustainable way.

Keywords: Gastrointestinal, nematode, wildlife, livestock

Environmental variability and fish species assemblage in the Okavango Delta

K. Makati*, [1]. Mosie, K. Mosepele, M. Murray-Hudson
University of Botswana Okavango Research institute, P/Bag 285, Maun Botswana
*Corresponding author: kaelo.makati@ori.ub.bw

Abstract

Fish are a key livelihood resource in most socio-economically marginalized communities. Therefore, sustainable management of this resource is fundamental towards ensuring that states can achieve some of the MDG's through efficient utilization of these natural resources. Floodplain fisheries fluctuate in time and space, and sustainable and comprehensive management of these requires enhanced understanding of the dynamics of their fish communities. Therefore, this study is part of a long term monitoring initiative by the Okavango Research Institute to generate knowledge on the dynamics of the Delta's floodplain fish community. Data (fish and environmental) are collected from three sites in the Delta monthly. Single factor ANOVA revealed significant differences in environmental variability among the three sites where DO (p=0.00), turbidity (p=0.00) and conductivity (p=0.00) were different, while no significant differences were observed for temperature (p=0.43) among the sites. Cluster analysis (based on Bray Curtis similarity) revealed that Lake Ngami fish community and Nxaraga closely resembled each other while that of Chanoga was different. However, single factor ANOVA revealed that there were no significant differences (p=0.62) in species diversity among the sites. An index of relative importance (IRI) revealed that Barbuspaludinosus was the most dominant fish species at Lake Ngami, while Schilbeintermedius was the most dominant at Nxaraga and Marcuseniusmacrolepidotus was the most dominant species at Chanoga. SIMPER analysis revealed that average dissimilarity between Lake Ngami and Nxaraga was 39%, where Barbuspaludinosus and Oreochromisandersonii contributed approximately 28% of the dissimilarity between these two sites. Meanwhile, SIMPER analysis revealed that average dissimilarity between Chanoga and Lake Ngami was approximately 52%, where B. lateralis and O. andersonii contributed approximately 24% of the dissimilarity. Average dissimilarity between Chanoga and Nxaraga was approximately 56%, where Marcuseniusmacrolepidotus and Schilbeintermedius contributed approximately 23% of dissimilarity between these two sites. These results show that there is spatial variability in the Delta's fish community, which is possibly driven by environmental partitioning in the Delta.

Keywords: Environmental partitioning, species diversity, floodplain fish community

Soil factors that influence the abundance and distribution of threatened and endangered species in the Okavango Delta; with particular emphasis on eulophiaangolensis

S.Middleton[1], K.B. Mfundisi[2*], N.Kurugundla[3]
[1]Environmental Sciences Department, University of Botswana, Gaborone
[2]Okavango Research Institute, University of Botswana, Private Bag 285.Maun
[3]Department of Water Affairs, Maun
*Corresponding author:kmfundisi@daad-alumni.de; kmfundisi@ori.ub.bw

Abstract

Eulophiaangolensis is an endangered plant species found in the Okavango Delta. Generally, there is lack of botanical information on this species in Botswana, which is necessary for its in-situ and ex-situ conservation. The objective of this study was to establish soil factors that influence the abundance and distribution of E. angolensis in the Okavango Delta. A survey of the area where the plant was sighted in 2004 was carried out using recorded GPS points. Soil samples were collected at 0-20cm depth from the floodplain where the species occurred to determine the nutrients (N, P, and K) and soil organic carbon (SOC) contents. A floodplain where the species did not occur was selected as a control site. The researchers discovered a newunrecorded site for the species. And t-test results showed a significant difference in N, P, K and SOC contents between the floodplain where the plant occurred and the control site with ($P \leq 0.05$) at 95% confidence interval. Furthermore, there was K biogeochemical gradient within the E. angolensis habitat, with more concentrations directly around the plant. Therefore, E. angolensis needs critical amounts of N, P, K and SOC, with K, SOC and water requirement being the crucial factors.

Keywords: *Eulophiaangolensis*; Okavango Delta; soil nutrients, soil organic carbon (SOC), endangered species

Community, government and non-government partnerships for science-based wildlife and habitat assessment and monitoring in large landscapes of northern Namibia and Botswana

K.Heinemeyer[1*], J.Muntifering[1,2], R.Karimi2, V. Kasupi3,
G.Lara [2],. D.Sizemore
[1,2] Round River Conservation Studies, 104 East Main, Bozeman, MT 58715, USA
[2]Round River Conservation Studies, 284 West 400 North; Suite 105, UT 84103, USA
[3] Round River Namibia, P.O. Box 39, Kamanjab, Namibia
Corresponding author: kim@roundriver.org;khein@xmission.com

Abstract

Understanding current and potential future distribution and abundance of wildlife and wildlifehabitat is challenging in remote landscapes. We present examples of collaborative efforts inNamibia and Botswana that build upon the strengths of multiple partners to develop regionalwildlife habitat assessment and population monitoring tools for decision support.In the Kunene region of northern Namibia, Round River Conservation Studies, local communityand the federal government developed a regional assessment of wildlife habitatand core values. Completed in 2008, this Kunene Regional Ecological Assessment (KREA)included wildlife habitat modeling, livestock grazing mapping and other spatial inputs to identifyhigh value ecological core and connectivity areas. Analyses include spatial options for meeting conservation goals while minimizing potential conflict with human uses. Bi-annual wildlife surveys were initiated in 2008 using distance sampling and strip transectanalyses for sixkey wildlife species. These surveys were powerful enough to document negativepopulation responses to the recent 3-year drought and initial recovery of some species with the2014 rains. Additionally, these data have allowed an assessment of wildlife responses to humanuses such as livestock grazing.Similar to work in the Kunene region, Round River has partnered with the Okavango ResearchInstitute, the Southern Africa Regional Environmental Program, the Botswana Department ofEnvironmentalAffairs and concessions in the Okavango region to develop collaborative wildlifemonitoring approaches. To provide a large-scale ecological framework for management, RoundRiver is proposing to develop a regional assessment of conservation values and how these maychange in the future.

Keywords: Community, partnerships, habitat assessment, landscapes

Assessing the benefits and risks of growing biofuel crops: the case of Jatrophacurcas L. (Jatropha)

K. Kashe*, D. Kgathi, M. Murray-Hudson
University of Botswana, Okavango Research Institute, Private Bag 285, Maun, Botswana.
*Corresponding author: kkashe@ori.ub.bw;

Abstract

Biofuels are attracting attention worldwide as 'green' renewable solution to the world's energy needs, particularly in light of increasing cost of fossil fuels and concerns over greenhouse-gas emissions, and consequential climate change. Because of greenhouse-gas emissions concerns and 'food–fuel' conflict, non-edible oils such as those extracted from Jatropha are preferred over edible oils for biodiesel production. Jatropha has recently gained global popularity as a potential non-edible oil plant because of its high oil content ranging between 30-40% by weight. It is a drought tolerant plant that can be grown in subtropical and tropical climates with minimal fertilizer and water needs. There are concerns about potential invasiveness of biofuel crops. Some evidence suggests that the attributes of an ideal biofuel crop such as rapid growth, low input requirements and wide habitat breadth match those of weedy and invasive species. The Botswana Government is currently in collaboration with the Government of Japan to promote cultivation of Jatropha for biodiesel production. Despite concerns about the potential invasiveness of biofuel crops, no attempt has been made to address the risks of cultivating Jatropha in Botswana. This paper aims to assess the benefits and risks of growing Jatropha for biodiesel production in Botswana. To reduce invasiveness, Jatropha should be cultivated under International Union for Conservation of Nature (IUCN) guidelines on biofuels and invasive species. Jatropha can only compete with fossil fuel use and be produced on larger scale if it can meet the energy needs and provided its cultivation is profitable.

Keywords: Biofuel; invasive species; risk.

Distribution of heavy metals in surface and ground water along a transect in Nxaraga Island, Okavango Delta, Botswana

B. S. Keabetswe*, W.R.L. Masamba, O. Mogobe
Okavango Research Institute, University of Botswana, P/Bag 285 Maun
*Corresponding author: bkeabetswe@ori.ub.bw

Abstract

Heavy metals are very toxic and persistent. They can concentrate and bioaccumulate in living organisms. Islands of the Okavango Delta are known to be sinks of water-borne nutrients and salts but little has been done on heavy metals. This study aims at determining the distribution of the heavy metals Cr, As, Fe, Pb, Cd and Hg in surface and ground water of Nxaraga Island in the Delta. Twenty one samples were collected along a transect originating from surface water to groundwater from a piezometer at the island center. Suspended particulate matter was also collected. Flame Atomic Absorption Spectroscopy (FAAS) was used for Fe analysis, Graphite Furnace Atomic Absorption Spectroscopy (GFAAS) for arsenic and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) for Cd, Pb, Hg and Cr. Carbonates, bicarbonates, Ph and EC were also determined. Results show that total arsenic ranged between 0.22µg/l -10320µg/l, total Fe ranged 564µg/l -53470µg/l, total Cr ranged 12.9µg/l -20.8µg/l. Total Cd ranged 0.11µg/l -0.91µg/l. Total Hg ranged 0.01µg/l-0.73µg/l and total Pb ranged 5.66µg/l-69.7µg/l.PHREEQC Geochemical model was used for speciation studies revealing that arsenic was abundant as the more toxic and mobile As+5, Cr was mostly the less toxic Cr+3. Fe existed as both Fe+2and Fe+3, Cd as Cd+2, Pb as Pb+2 and Hg was in element form. The study shows that in Nxaraga Island, surface water is generally uncontaminated but groundwater at the highest recorded concentration for each metal, exceeded WHO averages in aquatic environments.

Keywords: Heavy metals, pollution, speciation, water, wetlands

The influence of flooding variation on riparian plant community composition and distribution in the Okavango Delta, Botswana

G. Tsheboeng*, M. Murray-Hudson, K Kashe
Okavango Research Institute, Private Bag 285, Maun, Botswana.
*Corresponding author: gtsheboeng@tati.ub.bw

Abstract

In order to conserve the riparian woodland resources, there is need to understand how environmental factors including flooding affect them. The objective of this study was to determine the influence of flooding frequency on riparian woodland vegetation composition and distribution. Vegetation sampling was done in 20m x 50m plots in the Panhandle, Seronga, Jao, Santawani, Moremi and Nxaraga from February 2012 and November 2013. Plant percentage cover was estimated using the Braun-Blanquet cover/abundance scale. Tree height, basal area, seedling density, species richness and diversity were determined at each site. Twenty-five year flooding frequency was determined at each site from Landsat imagery. Indicator species analysis was used to determine characteristic species at each site. The Paired Student's t-test was used to compare vegetation parameters across sites. Flood frequency follows a gradient from highest in the Panhandle to lowest in the distal distributaries such as Santawani. Riparian woodland vegetation community composition, density, cover and diversity varied significantly ($p<0.05$) between different sites. There was strong correlation between vegetation parameters and flooding frequency. The results show that flooding frequency variation is important for maintaining ecosystem heterogeneity in the Okavango Delta. This study has also shown that there is a potential use of woodland vegetation composition and distribution in understanding past and ongoing changes in water resource availability. The study has also provided baseline information that can be used in establishing permanent plots for long term vegetation monitoring.

Keywords: Braun-Blanquet, Hydrology, Okavango Delta and Vegetation dynamic

Roles, relationships and consequences of institutional arrangements related to access, utilization and management of wetlands by local communities in Zimbabwe

T.Marambanyika[1,2*], H.Beckedahl[1]
[1]Discipline of Geography, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu Natal, Private Bag X01 Scottsville 3209, South Africa
[2]Department of Geography and Environmental Studies, Midlands State University, P. Bag 9055, Gweru, Zimbabwe
*Corresponding author: tmarambanyikat@yahoo.co.uk; marambanyikat@msu.ac.zw

Abstract

The research investigated institutional arrangements governing wetland utilization, access and management in communal areas of Zimbabwe in order to determine their efficacy in maintaining wetland ecosystems whilst benefiting local communities. The research adopted a descriptive survey design. A sample of 123 households for questionnaires was selected through stratified random sampling from six wetland sites studied in three districts of Midlands province, Zimbabwe. Key informants were purposively selected for semi-structured interviews from institutions which interact with local communities on wetland use, management and conservation such as Environmental Management Agency, Rural District Councils, Agricultural, Technical and Extension Services, political leaders and traditional leaders. Research findings revealed that there was multi-institutional participation in wetland resources governance. The role and relationship of institutions sometimes compromise wetland resources integrity due to conflicts, confusion and tensions exacerbated by divergent motives. The number of institutions participating at each wetland site and their degree of influence varied from wetland to wetland and sometimes district to district, resembling lack of a clear uniform institutional structure at communal level. The research further revealed that wetland resources can be sustainably utilized with traditional institutions shaped by kinship ties taking a leading role due to their proximity to people and wetlands unlike central government and local authorities whose frequency in monitoring wetland management is low or absent, although they contribute useful information where they co-operate. If wetland use is to be sustainable, there must be clear co-ordination of institutional roles and clarification on their relationships for the good of wetland resources protection.

Keywords: Institutional arrangements, wetlands, Zimbabwe

Spatial and temporal variation in flooding in rural floodplain farming areas in the Okavango Delta, Botswana

C. Molefe[1*], L. Cassidy[2], M. J. Chimbari[3], L. Magole[1],
[1]Okavango Research Institute, University of Botswana, P/Bag 285 Maun, Botswana
*Corresponding author: molefechandapiwa@gmail.com
[2]Ecosurv Environmental Consultants, Maun, Botswana
[3]University of KwaZulu-Natal, South Africa

Abstract

The Okavango Delta is subject to annual and inter-annual inundation of varying magnitude. The cyclic behaviour of the inundation process impacts on livelihoods of communities reliant upon the Delta for subsistence. One such livelihood option is flood recession (molapo) farming. Although flood recession farming contributes substantially to rural livelihoods, communities are faced with many challenges, particularly the unpredictability and unreliability of flooding. The study sought to determine the spatial and temporal variation in flooding that has occurred in the floodplains over the selected time-steps.Ten Landsat images (TM 5 and ETM+ 7) across two scenes (p174r074 and p175r073) were analysed. The analysis covered the period 1989 to 2008, it focused on three flood seasons separated by two time-steps each 10 years apart to show how flooding varies in both quantity and location in the molapo field areas. The study took place in three villages on the peripheries of the Delta namely Tubu, Xobe and Shorobe.Results show that the three study villages not only have very different floodplain lands available, but they also show different flooding patterns. There is a considerable variation in flooding extent between each time step and each community. It is important to note that only Shorobe follows the same wet-dry trend as the overall Delta, moving from dry in the early 2000s to wet in 2010, while that of Tubu and Xobe seem to follow an opposite trend.The relationship between volume and timing of inflow to the Delta and flood extent and timing at any given point in the Delta is not always linear, hence the variation in each village does not follow similar trends. This suggests that there are other factors operating to modify flooding behavior at the local level. The implication of this is that for both farmers and planners, it is not possible to have a single, blanket response to Delta flood inflows. Research outputs need to be communicated at the village level so that people can better accommodate the variation experienced where they live.

Keywords: Flood recession farming, geographic information system, hydro-climatic factors, molapo farming, Okavango Delta, remote sensing

A simple conceptual dynamic model of floodplain vegetation succession in the Okavango Delta

M. Murray-Hudson1*, P. Wolski2, F. Murray-Hudson1, M. T. Brown3, K. Burger4, C. Winterbach5, K. Mosepele1, R. Fynn1, G. Tsheboeng1
1 Okavango Research Institute, University of Botswana.
2Climate Systems Analysis Group, University of Cape Town.
3Howard T. OdumCenter for Wetlands, University of Florida.
4University of Pretoria.
5Tau Consultants, Maun, Botswana.
*Corresponding Author e-mail: mmurray-hudson@ori.ub.bw

Abstract

The Okavango Delta receives an annual flood pulse from summer rains in the catchment. The flood pulse drives the vegetation ecology of the Delta floodplains. It is characterised by large inter-annual and multi-decadal variability, which results in vegetation communities being in a state of constant adjustment. Seasonal floodplains, inundated for part of each year, are the most productive parts of the system, undergoing switching between anaerobic and aerobic soil conditions. These can be subdivided into sedge communities (longer hydroperiod) and grass communities (shorter). The flooded grass communities are a critical resource for mobile ungulate populations, providing dry season forage when resources in the hinterland are not available. Here we present a simple dynamic model which illustrates fluctuations of fish and water-dependent wildlife populations over the period of record of inflows to the Delta. The model is based on a duration threshold below which sedges suffer increased mortality, opening up space for grasses to establish. The model was constructed for testing hypotheses about system behaviour under hydrological conditions that reflected possible future changes, such as increased abstraction upstream, the construction of dams, and the effects of climate change. These were constructed by modifying the inflow record to reflect for example water offtake by reducing inflows by a given proportion, or impoundment of water for hydropower by reducing peak flows and increasing base flows. Offtake of water reduces the flooded area, increasing grassland at the expense of sedge community areas. This drives an increase in the population of terrestrial herbivores, with a concomitant drop in fish populations. Dampening of intra-annual variation as caused by hydropower development increases fish production at the expense of terrestrial herbivores. The fluctuations generated in wildlife and fish populations are intuitively credible, and may in part explain the trends observed in wildlife populations over the past three decades. Better calibration of the model may be achievable by invoking physical boundaries on the area modelled (such as the western Buffalo Fence), and through improved habitat preference information for wildlife species being modelled.

Keywords: Dynamic model, flood plain, Okavango Delta,vegetation

Effects of wildlife commercialization on poaching in Ngamiland District

K.Gaodirelwe[1*], M.R. Motsholapheko[1], G. Masunga1, D.L. Kgathi[1]
Okavango Research Institute, University of Botswana, P/Bag 285, Maun, Botswana
*Corresponding author: igaodirelwe@gmail.com

Abstract

Poaching is one of the major drivers of wildlife population declines around the world, including the southern African region. In Botswana, poaching is increasing leading to a reduction in the legally harvestable yields of wildlife for subsistence, commercial, cultural and recreational purposes. Few studies have attempted to measure the extent of poaching in Botswana but fell short of explaining why it increases despite many interventions to curb it. The general objective of this study is to improve the general understanding of subsistence poaching in Okavango Delta in order to contribute to policy on wildlife conservation in Botswana and beyond. Guided by the routine activities theory, this study assesses the extent and dynamics of subsistence poaching in community- and non-community-managed wildlife areas in Botswana.The specific objectives are: (a) to compare the patterns of subsistence poaching of wildlife in community and non-community-managed wildlife areas in the Okavango Delta (b) to explore the causes of subsistence poaching (c) to determine the impact of commercialisation of wildlife products on subsistence poaching(d) to examine the effect of wildlife management policies on subsistence poaching. Primary data will be obtained from a survey of 389 households, and from focus group discussions and key informant interviews. Data will be collected from Ditshiping and Khwai villages which have community-based natural resources management (CBNRM) projects, and from Tubu and Habu villages which do not have CBNRM projects. Secondary data will be derived from aerial surveysreports and existing literature. Qualitative data will be analyzed using thematic analysis, constant comparison and key-word-in-context, whereas quantitative data will be analyzed using descriptive and inferential statistics as well as measures of central tendency. The results will help in the formulation of appropriate policies for biodiversity conservation and contribute to the sustainable management of wildlife resources in the Okavango Delta and similar wetlands around the world.

Keywords: Community-based natural resources management, conservation, subsisten-cepoaching

The Socio-economic implications of wildlife crop-raiding to livelihood activities and conservation to communities living adjacent to protected areas in Botswana

P. Jibajiba[1*], J. E. Mbaiwa[1], O. T. Thakadu[1]
[1]Okavango Research Institute.P/Bag 285. Maun
*Corresponding author: poifoajibajiba@gmail.com

Abstract

Crop-raiding animals lead to food insecurity, loss of property and are a threat to human life, mainly among communities living adjacent to protected areas. This in turn becomes a challenge to wildlife conservation as the same communities perceive wildlife as a challenge to their livelihood activities. This article, guided by game theory, is aimed at assessing socio-economic options that could contribute to alternative livelihoods strategies and promote wildlife conservation among communities in Botswana. The theory helps understand why parties adopt certain positions and conditions under which they are likely to cooperate and form partnership and likelihood that optimal solutions can be found. The article largely draws from secondary data sources, past work experience and key informants to assess why different strategies employed to-date within human-wildlife conflict hot-spot areas in an attempt to addressing human-wildlife crop-raiding cases have not been very effective, as the problems persist. Previous empirical studies have suggested the need for studies such as this one, with focus on translating wildlife crop-raiding of various crops into economic loss to the farmers around protected areas and should include opportunity cost of the deterrents methods used. Though communities living adjacent to protected areas suffer socio-economic losses from wildlife and wildlife conservation, previous studies have also shown that they receive no formal benefits from living with destructive wildlife, either through tourism or through extractive use. There is therefore is need to understand human wildlife conflict and how best it could be addressed for the benefit of both livelihoods and conservation.

Keywords: Crop raiding, human wildlife conflicts, livelihoods, wildlife conservation

Investigation of the role of physical factors on fish and fisheries of the CahoraBassa reservoir, Tete (Mozambique)

J. M. Mafuca[1*]
[1]Instituto Nacional de InvestigaçãoPesqueira. P.O.Box 4603, Mao Tsé Tung Avenue No 389, Mozambique
*Corresponding author: jorgemario@sapo.mz

Abstract

The purpose of the present research was to investigate the role that physical factors play in the observed yields fluctuations on the CahoraBassa reservoir, an artificial lake which was constructed during the mid-1970s for electricity generation. Due to a short water turnover period (about nine months) this ecosystem has its resident life depend on the flooding and drawdown cycle. Thus hydrological regime (minimum, mean, maximum levels and amplitude of variation) and climatic factors (water temperature, rainfall and winds) are regarded as key to fish and fisheries fluctuations. In order to investigate existing relationships between the aforementioned factors and fish yields, historical data on fisheries statistics were obtained from IIP-database, while hydrological and climatic data were obtained from Hidrolétrica de CahoraBassa. Data from 2001 to 2013 were used for the Kapenta fishery while for the artisanal fishery data from 2008 were used. Inter – annual and seasonal variations were examined using multivariate analysis. The results indicate that the mean amplitude of water level variation plays the most important role on the observed yields fluctuations with regards to hydrological factors. Similarly, surface water temperature plays the most significant role in seasonal yields fluctuations. With the results from this study it is possible to develop a predictive model for catch and thus contribute to the management of the CahoraBassa fisheries.

Keywords: CahoraBassa, fisheries hydrological regime, Kapenta fishery

Movement ecology of lions living along the edge of cattle-dominated areas

C. Whitesell[1,2*], B. Sacks[1], C. Winterbach[2]
[1]University of California, Davis.
[2]Tau Consultants (Pty) Ltd.
*Corresponding author: cwhitesell13@gmail.com

Abstract

The African lion (Pantheraleo) is a species of conservation concern that is threatened because of increasing conflict with people. In the western Okavango Delta, Botswana, lions often move from protected areas to cattle-dominated areas, where they often kill cattle and risk being killed by farmers. Understanding the movement ecology of lions in such areas is therefore fundamental to effective lion conservation. As part of a larger project on human-lion conflict in the western Okavango Delta, in October 2013 a study was conducted using GPS satellite collars to track lions living along the periphery of Habu Village and adjacent wildlife management areas NG/26 and NG/29. Ten lions were collared, 4 of which have since been killed by farmers in retaliation for killing livestock. All 10 lions have been recorded crossing from the Wildlife Management Areas into the cattle-dominated areas. Preliminary data on the frequency of crossings into the cattle areas by these lions, the proportion of each lion's home range that is within the cattle areas, the relationship of movements into the cattle areas and seasonal cues, and the relationship between distance to cattle posts and lion movements will be presented.

Keywords: Pantheraleo, human-carnivore conflict, movement ecology

Soils, people and policy: Land resource management conundrum in the Okavango Delta, Botswana

O. D. Kolawole[1*], O. Mogobe[1], L. Magole[1]
Okavango Research Institute, University fo Botswana, Private Bag 285, Maun, Botswana
*Corresponding author: tkolawole@ori.ub.bw

Abstract

The multi-faceted aspects of natural resource governance underscore the complex nature of the subject. The intricacies associated with the skewed power relations between those who allocate these resources and those who access and use them in relation to environmental conservation make the subject a daunting one. Based on preliminary field observations and farmers' opinions on soil health conditions in their area, the paper assesses the nutrient status of selected farmers' fields in relation to how farmers and government respond to the peculiar ecological environment of the Okavango Delta of northern Botswana. It specifically analyses the perceptions of small farmers and scientists about the political ecology of soil management in the area; and determines the congruence between the opinions of Western trained soil researchers (about farmers' knowlegde and involvement in integrated soil fertility management, ISFM) and those of farmers themselves. A multi-stage sampling procedure was used to elicit quantitative and qualitative information from two groups of respondents (farmers and soil researchers) in the Delta. While 228 smallholder farmers were sampled and interviewed using interview schedules, information were obtained from 9 soil scientist/researchers through the use of questionnaires. Knowledge validation workshops, focus group discussions (FGDs) and key informant interviews were used to collect qualitative data from farmers as well. Thirty-three (33) composite soil samples were collected from 30 farmers' plots in three farming communities (Makalamabedi, Nokaneng and Mohembo) in the Okavango Delta for laboratory analysis. Although meeting points exist, farmers and scientists have divergent perspectives on soil fertility management. Laboratory analysis shows that most soils in the wetland and its dryland surroundings are generally acidic, low in essential nutients as well as in cation-exchange-capacity (CEC). While farming remains an important livelihood of rural communities, natural resource governance particularly along the river channels limit and restrict local farmers' ability to engage in meaningful integrated soil fertility management. Although results suggest the identification and use of appropriate soil ammendments and inorganic fertilizers, the low CEC is an indication that holistic cultural practices, which are beyond mere chemical fertilizations are critical and more desirable for improved soil health and sustainable rural livelihoods in the Delta and other similar wetland environments in southern Africa.

Keywords: Environment,soil fertility, ecology, policy, small farmers, scientists, perceptions, rural development.

Effects of wetland landscape changes on waterfowl population dynamics: Fuente de Piedra Lagoon (Malaga, Spain)

L.Maviza
National University of Science and Technology, Department of Environmental Science and Health, Bulawayo, Zimbabwe
Corresponding author: mavizaa@gmail.com; auther.maviza@nust.ac.zw

Abstract

Waterfowl are known to be very dependent on wetlands for various essential resources critical for their survival at various stages of their life cycle (Weller 1999; Özesmi 2001). In Fuente de Piedra lagoon, little is known about spatiotemporal changes of the landscape structure inherent to water level fluctuations and their relationship with waterfowl communities occurring thereof. In this study, the landscape was systematically hysic zed d into four distinct classes (namely deep water, shallow water, wet-muddy flat and land) using a high resolution DEM reclassified using historic water level data from 1991to 2008. The classes represented waterfowl microhabitats and these were validated using Landsat NDVI imagery for consistency. The waterfowl community was divided into four guilds (swimmers, waders, shoreliners and 'others') and then a three-level hierarchy under each guild. Spatiotemporal changes of each landscape class were quantified in FRAGSTATS and correlated with total population numbers of the waterfowl guilds to assess strength and significance of relationships and identify preferred microhabitats. Results showed that as water levels fluctuate, landscape composition also varied i.e. the areal cover of each class varied as well. Swimmers preferred deep water shown by a significant ($p< 0.001$) R of 0.523 with this class, while waders preferred shallow water. Shoreliners showed a positive correlation of 0.463 with shallow water and spatiotemporal changes in total perimeter of the wet-muddy class. The study concluded that presence of water and its temporal fluctuations were critical in determining waterfowl species abundance through influencing landscape spatial structural changes in Fuente de Piedra lagoon.

Keywords: Wetland, landscape, waterfowl ,Fuente de Piedra Lagoon

The potential role of Brycinuslateralisin seed dispersal and seed viability of Nymphaea nouchaliin a seasonal floodplain of the Okavango Delta, Botswana

M. Mmusi[1*], K. Mosepele[1], M. Murray-Hudson[1] D.Teketay[2]
[1] University of Botswana, Okavango Research Institute, Private Bag 285, Maun. Botswana
*Corresponding author: mmusimms@yahoo.com
[2] Department of Crop Science and Production, Botswana College of Agriculture

Abstract

Seed dispersal links the end of the reproductive cycle of mature plants with the establishment of their offspring, which effects vegetation structure. Birds and mammals are well known seed dispersal agents in ecology. The capacity of seeds to germinate after ingestion by frugivores is important for the population dynamics of some plant species and significant for the evolution of plant frugivoreinteractions. The potential of fish in floodplain systems as seed dispersal agents, especially borne on the seasonal flood pulse, has received little attention in plant ecology.Therefore the main aim of this study was to determine the role fish play in seed dispersal in the Okavango Delta. Experimental fishing nets were used to sample fish specimens in the study sites,where fish were then checked for the presence of seeds in their entire digestive tract. Seed viability and germination of seeds ingested by B. lateralis were then assessed through germination experiments. Results showed that B. lateralis ingest seeds of predominately Nymphaea nouchalivarcaerulea. Optimum seed germination was obtained from mid-sized fish (101-120 mm TL), suggesting that they are the best dispersers of seeds in the population. We hypothesize that gut treatment by B. lateralis improves germination success of N. nouchali seeds. Therefore, findings from this study suggest that B. lateralis is a key ecosystem engineer affecting floodplain plant population dynamics in the Delta.

Keywords: Brycinuslateralis, seed dispersal, viability, Nymphaea nouchali

Financial incentives underpinning bushmeat hunting in the western Okavango Delta

M. S. Rogan[1*], P. A. Lindsey[2], J. W. McNutt1
[1]*Botswana Predator Conservation Trust*
[2]*Lion Program, Panthera*
*Corresponding author: bushmeatproject@bpctrust.org

Abstract

Illegal bushmeat hunting threatens wildlife populations across sub-Saharan Africa. Although the Okavango Delta is ecologically and economically valuable, little research has investigated the extent and impacts of bushmeat hunting on its herbivore populations. Interviews with bushmeat hunters and randomly selected rural households were conducted to determine the status and socio-economic drivers of bushmeat hunting in the Okavango Delta. The interviews focused on hunters in six villages along the western portion of the Southern Buffalo Fence due to high rates of poaching incidents in the area. Among 76 interviewed hunters, 93% live in three of the six study villages. These three villages are highly dependent on livestock for livelihoods. Hunter households exhibited livestock ownership nearly four times greater than randomly selected households did (39.25LSU and 10.85LSU, respectively). Hunters' households were also more likely than randomly selected households to have income from outside employment (70% and 50%,respectively). Despite this income and wealth of livestock, 59% of hunters cite food security and/or the cost of legal meat as a reason for hunting. However, only 20% of hunters cite bushmeatas their most common source of protein other than milk. Results from this ongoing study provide compelling evidence that bushmeat contributes to livelihoods of those engaged in hunting, but it is not critical for most hunters' food security.

Keywords: Bushmeat, hunting, herbivore, Okavango Delta

Examining factors influencing knowledge sharing behavior in natural resources management program managers in the Okavango Delta: test of three models

O. T. Thakadu
University of Botswana/Okavango Research Institute (ORI), Private Bag 285, Maun, Botswana
*Corresponding author: othakadu@ori.ub.bw

Abstract

Effective knowledge sharing among stakeholders is one of the critical component in conservation and management of natural resources in wetland ecosystems. In order to ensure successful knowledge sharing, it is necessary to understand factors that will promote knowledge diffusion among stakeholders. Several models and theories have guided studies and interventions in diffusion of innovations or knowledge sharing for social change, e.g., diffusion of innovations, responsible environment behavior, theory of reasoned action and its cognate, theory of planned behavior. However, the use of these models to understand knowledge translation behaviors has not been without challenges, resulting in suggestions for more elaborate models that may better explain knowledge sharing behaviors. Against this backdrop, an extended integrative model was conceptualized to guide a quasi-experimental study investigating relative contribution of selected antecedents of knowledge sharing behavior among 120 community based natural resources management program managers in the Okavango delta. Subjects were exposed to two experimental treatments, after which they completed a retrospective pretest instrument. This article presents the results of a conceptualized model and other two post hoc models evaluated. In all three models, attitudes remained the most important predictor of knowledge sharing behavior (β = -.39, -.34,-.29) while issue and skill knowledge were the only significant predictors among the four knowledge sub-constructs, with skill knowledge being of greatest import (β = .19 -.24). The findings demonstrate that knowledge sharing interventions will benefit most from interventions that targets people's attitudes towards knowledge sharing and gives people basic understanding of a requisite environmental issue, coupled by skills to addressing the required action to avoiding the adverse effects. Implications for future practice of knowledge sharing interventions and research are discussed.

Keywords: CBNRM, diffusion of innovations, knowledge sharing, knowledge sharing behavior, Okavango Delta

African wild dog diets patterns and seasonal ungulate prey densities in Vumbura and Linyanti-Selinda Areas of northern Botswana

B. Tshimologo[1, 2*], M. C. Bonyongo[1, 3], R. P. Reading[4], L. P. Rutina1 G. Maude[2, 4] K. Collins[5.]
[1]Okavango Research Institute, University of Botswana.Maun. Botswana
*Corresponding author: boti1986@gmail.com
[2] Kalahari Research and Conservation. Maun
[3]Southern African Science Service Climate Change and Adaptive Land Management, (SASSCAL), Ministry of Environment, Wildlife and Tourism, Department of Meteorological Services. Gaborone, Botswana.
[4]Denver Zoological Foundation, Department of Conservation Biology. Denver, Co. USA
[5]Okavango Wilderness Safaris, Maun. Botswana.

Abstract

Large carnivore diets are difficult to quantify in most open vast natural systems. African wild dog diets in northern Botswana have not been well studied in recent history. Dietary patterns of African wild dog in Vumbura and Linyanti–Selinda regions, in northern Botswana were studied. The densities of potential wild dog prey ungulate were estimated using distance sampling techniques. Scat analysis and direct observations of wild dog kills were used to analyze the dietary characteristics. Pianka and Levin's indices were used to compare dietary overlaps and niche breadths of the wild dog packs in these sub-populations. The density of impala was higher than that of medium and large size ungulates in both study sites. Prey preference was tested using Jacob's index. Wild dog diets in Vumbura showed significant overlaps with that of wild dogs in Linyanti–Selinda sub-population. There was no significant difference in the seasonal dietary composition of wild dogs in both regions. Impala was the most common prey species but other medium sized ungulates were widely preferred by wild dogs. This finding is similar to that of other studies from other southern African reserves. Literature suggests that the Okavango Delta and Linyanti-Kwando Rivers systems have a hydro- geological connection; and the findings of the present study suggestan ecological resemblance, shown here by wild dog dietary similarities. Hence it is imperative for conservationist to adopt a wider ecosystem management approach to solve conservation problems of highly mobile and spatially demanding large carnivores.

Keywords: Diets, impala, ungulates, preference

Distribution of large carnivores in northern Botswana: The influence of herbivore abundance

L. Rutina[1] , K. Bachobeli[2]
1Okavango Research Institute, University of Botswana
[2]Department of Lands, Botswana
Corresponding author: lprutina@ori.ub.bw

Abstract

A significant positive relationship between densities of carnivores and biomass of their preferred wild prey has been observed, and this relationship has been suggested to be influenced by spatial and temporal availability of surface water especially during the dry season when seasonal pools are dry. We conducted carnivore spoor surveys in eight habitat types in northern Botswana from 2004 to 2008 to determine the abundance and distribution of large carnivores and their preferred wild prey species. We found that both the density and distribution of large carnivores and their preferred prey species differed among the habitats ($P < 0.05$ for all comparisons). Generally, the densities of large carnivore and their preferred species were higher in wetlands habitats than in dryland habitats. However the distribution patterns of large carnivores were not habitat specific. Lion and hyena had the highest density in all habitats ($P < 0.05$ for all habitats), followed by leopard, wilddog and least was for cheetah. The densities of preferred wild prey were higher for lion and hyena followed by leopard and cheetah and least for wilddog. Lion spoors were observed in 74% of the surveyed transects, followed by hyena (52%) leopard (34%), wilddog (11%) and Cheetah (10%). Controlling for stratum and carnivore species, the density of preferred prey was positively correlated with carnivore distribution ($P = 0.042$), but not with carnivore density ($P = 0.180$). The results suggest that preferred prey species are important for the abundance and distribution of the dominant large carnivores (lion and hyena), but only for the distribution of sub-ordinate species like wild dog and cheetah.

Keywords: Carnivores, livestock predation, wild dog, wildlife biomass, wild prey,

The potential importance of agricultural landscapes in carnivore conservation

L. Rutina[1*], K. Mogwera[1]
Okavango Research Institute, University of Botswana, Private Bag 285.Maun. Botswana
*Corresponding author: lprutina@ori.ub.bw

Abstract

Over the past 10 years southern African governments have been engaged in creating Trans Frontier Conservation Areas, consisting of mosaic of different land uses. Within this mosaic agricultural landscapes play an important role as habitat and corridors for wide-ranging wildlife such as large carnivores because the sizes of most protected wildlife areas are not large enough to adequately accommodate their home ranges. In particular, less competitive and endangered species are expected to use agricultural landscapes to avoid competition with dominant species. In this study we examined the potential of three agricultural landscape in northern Botswana in promoting co-occurrence among three sympatric carnivores; lion, leopard and wilddog. The three landscapes had different wildlife/livestock ratios and acts as corridors between protected areas in Northern Botswana and other Kavango-Zambezi Trans Frontier Conservation Area (KAZA TFCA). We used confirmed cases of livestock predation by these carnivores as a measure of their distribution and relative abundance. We calculated multidimensional niche overlap with two axes (location of predation and livestock predated upon). The results showed that in all agricultural landscapes niche overlap between lion-leopard and lion-wilddog were low ($P < 0.001$ for all pairwise comparisons), suggesting potential co-occurrence of lion and the other subordinate carnivores in these areas. Niche overlap between leopard-wilddog was relatively higher ($P < 0.01$ for all pairwise comparisons) and increasing with decreasing wildlife/livestock ratio. Leopard and wilddog significantly shared the location of predation and the prey preyed upon near wildlife areas ($P = 0.002$) and had low location (range) niche overlap far from wildlife areas, suggesting potential co-occurrence far from wildlife areas. The study suggests that the three species can co-occur in agricultural landscapes. However, it is recommended that studies to determine the utilization of wild prey by these carnivores be conducted to compare with livestock predation.

Red lechwe (Kobus lecheleche) population dynamics in two wetlands habitats of Linyanti-Chobe Floodplains, northern Botswana

P. Gadimang[1,2*] , G. S. Masunga[1]
[1]Okavango Research Institute, University of Botswana, Private Bag 285, Maun. Botswana
*Corresponding author: pggadimang@gmail.com
[2]Department of Wildlife & National Parks, Kasane, Botswana

Abstract

This study was conducted to determine differences in population sizes, age structure and sex ratios of the semi-aquatic red lechwe (Kobus lecheleche) antelope between two floodplain habitats of Linyanti-Chobe Floodplains differing in disturbance threats from humans and flooding regimes. The Linyanti swamps represented a relatively un-degraded habitat while Chobe floodplains represented a degraded habitat. Linyanti swamps are characterized by a dense and widespread distribution of aquatic reeds, vast water-filled floodplains and little tourism while Chobe floodplains are characterized by heavily grazed short-grasses, perennial Chobe River, intense tourism and floodplains which flood only on seasonal basis. A series of ground surveys were done during the dry season alongside the floodplains in both habitats. Results showed a higher population size of 104 lechwe, a male to female ratio of 1:1.6 and 56% of the adult proportion in the population in Linyanti as compared to 47 lechwe, a male to female ratio of 1:4, and 87% adult proportion in Chobe. As the dry season intensified and floods receded the lechwe in Chobe became localized to a few water-pools and the trailing end of the Chobe River while in Linyanti the lechwe were consistently widespread within the vast water-filled floodplains. Results suggest that red lechwe prosper in permanently flooded wetlands with minimal degradation compared to the degraded ones where tourism is also intense. For sustainable conservation of the red lechwe efforts should be directed at minimizing degradation and human disturbances which may exacerbate effects of climate change on this highly vulnerable semi-aquatic wildlife.

Keywords: Chobe, degradation, floodplain, Linyanti, population structure, red lechwe, resource availability, wetlands

Patterns of carnivores' predation on livestock in Makgadikgadi Agricultural landscape

E. Seonyatseng[1*], K. Mogwera[2], L. Rutina[2] , C. Mpofu[1]
[1]Department of Wildlife and Parks
[2]Okavango Research Institute, University of Botswana.Maun. Botswana

Abstract

Coexistence between large predators and pastoralists within the same geographic location has resulted in prevalent conflicts due to livestock depredations worldwide. This presentschallenges to conservation and concerns to local communities'livelihoods. This study aims to identify future risk areas for livestock depredation at cattle post level, based on past incidents.It wasconducted in cattle posts located in close proximity to the eastern side of Makgadikgadi and Nxai National Parks, Botswana. Spoor counts, aerial counts and Problem animal reports were analyzed to comprehend the association between incidents of predation on livestock and the ecology of predators and their prey at each cattle post. Preliminary results indicate that some cattle post are affected by livestock depredation than others. Livestock depredation occurs throughout the seasons with variation in the intensity during the dry and the wet seasons. Predation on livestock is relatively intense during the dry season when the preferred wild prey has migrated to more reliable water sources, leaving livestock in abundance and eventual secondary prey to carnivores. Distance of carnivores to the nearest cattle post and livestock has been found to influence risk of predation. On the other distance of cattle post to the national parks also play a significant role on the probability of attacks. High numbers of livestock compared to wild prey, and predator distribution and abundance within the cattle posts have indicated to positively associate with number of livestock depredation incidents. However predation pattern varies for each carnivore species and type of livestock.

Keywords: Agriculture, carnivores, human wildlife conflicts livestock, Makgadikgadi,

Wildlife abundance and diversity as indicators of tourism potential in northern Botswana

C. W. Winterbach[1,2*], C. Whitesell[2], M. J. Somers [1,3]
[1]Centre for Wildlife Management, University of Pretoria, Private Bag X20 Hatfield, Pretoria 0028, South Africa
*Corresponding author: tauconsultants@gmail.com
[2]Tau Consultants (Pty) Ltd, Maun, Botswana.
[3]Centre for Invasion Biology, University of Pretoria, Pretoria 0028, South Africa.

Abstract

Wildlife tourism can provide economic incentives for conservation. Due to the abundance of wildlife and the presence of charismatic species some areas are better suited to wildlife tourism. Thefirst objective was to develop criteria based on wildlife abundance and diversity to evaluate tourism potential in the Northern Conservation Zone of Botswana. Secondly,tourism experiences were quantified and compared in areas with high and low tourism potential. Aerial survey data were used to estimate wildlife biomass and diversity while data from ground surveys quantified the tourist experience. Areas used for High Paying Low Volume tourism had significantly higher mean wildlife biomass and wildlife diversity than the areas avoided for this type of tourism. Only 22% of the Northern Conservation Zone has intermediate to high tourism potential. Two study sites in low tourism potential areas had significantly less wildlife sightings and smaller varieties of species than the two study sites with high tourism potential. Even Low Paying tourism may not be economically viable in concessions that lack areas with intermediate to high tourism potential. Although the largest part of the Northern Conservation Zone has low tourism potential, the whole zone has a high conservation value. Alternative conservation strategies should be developed to complement the economic incentive provided by wildlife-based tourism in Botswana.

Keywords: Conservation, wildlife abundance wildlife based-tourism,

The ECOEXIST Project – Finding solutions to human-elephant conflict by connecting science with policy

M. Songhurst[1*], G. McCulloch1, A. Stronza[2],
[1]ECOEXIST Project. P.O. Box HA122HAK Maun, Botswana
*Corresponding author: anna.songhurst@hotmail.com
[2]Texas A&M University. Texas. USA

Abstract

The Ecoexist projectis a five-year program aimed at reducing human-elephant conflicts (HEC) and fostering coexistence. In areas of heightened competition for access to water, food, and space, the Ecoexist Project aims to find and facilitate solutions that work for both species. Moving from conflict to coexistence requires a number of focused, integrated management tools and strategies that provide short and long-term solutions. Aholistic approach includes working with famers to develop and deploy effective tools for deterring elephants from crop-raiding; facilitating land use planning in collaboration with government land boards and local communities; leading agricultural The experiment and innovation; facilitating tourism and micro-enterprise development so local communities can benefit from sharing space with elephants; and conducting applied, multidisciplinary research with a team of local and international students.The overarching goal is to create an enabling environment for policies and on-the-ground programs and incentives to reduce HEC. The project'sstrategies are, therefore, evidence-based and designed and carried out in close collaboration with all stakeholders, in a participatory way. Science andpolicy were linked, supporting informed decision-making through our research and field based evidence. In doing so, the existing work of government agencies, local communities, regional stakeholders, and the private sector are strengthened by facilitating collaboration, communication, capacity building, and information exchange. Full stakeholder participation is a key component of this approach and is, a key component of our policy decision support strategy, facilitating the transferal of key research findings and practical lessons learnt in the field to policy makers.

Keywords: ECOEXIST, human-elephant co-existence, policy

Farmer-African wild dog relations in the Kalahari, Botswana

V-L. Fraser-Celin[1*], A. Hovorka[2], G. Maude[3], M. Hovorka[4]
[1]University of Guelph, Canada
*Corresponding author: vfraserc@uoguelph.ca
[2]Queen's University, Canada
[3]Kalahari Research and Conservation Botswana
[4]Environment. Canada

Abstract

In Botswana, farmer-wild dog conflict most commonly occurs because of livestock depredation, especially of cattle that represent a vital source of socio-economic livelihood and ungulates stocked for hunting and photographic safaris. Conflict with farmers poses a significant challenge for wild dog conservation and documenting attitudes and experiences is an important step to unearthing the meaning and consequences of conflict scenarios, and ultimately designing conservation strategies relevant to the context at hand. The objective of the research was to document local people's perceptions of, value of, and experiences with wild dogs, as well as their insights on wild dog impacts in the eastern Kalahari region of Botswana using an ethnographic approach. This approach uses both quantitative and qualitative data aimed at eliciting people's encounters with and stories of wild dogs, more so than the often administered quantitative surveys that "may miss much of the complex and sometimes ambivalent ways in which local people think about, and relate with, wildlife" (Goldman et al., 2010, p.333). Eighty smallholder farmers, herders, commercial cattle, and game farmers were interviewed in two study sites (Boteti and Kweneng East) from May through July 2013. Results indicate that farmers are predominately negative toward wild dogs and that overall perception of, value of, and experiences with wild dogs are influenced by socioeconomic status and spatial circumstances. Some positive and nuanced perspectives were expressed as well. The research is expected to provide a baseline of farmer-wild dog relations in this understudied area to build upon existing research on Botswana wild dogs in the Okavango Delta, the Ghanzi area in western Kalahari, the Hainaveldt and Samedupi area in northern Kalahari, the Central Kalahari Game Reserve, and the Khutse Game Reserve. Moreover, the research is expected to generate insights on the nature and impact of farmer-wild dog encounters outside of national park boundaries, and to inform conservation efforts and conflict mitigation strategies.

Keywords: Attitudes, Botswana, conflicts, Kalahari, wild dog

Listing the Okavango Delta as World Heritage Site: Implications for socio-cultural and economic activities of resident communities

J. E. Mbaiwa
Okavango Research Institute. University of Botswana. Maun. Botswana
Corresponding author: jmbaiwa@ori.ub.bw

Abstract

The Okavango Delta, located in north-western Botswana was listed as the 1000th World Heritage Site (WHS) in Doha, Qatar in June 2014. This is Botswana's second WHS after Tsodilo Hills which was listed in 2001. The objective of this paper therefore is to analyze implications for listing the Okavango Delta as a WHS on the socio-cultural and economic activities of local communities in the wetland. The paper uses secondary data sources which include the 1972 Convention on WHS, published and unpublished literature on WHS in Botswana and outside Botswana. Results indicate that the Okavango Delta is home to 142,000 people who belong to various ethnic groups. Over 90% of these people directly or indirectly depend on resources found in the Okavango Delta to sustain their livelihoods. The rich wildlife diversity, permanent water resources, rich grasslands and forests and scenic landscapes of the Okavango Delta which are now the listed as a WHS will result in increased international tourism development in the wetland. The increase in tourism development will result in more employment opportunities and opportunities for the tourism business for local people. Listing of the Okavango Delta is expected to increase conservation of the wetland by all stakeholders, namely local people, government, and private tourism sector. Instead of creating a disturbance of the livelihoods options of resident communities, the listing of the Okavango Delta as a WHS is expected to increase such opportunities. It is from this perspective that the Listing of Okavango Delta as a WHS is expected to bring about the sustainable socio-cultural, economic and conservation of the wetland.

Keywords: Listing, Okavango Delta, socio-cultural and economic activities,World Heritage Site, 1972 World Convention on World Heritage Sites,.

Towards the bio-boundary: Pair-specific scents in African wild dogs, Lycaonpictus, and an example of a potential method to identify signals within complex mixtures

N. R. Jordan[1,2,3*], P. J. Apps[4], K. A. Golabek[1,5], J. W. McNutt[1]
[1]Botswana Predator Conservation Trust, Private Bag 13, Maun, Botswana
[2]Centre for Ecosystem Science, School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney NSW 2052, Australia
[3]Taronga Conservation Society Australia, Taronga Western Plains Zoo, Wildlife Reproduction Centre, Dubbo, NSW 2830, Australia.
[4]Paul G. Allen Family Foundation Laboratory for Wildlife Chemistry, Botswana Predator Conservation Trust, Maun, Botswana
[5]Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, UK
*Corresponding author: neilrjordan@gmail.com

Abstract

The African wild dog bio-boundary project investigates and manipulates the scent-marks of this endangered species with the aim of reducing human-wildlife conflict. Several hundred volatile components have so far been identified from the urine of African wild dogs, but which of these, if any, have active roles in the communication of territory residence is currently unknown, and identifying the specific signaling components within these complex chemical mixtures is a significant challenge. However, observations of scent marking behaviors of African wild dogs strongly suggest that dominant urine overmarks (DUO's) – where one member of a pair deposits urine on the urine of its partner – are the most likely source of such signals. Multivariate statistics were used to investigate > 990 separated chemical components found in these DUO's, and found as few as 10 components that together enabled statistical discrimination of specific dominant pairs. Further experimental work in the field will confirm whether these components are among the most important ingredients of our wild dog bioboundary. More broadly, it issuggested that this statistical method may be applied across communication systems to locate components of signals within complex 'mixtures'.

Keywords: African wild dog, bio-boundary, Lycaonpictus,scents

Patterns in prey choice in the large predator guild and the impact of environmental change in these hunting habits

K. A. Golabek[1,2*],J. W. McNutt1
[1]Botswana Predator Conservation Trust, Private Bag 13, Maun, Botswana
[2]Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, UK
*Corresponding author: krystyna.golabek@zoo.ox.ac.uk

Abstract

The prey choice of four large carnivores, African lion, cheetah, wild dog and leopard, from overlapping ranges were compared over time and across seasons to look for patterns in prey choice and plasticity. It wasfound as in other studies that in the Okavango delta African wild dog, cheetah and leopard all hysic zed in one prey species, the common impala Aepycerosmelampus making up 80%, 73% and 73% of their diet respectively. Wild dog and cheetah ate the fewest different prey species (n= 5 & 8 respectively), whereas the leopard showed the greatest plactisity, of n=15 prey species. The lion however showed the greatest diversity in prey choice and considerable patterns across the seasons, compared to the other three predator who showed no seasonal patterns in prey choice. Seasons where defined as the key drivers of herbivore migration, the wet-rainy season, the early flood (cold and dry) and the late flood (hot and dry) periods that typify the Okavango system. It was found that lion prey do vary across the seasons showing greater selection for impala in the wet seasons than expected by chance and more zebra in the late flood – dry season than expected by chance. Small preys, largely warthog, are most popular in the early flood. These patterns could largely be explained by the movement of zebra in and out of the region, a prey species to score high on the prey preference, Jacobs index. Patterns in lion sub-group size correspond with this, in that sub-group sizes are greater in the dry periods (2-3 individuals) rather than the more typical one lion in the rainy season.

Keywords: African lion, hunting, impala, large predator, prey

Carnivore distribution in relation to livestock grazing areas in the Makgadikgadi ecosystem

C. Mpofu[1], K. Mogwera[2], L. Rutina[2] , E. Seonyatseng[1]
[1]Department of Wildlife and National Parks
[2]Okavango Research Institute.University of Botswana.Maun. Botswana

Abstract

The decline and extinction of carnivores is one of the most persistent human impacts on ecosystems leading to most being currently threatened. It reported that the major causes of this decline includes changes in land-use practices, habitat loss and fragmentation, human persecution, declines in natural prey, and increased competition within carnivore guilds.In order to conserve and manage carnivore populations, demographic data are essential. However, due to their ecological hysic z, it is usually difficult to effective collection of these data. Track counts were used to map distribution of carnivores in relation to livestock grazing, protected areas, wild prey and livestock in the Makgadikgadi ecosystem. The results of the study showed that lions and leopard interaction less with livestock grazing areas. Lions were more distributed within 10 kilometres of protected areas during the dry season and move further from protected areas during the wet season. Contrary, leopards' spoors were distributed far from protected areas for all seasons. Spotted hyena, cheetah and wild dog spoor were distributed throughout the livestock grazing areas for both seasons. The results shows that lion while lion are the most reported problem carnivore in the area, they avoided livestock grazing areas. The implications for carnivore conservation and conflict reduction are discussed.

Keywords: Carnivore, ecosystem, livestock, Makgadikgadi,

Predicting spatio-temporal distribution of human-carnivore conflict in response to environmental factors in Makgadikgadi agro-ecosystem, Northern Botswana

K. Mogwera[1*], L. Rutina[1], O. T. Thakadu[1]
Okavango Research Institute, University of Botswana.Maun. Botswana
*Corresponding author: kmogwera@gmail.com

Abstract

Coexistence between large carnivores, pastoralists and their livestock around the world has resulted in prevalent human-carnivore conflicts especially due to livestock depredation. This presents challenges to conservation and concerns to local communities' livelihoods especially near wildlife protected areas. Large carnivores require large home ranges to meet their dietary requirements, however, most protected wildlife areas are not large enough to adequately accommodate them, leaving adjacent agricultural landscapes as important habitat. Small-scale farming is a major livelihood activity to rural communities and resources as livestock are of high value. Livestock farmers usually respond to direct or perceived carnivore damage by lethal action that often involves non-conflict species, thus hampering conservation efforts. It is suggested that predation on livestock is not random but rather occurs in areas with consistent set of natural and human environmental characteristics that influence livestock depredation. However, environmental predictors in Botswana are understudied and rarely considered in conflict mitigation. This paper aims to model how vegetation productivity, land cover, abundance of prey species (domestic and wild) and distance of cattle post to protected areas influence predation by lion, leopard and wilddogs. Satellite imagery was used to derive vegetation cover and Normalized Difference Vegetation Index as a measure of vegetation productivity. Spoor counts and prey counts along line transects were used to determine carnivore and prey abundance respectively. Coordinates for each cattle post were recorded via handheld Geographic Positioning System device to determine their distance to national park. The results were used to map potential carnivore predation risk areas.

Keywords: Agro-ecosystem, human-carnivore conflict, livestock, Makgadikgadi, predators

LOCATE: Locomotion, hunting and habitat hysic zed among large African carnivores and their prey

N.Wilson
The Royal Veterinary College, University of London, Hatfield, Herts, AL9 7TA, UK
Corresponding author: awilson@rvc.ac.uk

Abstract

This study discusses factors that define how fast an animal moves when ranging and hunting. Solar powered tracking collars containing high accuracy GPS and inertial sensors were developedfor this work. Data from these collars is presented as well as demonstrating the potential the collars have for enabling novel science. Ranging is undertaken at energetically optimum speeds and gaits, however speed during coursing and hunting is determined by the hunt strategy and factors other than energetics come into play. For instance, cheetahs (Acinonyxjubatus) rarely gallop at their maximum speed when hunting, rather they move slower so they have greater manoeuvrability and they appear to trade-off their superior high speed to get close to prey for slowing down to enable greater acceleration and turning to out-manoeuvre and capture their prey. African wild dogs (Lycaonpictus) do not use the very high turning forces or accelerations of cheetahs when capturing the same prey but are successful through having the endurance to make many hunting attempts and sharing kills. The project will be expanded to study relevant prey species and predator prey interaction in different terrains using a high resolution video camera system, survey grade camera and aerial LiDAR mounted on our small research aircraft. We collaborate closely with Botswana Predator Conservation Trust, Cheetah Conservation Botswana, Okavango Research Institute and Botswana Herbivore Research.

Keywords: Hunting, habitat utilization, LOCATE, Lycaonpictus, wild dogs

Managing the northern and Kalahari ecosystems: Same policies, same mistakes, same results

J. S. Perkins and C. Brooks
Department of Environmental Science, University of Botswana, Gaborone. Botswana
Corresponding author: perkinsjs@mopipi.ub.bw

Abstract

Manipulative management through the provision of fencing and artificial water point provision in the Northern and Kalahari ecosystems is damaging their resilience. It is a policy that has dominated the Kalahari ecosystem since the 1982-86 drought and the catastrophic decline of its key ungulate species. A similar policy response in the Northern Ecosystem of Botswana has followed concerns that declines of some of its key ungulate species may well be occurring since the return of high flows to the Okavango Delta System in 2009. This paper hysic zed the need to re-instate mobility of ungulate species over large areas by connecting up ecosystems through the provision of migratory corridors and meaningful development of CBNRM and sustainable income streams to rural livelihoods. As opportunities to establish an optimal balance between the livestock and wildlife sectors continue to be lost in both the Northern and Kalahari ecosystems, large areas in both ecosystems will continue to be hysic zed and the persistence of many ungulate species will be threatened. The financial costs associated with the effective subsidisation of the agricultural and wildlife sectors and policy attempts to overcome the ecological realities of ecosystem functioning, are wholly unsustainable, and will be fully exposed as such by climate change. The loss of key habitats and the ecosystem services they provide will continue to damage resilience and result in structural poverty amongst many rural communities who are already some of the most vulnerable in the country.

Keywords: CBNRM, Kalahari ecosystems, migratory corridors, ungulates

Chobe National Park and factors motivating or hindering conservation of the protected resources amongst the local people

B. B. T. Mosetlhi
Department of Environmental Science, University of Botswana. Gaborone. Botswana
Corresponding author: bothepha.mosetlhi@mopipi.ub.bw

Abstract

The importance of the input of local communities in conservation and the drive towards sustainability of ecosystems cannot be overemphasized. In the bid to understand factors promoting or hindering sustainable use of the Chobe River basin resources, this paper employs the social exchange theory to determine if Chobe National Park has a bearing on both the positive and negative conservation practices prevailing in the hinterland communities. In particular, it examines if the socio-economic effects of the park condition the conservation behaviors, and whether there are other underlying factors over and above the effects.Findings drawn from household surveys and in-depth interviews indicate that conservation behaviors are generally positive amongst the local communities – a state largely prompted by restrictive policy, passivity and reduced focus on environmental resources due to alternative livelihood activities,Also, though limited, the socio-economic effects of the park are shown to significantly influence the conservation behaviors. The more beneficial the socio-economic effects, the more positive the conservation behaviors. This validates the social exchange theory's contention that rewards lead to commitment to perform desired behaviors. However, over and above the socio-economic effects of the park, miscellaneous other motives are shown to be shaping the conservation behaviors in the study area. Typically, the fear of penalties of non-compliance is the key driver of positive behaviors, while determinants of negative behaviors include frustrations emanating from resource deprivation, wildlife damages and poor compensation. The paper concludes by emphasizing the need for creation of meaningful economic incentives and people oriented motives for conservation.

Keywords: Behaviours, Chobe National Park, conservation, protected resources,

Bird diversity in an elephant impacted ecosystem

M. Jenamiso[1], L. Rutina[2] and W. Makrokane[3]
[1]Geoflux, Botswana
[2]Okavango Research Institute, University of Botswana, P/Bag 285. Maun
[3]Department of Wildlife and National Parks, Gaborone, Botswana

Abstract

The ecological role played by elephants in African savannas has been of central concern to ecologists for decade. While elephant herbivory has been suggested to reduce biodiversity, it enhances biodiversity in some ecosystem. Elephants have been structuring woodlands along the Chobe Riverfront, changing them to shrublands. We investigated bird distribution in different habitat along the Chobe riverfront. We recorded 46 bird species, 18 of which were specific to close woodland, 2 to open woodland, 10 to shrubland and 5 common to all habitats. Bird diversity was high in closed woodland and less in shrubland. Bird diversity was high at low and medium elephant density and low at high elephant density. Baikiaea woodland had the highest diversity index, followed by mixed woodland; mixed shrubland and riparian woodland in descending order. Elephant density (20.97 elephants/ square kilometer) was higher in mixed shrublands, followed by riparian woodland (10.51 elephants per square kilometer), mixed woodland (8.1 elephants per square kilometer) and Baikiaea woodland had the least elephant representation, with 3.34 elephants per square kilometer. There was a negative correlation between elephant densities and avian diversity ($P < 0.05$). The results suggest that although elephants have been reported to facilitate populations of herbivores in Chobe riverfront, it might have negative influence in avian diversity. Further studies to assess the influence of elephant herbivory on avian guild structure are recommended.

Influence of land use/coveron soil physical and chemical properties in Seronga, Botswana

C. Gwatidzo*, W.R.L. Masamba & T. Mubyana-John
Okavango Research Institute, University of Botswana, P/Bag 285, Maun, Botswana
*Corresponding author : conniegwatidzo@gmail.com

Abstract

Evaluating soil properties in different land use/cover systems is necessary in determining productivity and appropriate management activities for sustainable land use. This study evaluated soil hysic-chemical properties in three adjacent land use/cover systems (woodland, fallow land and cropped land). A total of 168 soil samples were collected at the onset of rains in November 2011 and analyzed using standard methods at different soil depths. Soil moisture content ranged from 4.5±1.5% at 0-10cm in woodland to 0.4±0.3% at 20-30cm in fallow land. Soil EC was highest at 0-10cm in woodland (165±17µS/cm) and lowest at 20-30cm in fallow land (55±2µS/cm). Soil Ph ranged from slightly acidic to neutral. Woodland had the highest organic matter content at 0-10cm (0.94±0.08%) while the lowest (0.46±0.07%) was at 20-30cm under cropped land. Total N ranged from 0.04±0.02% at 10-20cm (woodland) to 0.01% at 20-30cm in woodland and fallow land. Available P ranged from 6.24±0.37mg/kg at 0-10cm in woodland to 2.26±0.05mg/kg at 20-30cm in fallow land. Exchangeable K was highest (0.31±0.04 meq/100g) in woodland and lowest (0.13±0.01meq/100g) in cropped land. The results showed that soil moisture content, EC, organic matter, total N and K differed significantly (P<0.05) with land use/cover. Land use/cover did not have a significant impact on soil Ph and available P. Overall; woodland retained high levels of soil nutrients when compared to fallow land and cropped land. The results suggested that conversion of the woodland to cropped land could result in distinct decreases in organic matter, total N and K.

Keywords: Cropped land, nitrogen, Okavango Delta, organic matter, woodland

Distribution of Cadmium, Mercury and Lead in surface and ground water along a transect in Nxaraga Island, Okavango Delta, Botswana

B.S. Keabetswe[1*], W.R.L. Masamba[1], O. Mogobe
[1]Okavango Research Institute, University of Botswana, Shorobe road, Sexaxa, P/Bag 285 Maun
*Corresponding author: bkeabetswe@ori.ub.bw

Abstract

Heavy metals are very toxic and persistent. They can concentrate and bioaccumulate in living organisms. Islands of the Okavango Delta are known to be sinks of water borne nutrients and salts but little has been done on heavy metals. This study aims to determine the distribution of the heavy metals Cd, Hg and Pb in surface and ground water of Nxaraga Island in the Delta. Twenty one samples were collected along a transect originating from surface water to groundwater located at the island center. Suspended particulate matter was also collected. Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) was used for analysis of Cd, Hg and Pb. Carbonates, bicarbonates, Ph and EC were also determined. Results show that total Cd ranged between 0.11µg/l – 0.91µg/land total Pb ranged between 5.66µg/l – 69.7µg/l and total Hg ranged between <0.01µg/l – 0.73µg/l.PHREEQC Geochemical model was used for speciation studies revealing that Cd was abundant as free Cd+2(>84%) throughout the transect while Hg was abundant as Hg (0) (>99%). Pb existed mostly as Pb+2 (98%) in surface water, and Pb(CO3)2-2 (92%) at the island center. The study shows that in Nxaraga Island, mercury concentration was high in the island center while cadmium and lead were more concentrated in the island fringe because of the dominating species of the metals along the transect.

Keywords: Heavy metals, pollution, speciation, water, wetlands

Analysis of the hydrological processes of a semi-arid region lake, the case of Lake Ngami, Botswana

E. Mosimanyana[1*], C.N Kurugundla[2], M. Murray-Hudson[1]
[1]Okavango Research Institute, University of Botswana.Department of Water Affairs, Maun, Botswana.
Corresponding author: emosimanyana@ori.ub.bw

Abstract

The water balance concept is fundamental to the study of hydrological processes. It aims at quantifying the hydrological fluxes into and out of a defined hydrological system, together with the related changes in storage. In this study, the hydrological fluxes of Lake Ngami, which is part of the Okavango Delta Ramsar Site in Botswana, are quantified on a monthly, seasonal and annual time scales using the water balance concept to inform sustainable management of the lake. The lake is a closed lake, characterized by alternating episodes of filling up and desiccation. This, together with its remote location, has rendered hydrological and meteorological monitoring around the lake almost non-existent. Existing hydrological and meteorological time series data were used to quantify inflows into and outflows from the lake. Inflows were estimated from runoff from the Okavango Delta and direct precipitation on the lake, while lake evaporation was estimated using the Hargreaves method. Satellite imagery, together with water depth measurements, were used to determine the relationship between lake surface area, lake depth and volume of water stored in the lake. The total surface area of the lake was estimated at 266.2 km2 in 2012, corresponding to 1143 million cubic meters of water. The average residence time of water in the lake was estimated using the volume of water stored in the lake and inflows. The main inflow into the lake is the discharge from the Okavango Delta, while most of the water is lost through evaporation than to groundwater recharge.

Keywords: Evaporation, Lake Ngami, residence time.Water balance

The Role of Vegetation in the Okavango Delta Silica Sink

E. Struyf[2], K. Mosimane[1*], D. van Pelt[2], M. Murray-Hudson[1], P. Meire[2], D.J. Conley[3], P. Frings[3], P. Wolski[1], M. Gondwe1, J. Schoelynck[2]
[1]Okavango Research Institute, University of Botswana, P/Bag 285, Maun, Botswana
[2]ECOBE, Antwerp University, Universiteitsplein, Antwerp, Belgium
[3]Department of Geology, Lund University, Sölvegaten 12, LUND Sweden
*Corresponding author: k.mosimane@yoo.com or kmosimane@tati.ub.bw

Abstract

It is now acknowledged that temperate wetlands play an essential role in the cycling of silica, while cycling in tropical wetlands has received virtually no attention. We investigated the distribution of biogenic silica in a tropical freshwater wetland, the Okavango Delta; Botswana. The Delta consists of a mosaic of permanent and seasonal floodplains, intersected with tree-covered islands. The islands, through evapotranspiration by riparian trees, play an essential ecological role in the Delta: they are permanent sinks for a major part of the solutes (ca. 360 000 tons annually) that enter the system, including silica. While we have a relatively good understanding of silica processing in the island sediments and soils, processing in the floodplains has never been duly quantified.We sampled topsoil from islands and floodplains and the associated vegetation, across gradients from the island center to the channel bordering the floodplain. We sampled bothseasonally (Nxaraga) and permanently (Guma) flooded eco-regions. Soil amorphous silica standing stocks were higher at close proximity to the channel and in the uppermost soil layers (top 5 cm). Floodplain vegetation in both the permanent and seasonal eco-regions contained approximately the same standing stocks of biogenic silica, between 20-100 g•m-2. The standing stocks were lower in the island vegetation, especially in the permanent eco-region.Our results show that wetland vegetation plays a key role, as short term storage, in the annual Si budget of the Okavango Delta. Most of the dissolved silica entering the permanent floodplains is cycled through wetland vegetation before transport further downstream and to the islands.

Keywords: Floodplains, Okavango Delta, Phytogenic trapping, Silica, and Tropical wetlands.

Contrasting regeneration structure of riparian tree species in different land use types in the Okavango Delta, Botswana.

G. Tsheboeng*, M. Murray-Hudson, K. Kashe
Okavango Research Institute, Private Bag 285, Maun, Botswana.
*Corresponding author: gtsheboeng@tati.ub.bw

Abstract

The regeneration status of common riparian tree species in two contrasting land use types of Moremi game reserve (Protected area) and Seronga (Communal area) in the Okavango Delta were investigated. These species were Croton megalobotrysMüll. Arg, Philenopteraviolacea(Klotzsch) Schrire, Acacia nigrescensOliv and DiospyrosmespiliformisHochst.Ex A. Dc. Height of tree individuals was estimated in 20m x 50m randomly selected plots. Individuals were assigned to >0-0.5, >0.5-1, >1-2, >2-4 and >4m regeneration classes. A total of 89 plots were sampled. Linear regression was used to infer regeneration status of each species. Paired Student's t-test was used to determine statistical difference in seedling density/ha and sapling density/ha of different species between different sites. Philenopteraviolacea showed a similar regeneration pattern of reverse J shaped in both sites. However, in Seronga it had missing individuals at 1-2m class. Diospyrosmespiliformis showed a reverse J shaped regeneration structure with missing individuals at 1-2m, 2-4m and >4m in Moremi while in Seronga it had a U shaped pattern. Croton megalobotrys showed J shaped pattern in Moremi while in Seronga it showed irregular pattern with missing height classes at 0.5-1m and 2-4m. Acacia nigrescens showed a reverse J shaped pattern in both sites. There is need to raise awareness to the Seronga community on the unstable regeneration structure of C. megalabotrys, P. violaceaand A.nigrescens to encourage them to reduce over-dependence on these species.

Keywords: Recruitment, riparian woodland, vegetation dynamics, wetlands

Land use and agriculture: political ecology of soil management in the Okavango Delta, Botswana

O. Kolawole*, O. Mogobe, L. Magole, R. Mothobi, W. Khaneguba
Okavango Research Institute, University of Botswana,Maun, Botswana
*Corresponding author: tkolawole@ori.ub.bw

Abstract

The choice between eco-toursim and farming-related livelihoods strategy in the Okavango Delta remains a contorversial issue. The need to conserve the flora and fauna in a peculiar ecological environment at the expense of traditional farming practices and other related rural livelihoods poses a rural development conundrum yet unresolved amongst stakeholders. In the poster, we present the analysis the perceptions of small farmers and scientists about the political ecology of soil management in the area. The poster also outlines farmers' knowledge and the constraints they face in enhancing soil fertility management. A multi-stage sampling procedure was used to elicit quantitative and qualitative information from two groups of respondents (farmers and soil researchers) in the Delta. While 228 farmers were sampled and interviewed using interview schedules, information were obtained from 9 soil scientist/researchers through the use of questionnaires. Knowledge validation workshops, focus group discussions (FGDs) and key informant interviews were used to collect qualitative data from farmers as well. Thirty-three (33) composite soil samples taken at 300mm soil depth level were collected from 30 farmers' plots in three farming communities in the panhandle, mid-Delta and the distal area (Makalamabedi, Nokaneng and Mohembo) in the Okavango Delta for laboratory analysis. Graphical representations and analysis of variance (ANOVA) were then used to show the differences in soil chemical compositions and nutrient constutients in the three geographical locations within the Delta. Although meeting points exist, farmers and scientists have divergent perspectives on soil fertility management. Laboratory analysis shows that most soils in the wetland and its dryland surroundings are generally acidic, low in essential nutients as well as in cation-exchange-capacity (CEC). Although results partly suggest the identification and use of appropriate soil ammendments and inorganic fertilizers, the low CEC is an indication that holistic cultural practices, which are beyond mere chemical fertilizations are critical and more desirable for improved soil health and sustainable rural livelihoods in the Delta and other similar wetland environments in southern Africa.

Keywords: Ecology, environment,land use,policy, scientists, perceptions, small farmers, soil fertility, rural development.

OBIS – An integrated environmental data management system for the Okavango River Basin

S. Kralisch[1], F. Zander[1], M. Dhliwayo[2*], W. Masamba[2], W-A. Flügel[1] , C. Kabomo[2]
1Institute of Geography, Geographic Information Science Group.1University of Jena, Germany,
[2]Okavango Research Institute, University of Botswana, Maun, Botswana
*Corresponding author: mdhliwayo@ori.ub.bw

Abstract

Sustainable land and resource management and related interdisciplinary research projects like The Future Okavango (TFO) demand for integrated data management systems to store, describe, analyze and disseminate related information. These systems should not only take account of the possibly large range of varying data types and formats, but also have to consider different user groups and the demand for collaborative data access and data sharing.Within TFO these requirements are addressed with the development of the Okavango Basin Information System (OBIS). OBIS is designed as a web-based data management and analysis platform with full read/write access to all data, using open software and open standards whenever possible. This poster briefly describes OBIS, its functions and interfaces, and gives an overview of the types data already stored in the system.

Keywords: OBIS, data management, Okavango River Basin

A social and gender analysis of community knowledge of climatic risk impacts on and adaptation strategies to malaria and schistosomiasis in the Okavango Delta, Botswana

B N Ngwenya[1*], M. R. Motsholapheko[1], L Magole[1], D Maphane[1] K Malela[1]
[1]Okavango Research Institute, University of Botswana. Maun Botswana
*Corresponding author: bntombi@ori.ub.bw

Abstract

Climate projections in southern Africa suggest that variability is likely to increase in the future and extreme events might become more frequent. Understanding people's knowledge and practices regarding how they link climatic variability impacts and changing disease patterns within and across social groups is important in order to develop appropriate intervention strategies. The presentation focuses on impacts of climate risk variables (rainfall, floods, temperature stress and drought and shifting seasons) on VBD Okavango Delta communities in north western Botswana. Data from four focus group discussion (FGD) collected during one week Participatory Rural Appraisal workshop and Key informants interviews in Ngarange and Shakawe villages in north western Botswana were analysed. Findings indicate that Key informants respondents described their understanding/experiences of the climatic change phenomenon (phetogoyaluapi) in terms of changing cosmology conditions using specific indicators to refer to the phenomenon. These included high temperatures, 'hot summers' and 'warm' winters, increased/decreased/unpredictable rainfall, and changing human and animal disease patterns. PRA focus group participants were able to establish the direction of the impact and the extent (positive/negative) with regard to specific climatic risks and effect on vector abundance (snails and mosquitos) and diseases incidences. Community perceived poor public health education and community awareness, especially bilharzia in relation to lack of screening services, poor adaptation strategies because more resources were channeled towards HIV/AIDS campaigns. The male and female only groups ranked disease problems, causality and adaptation strategies differently. These differences have implications for policy and efficacy of program interventions.

Keywords: Bilharzias, climatic variability, gender, malaria, schistosomiasis

Mapping inundation extent, frequency and duration in the Okavango Delta from MODIS images

K. Thito[1*], P.Wolski[2], M. Murray-Hudson[1].
[1]University of Botswana, Okavango Research Institute, Private Bag 285, Maun, Botswana.
[2]University of Capetown, Climate System Analysis Group, Private X3,
Roundbousch 7701, South Africa.
*Corresponding author: kgalalelothito@yahoo.com

Abstract

The frequency and duration of inundation are important for a variety of applications such as early warning, water resource management, floodplain mapping and habitat restoration. The Okavango Delta; the 5th largest Ramsar site in the world has experienced series of large floods since 2007, following the much lower flooding of the 1990s and early 2000s. This study aims at establishing the inundation frequency and duration maps of the Okavango Delta for the years 2001 to 2012 using MOD09Q1 and MOD11A1 datasets. A method based on time-varying threshold derived from bimodal histogram was used to classify the maps into inundated and/or non-inundated area. The method relies on the difference in reflectance between water bodies and dry or vegetated soil, with the former having low reflectance, while the latter displaying higher reflectance values, and takes into account seasonal change in these reflectances. Inundation maps showed a gradual decrease from 2001-2003 and a gradual increase from 2004-2012 in the Detla's maximum annual inundation extent, with maximum inundation extent in the years 2010, 2011 and 2012 in the month of September. MODIS imagery may assist in making accurate flood predictions which will be beneficial for both the Molapo farmers and surrounding community.

Keywords: Hydroperiod, land-water discrimination, MODIS, Okavango Delta

Commitment to public access and sustainable utilization of PSUB collection data.

Joseph Madome*, Frances Murray-Hudson, Keotshepile Kashe
Okavango Research Institute, University of Botswana, P/ Bag 285, Maun, Botswana
Te. (+267 681833 Direct line +267 6867257
*Corresponding author: madome@ori.ub.bw

Abstract

The Peter Smith University of Botswana (PSUB) herbarium of the Okavango Research Institute houses well over 13 000 specimens representing over 1 700 species from in and around the Okavango Delta, a World Heritage site. The main purpose of the collection is to support botanical research of this unique habitat. Sharing and facilitating access to information is central for maintaining the relevance of the herbarium to ORI's mission of undertaking engaged wetland research and training on wetland ecosystems. Here we indicate PSUB's commitment to facilitating access and sustainable utilization of the PSUB collection. We highlight the availability of a checklist of all the plants housed in PSUB and their respective taxa, use and benefits of the adopted Botanical Research and Herbarium Management System (BRAHMS) database and ongoing digitization of the P.A Smith collection specimens. The targeted scanning of the collection through the Herbscan and the high resolution images generated that contribute to the PSUB Virtual herbarium linkable to P.A Smith annotated maps legacy housed in the ORI library. The BRAHMS database and the virtual herbarium information will be accessible through the Okavango Delta Information System (ODIS) and Okavango Basin Information System (OBIS) websites.

Key words: Herbarium, Okavango Delta Information System, species collection

Household access to water resources, and vulnerability to malaria and bilharzia in the Okavango Delta, Botswana

M.R. Motsholapheko*, B.N. Ngwenya
University of Botswana, Okavango Research Institute, Private Bag 285, Maun, Botswana
*Corresponding author email: rmoseki@ori.ub.bw

Abstract

In wetlands of most developing countries, rural households contend with the challenges of access to natural resources and endemic vector- and water-borne diseases. There is a need to understand household vulnerabilities to these diseases in order to improve ways for prevention and treatment.This study assesses household access to water resources, and vulnerability to malaria and bilharzia in the Okavango Delta, Botswana. It determines: a) household access to water resources in Shakawe and Ngarange villages in the Okavango Delta, b) the effects of seasonal variations on household livelihood activities, c) household vulnerability to malaria and bilharzia, and d) the effect of institutional factors on household vulnerability to these diseases. Secondary data will be collected from published and unpublished reports. Primary data will be obtained from a cross-sectional survey of 367 households, interviews with 20 key informants, PRA-based focus group discussions (FDGs), interviews with experts in various fields, and PRA workshop participant interviews. Quantitative data will be analysed using measures of central tendency, dispersion and inferential statistics. Qualitative data will be analysed using key-word-in-context and content analysis. Preliminary results from the FGDs and some key informants indicate that malaria mostly affects pregnant women, commercial fishers, reed and grass harvesters, hook and line fishers and under-five children. Bilharzia mainly affects primary school children who engage in swimming in the river. There is a relationship between engagement in water-based livelihood activities, the social group involved and exposure to malaria and schistosomiasis in the Okavango Delta. There is a need to further determine the overall effect of this vulnerability in the Okavango Delta and similar wetlands.

Keywords: Vulnerability, water- and vector-borne diseases, wetlands.

Farmers' perceptions on the influence of the erection of the Makgadikgadi electric fence and the flowing Boteti River on the spatio-temporal distribution of human lion conflict

K. Ngaka[1,2], L. Rutina1, G. Maude[2], G. Hemson[3]
[1]Okavango Research Institute, Private Bag 285, Maun, Botswana
[2]CKGR Research Group, P.O. Box HA 33 HAK, Maun, Botswana
Corresponding author: botetilion@gmail.com

Abstract

People and wild animals' life is basically dictated by the habitat in-which they live in. Some of the habitats such as wetlands can be rich in terms of the necessary resources like water, and fertile soils therefore favouring different activities which people can practice for a living. Such resources end up being a pull factor for both people and wild animals therefore leading to their direct contact between the two which could result into human wildlife conflict (HWC). Additionally, mitigation measures (e.g. barriers) which could be in-place to eradicate/reduce the conflict can also influence this interaction. Furthermore the interaction outcomes can influence how people perceive such interactions. These people's perceptions can therefore be positive or negative. In the Boteti River area, along Makgadikgadi Pans National Park (MPNP) most farmers are located within a 6km range to access water from the river for various activities such as ploughing, and providing the water to livestock. The aim of this study was to assess the farmers' perceptions on how the Okavango floods might affect the human lion conflict along the Boteti River. The study assessed the perceived conflict level, and other possible factors. Semi-structured interviews were conducted with the farmers along the Boteti River area. The questions were asked in such a way that will encompass all the periods which the two factors (electric-fence, and river-flow) were either active or not; Before fence (BF):- when the electric-fence was not active, and river not flowing; After fence (AF):- when the fence was intact but the river not flowing; River flowing (RF):- when the river was flowing but the fence being partially permeable. Cattleposts were grouped into four blocks; North, North-central, South-central, and South. Most farmers indicated that the conflict situation was worse before fence-erection and river-flow, and better after fence-erection , but becoming worse again during RF period. In most cases people who have direct interactions with certain resources are not involved in decision making process.

Wildlife and livestock activities in Chobe Enclave, Botswana

N. Matomela[1] , L. Rutina[2]
[1]Department of Environmental Science, University of Botswana. Gaborone.
[2]Okavango Research Institute, University of Botswana

Abstract

Land use conflict between human and wildlife is an increasing problem around the world mainly due to poor or lack of land use zoning. In Chobe Enclave in Northern Botswana a land use management plan which proposed improved land use and land zoning was adopted by the communities. The plan advocated forb improved land use achieved through zoning based on the integration of economic, ecological and social values of the communities developed through participation of stakeholders. We analyze human and wildlife activities in different land use zone and how they were affected by vegetation productivity in Chobe Enclave, Botswana. We found that that both wildlife and livestock biomass were distributed across all the main land use types. However, within each land use type wildlife distribution were associated with low to medium NDVI values while livestock were associated with high NDVI values. Similarly, Wildlife distribution was associated with open vegetation while livestock distribution was associated with dense vegetated areas. Most of the wildlife and livestock is found in medium leaf area index, nonetheless there is also considerable wildlife in low leaf index areas. Potential factors contributing to this are discussed.

Keywords: Chobe enclave, NDVI, corridors, land use, land zoning, land cover

Monitoring water birds in water bodies around Central District

V. Kholi[1], M. Makwati, C. Mpofu, M.J. Kgari, P. Maningi, K. Mogale, S. Gabankalafe
[1]Department of Wildlife National Parks, Research Division, Central Region,
P.O. Box 679, Serowe

Abstract

Birds serve as important indicators of the status of the environment within which they exist. This becomes more important in areas where Birds coexist with Man and his numerous activities. Trends in avian population over time are indicative of what is happening within an area before such changes can be experienced by people. The main aim of this monitoring project carried out over a three (3) year period was to establish an index of Bird populations over time at selected sites around the Central District. The 50 x 50 national grid squares were used as the basis for A Point Count Method within which Two (2) kilometre long transects, consisting of eleven (11) counting points at two (200) hundred meters intervals were used. Results indicate that a total of 6680 Birds were recorded in all the different habitats. The results also shows that the Mixed Savanna habitat had the highest number of Birds recorded at 61.4% while the Grassland habitat had the least number of birds with a 6.4%. Findings further indicate that the Laughing dove (Straptopelia senegalensis) was the most common Species in all habitats while the Glossy Starling (Lamprotornis nitens) was the least common. Findings of this study indicate that the Central District support significant numbers of Avian species making the District an Important Birding Area.

Keywords: Birds, Mixed Savanna habitat, Grassland habitat

Monitoring of terrestrial Birds around Central District

V. Kholi1, M. Makwati, C. Mpofu, M.J. Kgari P. Maningi, K. Mogale and S. Gabankalafe
[1]Department of Wildlife National Parks Research Division, Central Region,
P.O. Box 679, Serowe

Abstract

Even though Birds play an important ecological role in nature, they also serve as indicators of the ecological and environmental integrity of any form of habitat. Therefore a decline in avian population status over time would indicate that there is some changes affecting birds and other forms of life in a particular area. However, healthy avian populations would be an indicator of healthy habitats. Thus the main aim of this three (3) year monitoring project was to develop an index of population trends of birds over time at all major water bodies in the Central district so as to set conservation priorities and note related changes at such sites. Counts were carried out during the morning from 0600hrs to 1100hrs at selected clear sites along the perimeter of the dams where species, time, habitat, weather conditions and potential threats were recorded on prepared data sheet. Results indicate that natural water bodies (ponds and lakes) had more aquatic birds than man made water bodies such dams. As such, Mea pan had the largest number of water birds at 29% followed by Nata Sanctuary with 20.1%, Letsibogo dam at 17.2%. Ntimbale dam with 2.6%, and Dzibanana pond with 2.8%. Further, the results show that more Birds, 45.7% were counted in the year 2012 while 2013 had the least number of Birds at 9.8%. The results also indicated that Dams are the most threatened by a variety of human activities while natural bodies were found to be facing the least threats. Common sandpiper was found to be the most common species while Cattle egret was the least common at all water bodies. Findings of this study indicate that water birds prefer natural water bodies than man made bodies even though both the water bodies remain Important Birding Areas in the Central District.

Keywords: Water Birds, Natural water bodies, artificial water bodies

Assessment of socio-economic benefit derived from Blue Water lily (Nymphaea nouchali) harvesting by Sexaxa Community: A Case study in Ngamiland District

E. Bontshetse[1] , A. Koruyezu[2]
[1]Department of Wildlife and National Parks, Anti-Poaching Unit, Maun, Botswana
[2]Botswana Wildlife Training Institute, Department of Wildlife and National Parks, Maun, Botswana

Abstract

Water lilies are aquatic plants which have been around much longer than any human culture; they are gathered to supplement the diet of most of the households around the world. Today, only water blommetjies, (flowers) are still eaten. The most edible one in Okavango Delta is the N. nouchali. Harvesting of blue water-lily plant is one of the practices that can socially and economically benefit local residents in rural areas but there should be an assessment and regulations to monitor the blue water-lily harvesting. This study analyzes the socio economic benefit derived from Water lily harvesting by the semi-urban community. Results showed that the dominant age group depended on water lily was 60 years and above, followed by age groups of 30-39 years at 23%, and lastly 18-39 years and 50-59 years both at 13%. This shows that majority of water-lily harvesters are adult. Most of the Local people i.e. 63% are employed in Ipelegeng programs, Safari companies and Lodges that are adjacent to Sexaxa settlement and only 37% of people who harvest water-lily are not employed hence majority alternate their live through harvesting of water-lily. The community also shows that they have started harvesting this plant long time ago. Those who have been harvesting water lily for more than 20 years are dominating at 40%, followed by 20% of those who have harvested for past 10yrs. 3 and 5 years at 7% each and lastly 26% for those who are new at that i.e. 2 years and less.

Elephant cross border poaching in the Chobe National Park: 2011 to 2014

G. Kegomoditswe[1] , K. Nkape[2]
[1]Department of Wildlife and National Parks, Anti-Poaching Unit, Maun, Botswana
[2]Botswana Wildlife Training Institute, department of Wildlife and National Parks, Maun, Botswana

Abstract

The study investigated the extent of elephant cross border poaching from January 2011 to June 2014 in Chobe district. Semi structured interviews were used to obtain information from the respondents (primary data) in the field. Officers within Anti- Poaching Unit (Department of Wildlife and National Parks), Narcotics Fauna and Flora Investigations (NFFR) unit which is under the Botswana Police and Regional Wildlife Office-Law Enforcement Unit (DWNP) who were charged with the responsibility of controlling elephant poaching were interviewed. The responded reported that elephant cross border poaching around Chobe National Park is prevalent during the winter season and it is speculated to be done mostly by foreign poachers. The most used rifles include AK47 and .375. The poachers enter the Chobe National Park mostly through the area between Lesoma and Pandamatenga settlement targeting the Poha sector. At Poha poachers kill both male and female elephants although they are mostly interested in male elephants. The results also indicated that all cross border poaching cases registered between January 2011 and June 2014 have been closed because the suspects had fled Botswana before being arrested. Elephant poaching trend by the cross border poachers however, has shown a gradual decrease from January 2011 to June 2014.

Fish stock assessment and exploitation patterns of the main fish stocks in the Okavango Delta fishery

K. Mosepele, J. Kolding, T. Bokhutlo

Abstract

Most African freshwater fisheries are small scale, artisanal, labour intensive and provide approximately half of fish consumed annually by over 200 million people in Africa. They are therefore, a key source of food and nutrition security, and hence underpin the livelihoods of poor communities in Africa, which increases pressure on them. A key management objective in fisheries is to determine the exploitation patterns and levels of exploited stocks to make informed management decisions. Hence, this study used several techniques to assess the Delta's fish stocks, which included cluster analysis, simple regression, VPA and Thompson and Bell yield prediction. Results indicate that Oreochromis andersonii, O. macrochir and T. rendalli are key fish species in the Delta's fishery. Generally, the fishery harvests mid-trophic level, mature (based on L50% maturity ogives) species. Regression analysis revealed a significant relationship ($p<0.01$) between fishery production and flooded area, at a 2 year time lag, suggesting that the fishery is not over-exploited. Length based modelling showed that mean exploitation rates and instantaneous fishing mortality for all the study species were within the range of the biological reference points. Thompson and Bell analysis revealed that different fishing gears had different effects on exploited species. Present effort using some gears is exploiting certain species above their MSY, while effort for some species can be quadrupled without fear of over-exploitation. Overall, these indicators showed that the delta's fishery is not biologically over-exploited, but is characterized by a well-balanced exploitation regime. This study has revealed that the Delta's fishery is flood-pulse driven whose management can't be achieved through classical approaches.

Keywords: Fish stock assessment, exploitation rates, fishing gear

Floodplain fish community dynamics, drivers and processes; the case of the Okavango delta

K. Mosepele, J. Kolding, T. Bokhutlo

Abstract

Tropical floodplain fish populations fluctuate at spatio-temporal scales. Since these fisheries are a major source of rural livelihoods, there is need to assess the nature and extent of these fluctuations. Understanding the variability in these systems will contribute to comprehensive management of these resources. Therefore, the main objective of this study was to assess the seasonal dynamics of floodplain fish community, by investigating their seasonal dynamics, drivers and processes. Data were collected using standard methods between 1999 and 2009 from the main channel and two connected lagoons in the delta's panhandle. Various analytical tools (e.g. CCA, SIMPER, cluster, ANOVA, etc.) were used to assess fish community dynamics. SIMPER analysis revealed differences between lagoon and channel fish communities. Results also showed that lagoons had significantly higher fish biomass, but had significantly ($p<0.05$) smaller fish. CCA revealed that similar fish species were structured along different environmental gradients in different habitats. PCoA, cluster analysis and regression techniques revealed significant inter-specific associations along the seasonal hydrograph, especially at decreasing floods. We concluded that floodplain fish communities are driven by stochastic and deterministic processes and that floodplain fish assemblages are persistent, stable and heterogeneous. This is incongruent to the static oriented paradigms currently used in their management. The best management approach of these systems, therefore, is to manage them for resilience, persistence and heterogeneity, which fits the balanced exploitation regimes traditionally used in them. This study contributes knowledge to floodplain fish ecology and enhances management of this resource for the benefit of socio-economically impoverished riparian communities.

Keywords: Persistence, dynamic, floodplain fisheries, Okavango Delta

The distribution pattern of human wildlife carnivore conflicts in Chobe Enclave

B. Latiwa[1] , M. Mogopa[2]
[1]Department of Wildlife and National Parks, Research Unit, Kasane, Botswana
[2]Botswana Wildlife Training Institute, Department of Wildlife and National Parks, Maun, Botswana

Abstract

The geographical location of the Chobe enclave villages in relation to the Chobe river and the Chobe National Park (CNP) within the Chobe district puts them under increased risk of livestock predation. This study was conducted with the aim of documenting the extent of predation on livestock by wild carnivores, the economic loss to farmers as well as the effectiveness of control measures. Data was obtained through interviewing farmers by the use of questionnaire as well as record of reported cases of livestock depredation from PAC office in Kasane. The results indicated that although reports at DWNP office indicate the lion to be the most problematic animal, farmers indicate that the spotted hyena causes the most damage, that although predators distribution seems not to follow any pattern, the lions seem to prefer cattle-posts adjacent to the park, that most farmers do kraal their livestock at night and herd during the day while over a million Pula worth of livestock has been lost to predators between years 2010 and 2013. Finally the study recommends that, DWNP should increase human awareness on the importance of wildlife, advice relevant government departments on predator friendly land use as well as undertake research on more innovative ways of alleviating the problem.

Local farmers' attitudes towards African elephants in the Makgadikgadi region, Botswana

J. Stevens
Elephant for Africa

Abstract

Through successful conservation practices and ecological changes elephants are returning to historical ranges. However, this results in increasing range overlap with human populations and subsequently increased conflict in the form of crop-raiding. Most studies investigate conflict from the wildlife's perspective, yet it is often the local communities that are required to implement mitigation strategies. The Boteti region west of the Makgadikgadi Pans National Park is one of Botswana's highest conflict zones. To address this conflict the study examined local farmers' value for, and tolerance of, elephants whilst also learning about local farming practices through structured questionnaires. The results suggest that most respondents do value elephants although tolerance is lower. The first-hand experience of crop-raiding significantly reduced value and tolerance. Certain farming practices such as which crop species are planted may make farmers more vulnerable to the impacts of crop-raiding. While efforts to reduce crop-raiding incidences are required, effective conflict mitigation initiatives should also involve strategies to improve attitudes towards elephants and general wildlife, whilst also addressing drivers of conflict such as farming practices

Livestock ranging distances in relation to Protected Areas and Makgadikgadi Ecosystem: implication for human wildlife conflict.

D. Ntloyathuto, K. Mogwera, L. Rutina
Okavango Research Institute, University of Botswana. P/ Bag 285. Maun

Abstract

Livestock ranging distances differ based on their location of their respective cattle posts due to the destined habitat they forage in. Animals travel long distances in search for better forage especially in the dry season. This results in some animals going far away from cattle post and spending a night out of enclosures, vulnerable to predation. The objective of the study was to determine livestock ranging distances in relation to cattle posts and protected areas (PAs) in Makgadikgadi ecosystem. A Chi Square analysis was performed to test the association between distance travelled and season for each livestock type. The results show that donkeys always graze far from PAs and near cattleposts for both seasons ($P > 0.05$ for all associations). However, cattle, horse and shoats tend to move far away from cattle posts during the wet season ($P > 0.005$ for all associations). There was no significant association between distance to PAs and season for donkeys and horses ($P > 0.05$ for all associations). Cattle tend to be closer to PAs during the dry season while shoats tend to be closer to PAs during wet season. Using the distance travelled by livestock in relation to PAs as an indicator of carnivore predation risk, the results show that more livestock move near PAs in the dry season than wet season. This has implication for human-carnivore conflict in the area.

Space use by re-introduced white rhinos (Ceratotherium simum) in the Okavango Delta, Botswana

C. Rees
Corresponding author: caroline.rees@hotmail.co.uk

Abstract

The iconic white rhino (Ceratotherium simum) are one of the most endangered African herbivore species. It's hard to accept that this living dinosaur which has been present in Africa for millions of years could soon to be lost. A renewed demand of rhino horn for the illegal Asian medicine market has put the rhino under significant threat.The re-introduction of rhinos to the Delta offered a unique opportunity to see how rhino held in a collective boma behaved socially pre- and post-release. 6 white rhino were observed for a 2 month period in their boma in Botswana. Sociality and dominance hierarchy of the animals were studied. I was able to successfully predict the social bonds of the project rhino upon release and I was able to reveal not only 'who' the rhino chose to pair with, but also 'why' the rhino selected particular partners. Using GPS information from rhino ankle collars, I was able to observation that these bonds did not change within the first 5 months after the release into the Delta. This information may be important for anti-poaching teams to identify the potential number of independent groups of rhino that will form after being released into the wild, thereby being able to manage resources effectively.

Encroachment of vegetation by woody species at Maun Wildlife Educational Park

S. Semong[1] , M. J. J. Mangubuli[2]
[1]Department of Wildlife and National Parks, Anti-Poaching Unit, Maun, Botswana
[2]Botswana Wildlife Training Institute, department of Wildlife and National Parks, Maun, Botswana

Abstract

Maun Wildlife Educational Park (MWEP) is a 3km² sanctuary in Northern Botswana stocked with grazing and browsing herbivore species of wildlife to various levels since its establishment in 1973. The absence of objective habitat management programmes prompted this study in June 2014 to determine the state of habitat encroachment by woody plant species and assess the effects of the encroachment on the herbaceous layer of the once open woodland and flood plain vegetation in the Park. The point centered quarter (PCQ) and line intercept (LIM) methods were used to sample plants in the woody and herbaceous layers respectively. Results showed encroachment of the Park habitats by eight woody plant species changing it into a forest. This has possibly reduced the production of herbaceous forage and grazing capacity of habitats. Objective habitat management programs are required more so in recent years the Park has experienced annual floods that cover up to 60% if the Park area.

Water quality variations along the lower parts of Okavango delta

B. E. Setomba, O. Mogobe, W. R. L. Masamba
Okavango Research Institute, University of Botswana, P/Bag 285, Maun, Botswana

Abstract

The Okavango Delta provides all the different types of ecosystem services (provisioning, regulating, cultural and supporting services). Water quantity and quality are key driving factors for the provision of these services by the wetland. The aim of this study was to investigate the water quality status of the lower part of the Okavango Delta. Seven sampling sites were selected (Xakanaka, Khwai, Boro, Maun Lodge, Tsanekona, Mogapelwa, Lake Ngami) and three water samples per site collected every 3 weeks. Inductively coupled plasma – optical emission spectrometry (ICP-OES) was used for the determination of cobalt, chromium, cadmium, calcium, magnesium, copper, manganese, zinc and nickel while flame Photometry was used for sodium and potassium. Dissolved oxygen, pH, temperature, electrical conductivity and turbidity were measured on site and microbiological parameters quantified were Faecal coliforms and Faecal streptococci. Sodium concentration ranged from 3-10.6 mg/L with Mogapelwa and Lake Ngami having the highest concentrations. Nickel ranged from 22.34 -35.74µg/L with high concentrations recorded at Maun Lodge. Potassium concentrations ranged from 2.40µg/L (Xakanaka) to 7.87µg/L (Tsanekona). The concentration of Zinc varied between 6.19 µg / L (Maun Lodge) and 40.69 µg / L (Boro). At Lake Ngami manganese was at a peak of 52.22 µg / L, copper was found at a concentration of 101.87 µg / L, calcium (22.98 mg/L) and magnesium was 7.51mg/L. The highest Faecal streptococci count (908 CFU/100ml) was recorded at Mogapelwa. Highest Escheria coli count (534 CFU / 100 ml) and total coliform count (564 CFU / 100 ml) were observed at Khwai. Dissolved Oxygen ranged from 1.1 - 8.93 mg/L, Electrical Conductivity varied between 61.2 – 231 µS/cm with the highest values at Lake Ngami and Mogapelwa which are the last receiving water-bodies of the Okavango River. The results indicate that most of the delta's water is of acceptable quality basing on the tested parameters, with few points exceeding limits set by the Botswana Bureau of standards and Environmental Protection Agency. On the other hand, the total coliform count highlights a potential microbial contamination in the Okavango River and therefore continuous monitoring is recommended.

Sponsors


BOTSWANA


UNIVERSITY
BOTSWANA


WORLD BANK


UNDP


ecoexist


WILDERNESS
SAFARIS