

Estimating Birds Density and Diversity in the Pindi Nature Forest Reserve, Lindi, Tanzania

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Abstract

Species count is among inevitable inventory when it comes to understanding your biodiversity, population estimate, density, and distribution in an area. The Tanzanian Coastal Forests and Nature Reserves are composed of flora, and fauna species of biological importance. The forests serve the main part of the disturbed ecosystem in the area by hosting pollinators, and seed dispersal agents. Among these, birds are taken as good bio-indicators of ecosystem health, hence studying their population composition is important. In this study, a distance sampling technique was used to determine birds' population estimate and density in the Pindi Nature Forest Reserve. A total of 18 random transects (2 km each) were used to cover an area of 121 km² during the exercise. A total of 75 birds species was identified in the area with a diversity of 3.681 and 88% evenness (Hmax=4.4). The Nature Reserve had a density of 0.008835/m² vary from 1 to 11 km². Despite the promising richness and diversity, the area is highly threatened by human activities includes mining, agriculture, and poaching. Initiatives were made to convert the Forest Conservation Status to become Nature Reserve but protection activities should be applied to ensure the total protection of the area.

Keywords: Species; Forest; Biological; Pollinators; Biodiversity

Introduction

The coastal region is composed of 37 Coastal Forest Reserves located between Rufiji and Ruvuma Rivers [1]. Pindi Nature Forest Reserve (NFR) is among the list and was officially gazetted as Forest Reserve in 1956 by Government Notes Number cap.132 p 1363 of 1.12.1957 as a productive forest reserve. Due to its high and unique endemism of plants and animals and its cruciality for maintaining wildlife habitats [2], the reserve was later upgraded to be a Nature Forest Reserve by GN No. 126 of 2019. The Nature Reserve belongs to the central government under the Ministry of Natural Resources and Tourism (MNRT) managed by the Tanzania Forest Services Agency (TFS). The Nature Reserve management is obliged to protect the unique and biologically important coastal forest ecosystem and maintain biodiversity, genetic resources, natural processes, and cultural values in an undisturbed, dynamic, and evolutionary state to have an ecologically representative example of the Pindi landscape and forest ecosystem available for present and future generations. Along with, enhanced scientific study, environmental monitoring, environmental education, and sustainable controlled local and recreational use. The need for improved knowledge of the natural history of these reserves and precisely what biodiversity is protected is critical, given the observed destruction that has occurred and human encroachment presently threatening most, if not all reserves [2]. Upon the decision, initially, birds were agreed to be taken as good bioindicators of the forest's habitat [3, 4] therefore it is important to note the status, distribution, and biological importance of this area. Knowing the birds status in one of the Tanzania coastal forests ensures the conservation strategies and plan of the Tanzania Forest Services Agency, which also acts to ensure the development and utilization of all National Forest and pollinators resources so that to contribute to the social, economic, ecological, and cultural needs of present and future generations. Estimating population abundance is the first step in improving wildlife conservation and management.

Study area

The Nature Reserve has the size of 122 km² and is located in the

Lindi region (Kilwa district) at 9°31'60" S and 39°16'0" E in DMS (Degrees Minutes Seconds) or -9.53333 [5] and 39.2667 [6] (Figure 1). Operation Graphics reference is SC37-07. The area is rich in wildlife flora and fauna hence requires a high conservation status [7]. The accessibility to Pindi NFR from Dar es Salaam is through tarmac road to Kiranjeranje Village, then through an earth road some 23 km from Kiranjeranje via Najiringi and Ruangwa road. On the way, the forest is located adjacent to Makangaga village and Mbwekuru river borders Kilwa and Lindi districts.

Weather

The area has a coastal climate, which is hot and humid with an average temperature range between 16°C to 28°C. Humidity is high, nearly 98-100% during the long rains. The district receives a total rainfall of 800-1400 mm/year and its distribution vary according to locality. The period of rainfall coincides with the onset of each monsoon; the long rains start from mid-March to May, and the short rains, from late October to December. Climate change and variability are rapidly emerging as one of the most serious global problems affecting many forest conditions in Tanzania and are considered one of the most serious threats to sustainable development with adverse impact on the environment, human health, food security, economic activities, natural resources, and physical infrastructure. It is likely to affect most of Africa's natural resources with a range of potential impacts on both terrestrial and aquatic ecosystems result in the shifting

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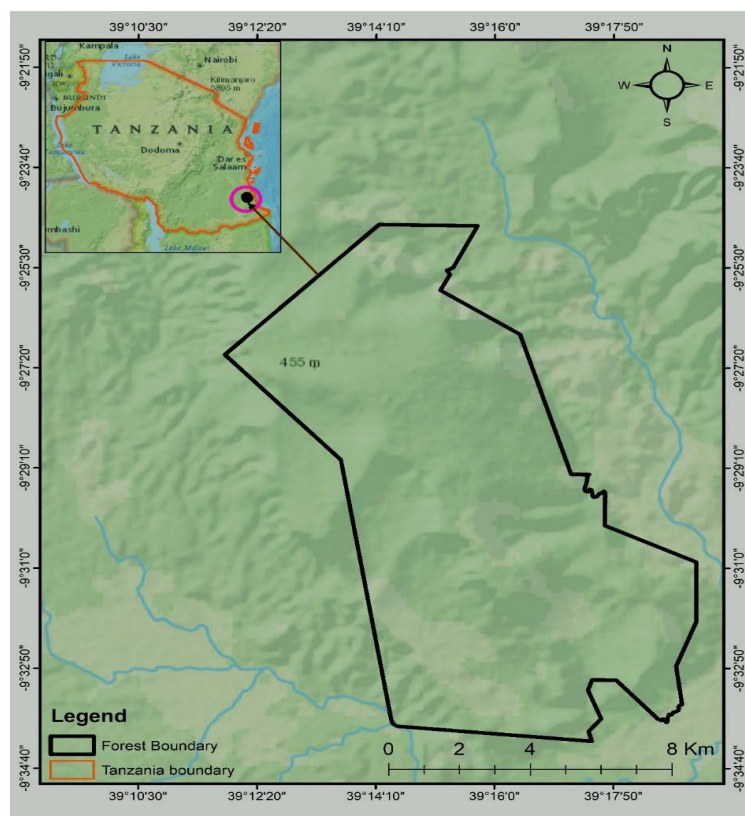


Figure 1: Pindirol nature forest reserve location in Tanzania.

of ecological zones, loss of flora and fauna, and an overall reduction in ecological productivity [8].

Topography and hydrology

The topography of the forest area is hilly and undulating. The area is within the Indian Ocean drainage basin with its rivers and streams directly draining its water to the ocean. There is one natural dam called Nyage (Njange) which is permanent and provides habitat for white Hippopotamus, Crocodiles, and different fish species. The Nyange dam acts as the water source for the Nyange River. There is no tributary identified in place that drains/pours its water to the dam. Several rivers originate from the reserve, these include; Pindirol, Nyange, Makumba, and Nandika, where all these drains their water to Mbemkuru River. Mbemkuru River drains its water to the Indian Ocean and on the way communities living adjacent to it use the water for various purposes.

Geology and soils

Generally, the soils of the area comprise coastal alluvial sand gravels, sandstones, mudstones, shale, and limestone with some areas having clay soils mixed with sand. These soils have good drainage except clay which have moderate to poor drainage. Soils of the areas are suitable for the cultivation of crops like paddy, maize, and cassava. Likewise, major rocks of gypsum and anhydrite resource are situated 20 km from the coast (Pindirol NFR) it's ground shaped structure penetrating limestones, the ground consists of gypsum at the top underlain sequence of rock salt proven reserves over a small area of deposit were determined by STAMICO to be 5 mt containing 85% gypsum (Ibid).

Methods

The counting technics

Distance sampling was deployed to assess the birds' population and density in the area.

The point transect method

The point transect method was used to count birds within a sample of defined areas point [9]. Along a transect of 2000 m (2 km) distance, the team established a point count station every 240 meters and spend 20 minutes counting at each point. The assumptions were, all birds' species were present in the plot just before the arrival of the observer are counted without error. The technique allows for the possibility that birds are present in the plot and can be detected. Birds are detected at their initial location. Distance sampling methods are 'snapshot' methods; conceptually, the team 'freeze' the birds in position. If birds move in response to the observer before detection, either towards or away from the line or point, then considered as bias. If movement is independent of the observer, bias is slight for line transect sampling provided on average the birds are moving at less than half the speed of the observer [9]. Even random movements of birds within the plot lead to overestimation of abundance if they result in individuals being double-counted, and because the bird is more likely to be detected if it moves closer to the point, giving a downward bias in the recorded distances. The technique supposed that an unknown proportion 1-Pa of birds within an estimated density can be obtained by $D = \left(\frac{n}{aPa} \right)^n = \frac{n}{kwx^2Pa}$ [10]. At a low detection rate and high forest

coverage area, the Mist net technique [11] was used to capture forest

bird species that were not observed on the sampling transect due to high forest cover and fleeing. Mist net ensured the species richness detection in the area. The mentioned methods require a long and short-term monitoring process to come up with a concrete list of birds' species composition in an area.

Results

Richness and diversity

75 bird species were observed in the Pindirol Nature Forest Reserve (Figure 2). The species composition provides a diversity of 3.681 ($H_{\max}=4.4$), whereby indicates 0.88 equitability (88% species evenness) in the study area. The most encountered and diverse species were Trumpeter Hornbill ($e=27$, $H'=0.178$), African Black Headed

Oriole ($e=21$, $H'=0.151$), Yellow Streaked Greenbul ($e=20$, $H'=0.146$) and Retz's Helmeted Shrike ($e=16$, $H'=0.126$). The least encountered and less diverse birds species were White-browed Coucal, Stripped Kingfisher, Singing Cisticola, Red Fronted Tinkerbird, Peters Twinspot (all with $e=1$, $H'=0.015$). 50 bird species in the area were less frequent, ranging from 1 to 4 frequency of observation, while the other 25 species range from 5 to 25.

Birds' density

Bird sampling strata had a significant detection rate and a substantial number of species were mostly detected between 0 to 50 meters from the transect line (Figure 3). The detection probability rate was reduced as the perpendicular detection distance increased from the transect (Figure 4). However, there were confounding detections

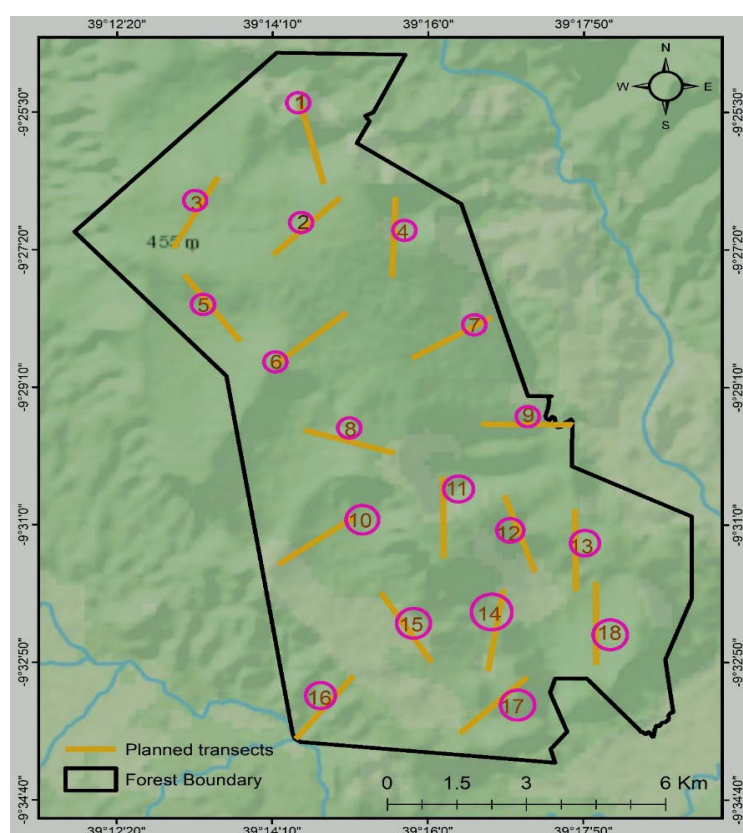


Figure 2: Planned randomly oriented transects of 2 km each in the Pindirol Nature Forest Reserve.

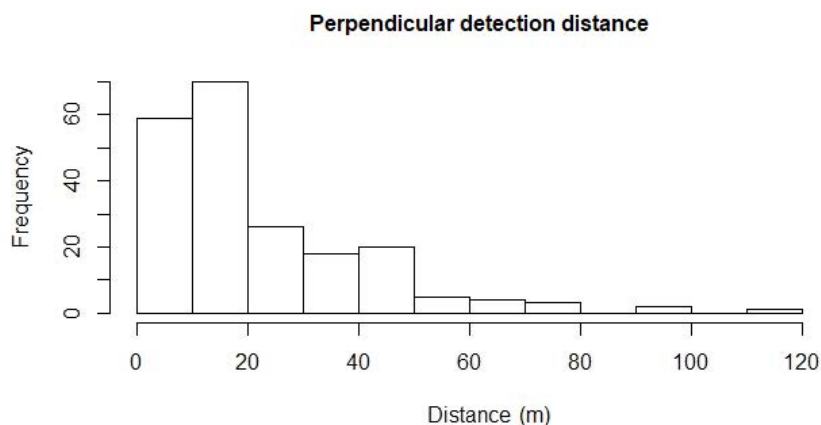


Figure 3: Detection distance in the Pindirol Nature Forest Reserve.

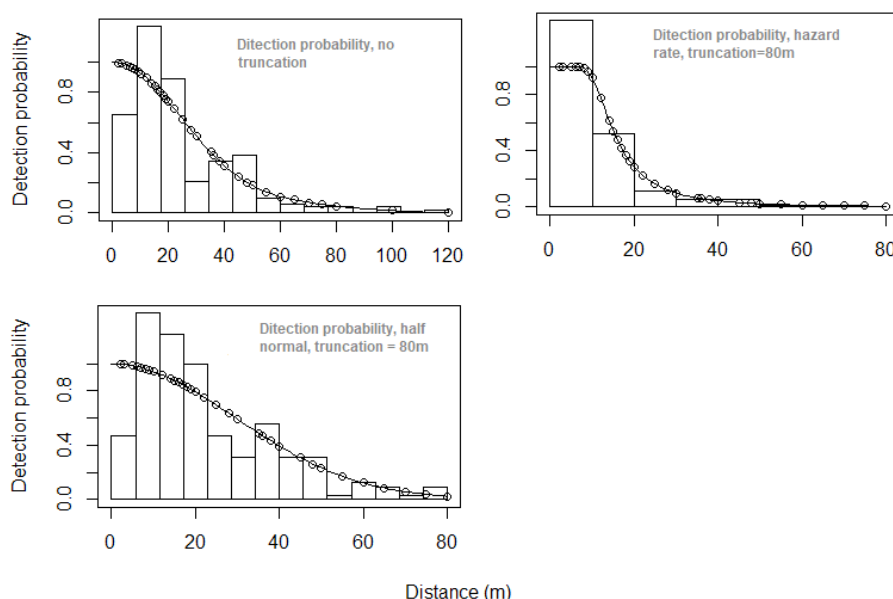


Figure 4: Birds' detection probability in the Pindirol Nature Forest Reserve.

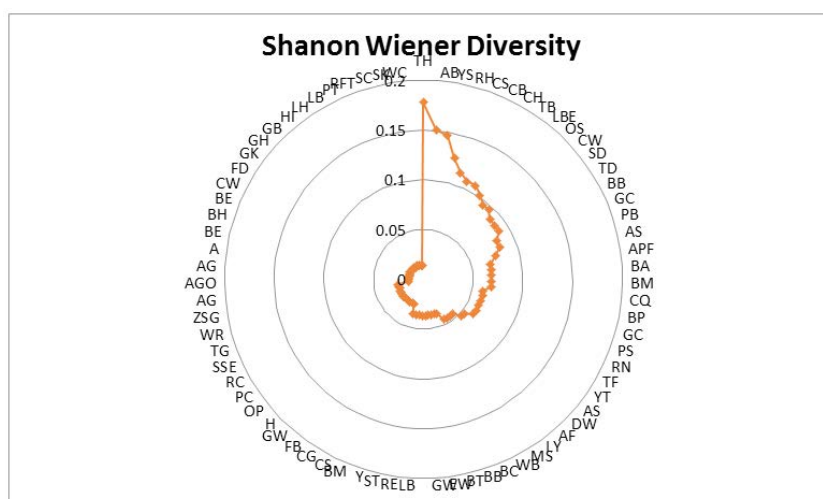


Figure 5: Birds' diversity in the Pindirol Nature Forest Reserve. $H' = 3.681$ ($H_{max} = 4.4$).

at 120 and 150 meters which were reduced by 80 meters' truncation, (half normal) and later truncated to 80 meters, (hazard rate) (ibid). The species is estimated to have a density of $0.008835/m^2$ (ibid), and vary from 01 to $11/km^2$ (Figure 5).

Abbreviations

Trumpeter Hornbill=TH, African Black Headed Oriole=AB, Yellow Streaked Greenbul, YS Retz's Helmet-Shrike=RH, Collared Sunbird=CS, Common Bulbul=CB, Crowned Hornbill=CH, Tropical Boubou=TB, Little Bee-Eater=LBE, Olive Sunbird=OS, Common Waxbill=CW, Square tailed Drongo=SD, Tambourine Dove=TD, Bohm's Bee-eater=BB, Grey-backed Camaroptera=GC, Pale Batis=PB, African Palm Swift=AS, African Paradise Flycatcher=APF, Black headed Apalis=BA, Bronze Mannikin=BM, Cardinal Quelea=CQ, Black-backed Puffback=BP, Green Capped Eremomela=GC, Purple banded Sunbird=PS, Ring Necked Dove=RN, Tawny Flanked Prinia=TF, Yellow-umped Tinkerbird=YT, Abdim's Stork=AS,

Dark-backed Weaver=DW, African Fish Eagle=AF, Little Yellow Warbler=LY, Mottled Spinetail=MS, White-eared Barbet=WB, Black Cuckoo-shrike=BC, Brown Breasted Barbet=BB, Brown-crowned Tchagra=BT, Emerald spotted Wood-Dove=EW, Green-backed Woodpecker=GW, Lilac-breasted Roller=LB, Red Eyed Dove=RE, Scaly Throated Honeyguide=ST, Yellowbill=Y, Blue Mantled Crested-flycatcher=BM, Common Scimitarbill=CS, Crested Guineafowl=CG, Forest Batis=FB, Grosbreak Weaver=GW, Hamerkop=H, Orange winged Pytilia=OP, Purple Crested Turaco=PC, Rattling Cisticola=RC, Southern banded Snake Eagle=SSE, Tiny Greenbul=YG, White Browed Robin-chat=WR, Zanzibar Sombre Greenbul=ZSG, African Green pigeon=AG, African Golden Oriole=AGO, African Goshawk=AG, Amethyst Sunbird=A, Bateleur Eagle=BE, Brown Headed Parrot=BH, Brown Snake Eagle=BE, Cardinal Woodpecker=CW, Fork-tailed Drongo=FD, Giant Kingfisher=GK, Greater Honeyguide=GH, Grey-headed Bushshrike=GB, Hadada Ibis=HI, Lesser Honeyguide=LH, Lizard Buzzard =LB, Peters Twinspot=PT, Red Fronted Tinkerbird=

RFT, Singing Cisticola=SC, Striped Kingfisher=SK, White-browed Coucal=WC.

Discussion

The Nature Reserve contains a significant component of bird species in the area. The family and species diversity reveal a healthy ecosystem hence improving the production of coastal forests and the entire ecosystem [12]. The area also hosts some of the endemic species of East African Coastal Forests e.g. Zanzibar Sombre Greenbul, among other few [13], and other specialized forest birds' species such as Trumpeter Hornbill (*Bycanistes buccinator*), African Black Headed Oriole (*Oriolus larvatus*), Yellow Streaked Greenbul (*Phyllastrephus flavostriatus*) and Crowned Hornbill (*Tockus alboterminatus*), few are mentioned (Figure 5). These species were also observed in good number but highly vulnerable due to the spread of human activities in the area such as mining that clear most of the important habitats by engaging heavy machinery and the use of dynamites [14]. Apart from birds' species, the Forest Nature Reserve is also a refugee of mammals' species from the nearby protected areas such as Selous Game Reserve and Nyerere National Park during the peak of a dry season [7], and also hosts endemic terrestrial species of snail [15-18].

Conclusion

Apart from this scientific work, still, little biodiversity information is known in the Pindi Nature Forest Reserve; therefore, other biodiversity inventories are needed to reveal the potential resource in the area. In this case, birds were chosen among many wildlife individuals to be assessed in the area. The assessment provides the basis and significant knowledge and information to the management which enhances outstanding initial decision making. Further, other methods e.g. call and night counts can be used to improve the collected checklist hence diversity, density, and abundances [19-22].

Recommendation

It is highly recommended to conduct a mammals', fish, amphibians, and reptiles survey in both wet and dry seasons. Establishments of important new roads in the Nature Reserve are highly recommended to improve the management of an area. The survey was quite delayed due to bad roads accessibility. The area is significant for tourism activities such as canoeing and bird watching, therefore tourism infrastructure and facilities such as nature trails, accommodation, and communication facilities are highly recommended. In addition, the annexing of Nyange and Mbwenkuru rivers to Pindi Nature Forest Reserve could enable smooth animal movement to and from Pindi Nature Forest Reserve, Nyerere National Park, and Selous Game Reserve, therefore should be considered.

References

- Jensen J FP, Tottrup AP, Christensen KD (2005) The avifauna of coastal forests in southeast Tanzania. 22.
- Burgess ND, Dickinson A, Payne NH (1993) Tanzanian coastal forests new information on the status and biological importance. *Oryx* 27: 169-173.
- Venier LA, Pearce JL (2004) Birds as indicators of sustainable forest management. *For Chron* 80: 61-66.
- Nelson BR, Mamat MA, Cheeho W, Shahimi S (2020) Forest birds as diversity indicator in suburban and residential areas. *Ecofeminism and Climate Change* 1: 57-62.
- Lynch TB, Rusydi R (1999) Distance sampling for forest inventory in Indonesian teak plantations. *For Ecol Manag* 113: 215-221
- Primitiva, Marwa AP, Kaaya A (2018) Characterization of Selected Gypsites of Tanzania for Agricultural Use. *Int J Plant Soil Sci* 23: 1-9.
- Howell KM (2012) Biodiversity Surveys of Poorly Known Coastal Forests of Southeastern Tanzania and Zanzibar.
- URT (United Republic of Tanzania) (2001) Project Implementation Manual: Annex 2. Improving Service Delivery for Participatory Forest Management. Unpublished Report. Ministry of Natural Resources and Tourism, Forestry and Beekeeping Division, Dar es Salaam, Tanzania.
- Buckland ST, Anderson DR, Burnham KP, Laake JL, Borchers DL, et al. (2001) Introduction to distance sampling. Oxford: Oxford University Press.
- Buckland ST, Marsden SJ, Green RE (2008) Estimating bird abundance: Making methods work. *Bird Conserv Int* 18: S91-S108.
- Enrique (2005) Using canopy and understory mist nets and point counts to study bird assemblages in Chaco forests.
- Ndanganga P, Eshiamwata G, Ngari A, Kiresua E, Arinaitwe J, et al. (2009) Status Report for the Eastern Arc Mountains and Coastal forests of Kenya and Tanzania Region, 2008.
- Werema C (2016) Seasonal variation in understory bird species diversity and abundance in the Uluguru Nature Reserve, Tanzania. *Afr J Ecol* 54: 299-307.
- Burgess ND, Malugu I, Sumbi P, Kashindye A, Kijazi A, et al. (2017) Two decades of change in state, pressure, and conservation responses in the coastal forest biodiversity hotspot of Tanzania. *Oryx* 51: 77-86.
- Emberton KC, Pearce TA, Kasigwa PF, Tattersfield P, Habibu Z (1997) High diversity and regional endemism in land snails of eastern Tanzania. *Biodiversity & Conservation* 6.
- Buckland S, Elston D (1993) Empirical Models for the Spatial Distribution of Wildlife. *J Appl Ecol* 30: 478-495.
- Burnham KP (1981) Summarizing remarks: environmental influences. *Stud. Avian Biol* 6: 324-325.
- Kangalawe (2015) Sci-Hub | Climate change and variability impacts on agricultural production and livelihood systems in Western Tanzania. *Climate and Development* 1-15.
- Kessy JF, Nsokko E, Kaswamila A, Kimaro F (2016) Analysis of drivers and agents of deforestation and forest degradation in Masito forests, Kigoma, Tanzania. *Int J Asian Soc Sci* 6: 93-107.
- Kumarathunge (2011) Evaluation of the plotless sampling method to estimate aboveground biomass and other stand parameters in tropical rainforests. *Appl Ecol Environ Res* 9: 425-431.
- Phillipo F (2008) Contribution of women's income-generating activities to household income in Kigoma urban district, Kigoma region, Tanzania. The Sokoine University of Agriculture.
- Royle JA, Dawson DK, Bates S (2004) Modeling Abundance Effects in Distance Sampling. *Ecology* 85: 1591-1597.