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A Survey of the Abundance, Population Structure, and Distribution of Nile Crocodiles (*Crocodylus Niloticus*) Using Day Ground Surveys in Sengwa Wildlife Research Area, Zimbabwe

***Mercy Sai*[1], *Beaven Utete*[1,3], *Exeverino Chinoitezvi*[1,2], *Gilbert H. Moyo*[2], and *Edson Gandiwa*[1]**

[1]*School of Wildlife, Ecology and Conservation, Chinhoyi University of Technology, Private Bag 7724, Chinhoyi, Zimbabwe*
[2]*Scientific Services, Sengwa Wildlife Research Area, Zimbabwe Parks and Wildlife Management Authority, Private Bag 6002, Gokwe, Zimbabwe*
[3]*Corresponding author, e-mail: mkaiyo@gmail.com*

***Abstract*.—The Nile Crocodile (*Crocodylus niloticus*) is an apex-predator in lotic freshwater systems and is increasingly recognized as a useful indicator in ecosystem monitoring and in sustainable use conservation programs. Previous wildlife surveys in Sengwa Wildlife Research Area (SWRA) in northwest Zimbabwe have routinely neglected to include Nile Crocodiles. Our objectives were to examine population size, structure, and spatial distribution of the Nile Crocodile in SWRA. Using a total count day time ground survey approach, we collected crocodile sighting data along the Kove and Sengwa rivers inside the SWRA in April and May 2014, and analyzed crocodile abundance and population structure using Chi-Square. We performed a wet season Getis-Ord hotspot analysis to show spatial distribution of Nile Crocodiles. We documented 82 Nile Crocodiles in both rivers with an average encounter rate of 2.28 crocodiles per km. We recorded significant differences in crocodile encounter rates and population structure between the Kove and Sengwa rivers, although both exhibited a predominantly juvenile-biased population. Hotspot analysis indicated cold-moderate ($0 < Z < 2$) clustering in the Kove River, with high hotspot clustering ($Z > 2$) of crocodiles in the Sengwa River. We attributed variations in Nile Crocodile clusters and abundances to differences in river habitat structure. We recommend continued regular and varied surveys to establish long-term population trends and spatial dispersion of Nile Crocodiles in SWRA.**

Key Words.—apex predator; aquatic ecosystems; conservation; human communities; wildlife

Introduction

The Nile Crocodile (*Crocodylus niloticus*) is a widely distributed apex predator, found within different aquatic ecosystems in Africa (Fergusson 2010; Zisadza-Gandiwa et al. 2013; Nyirenda 2015). This crocodile species fulfils essential ecosystem roles and has inherent commercial value for the wildlife and tourism industries (Wallace et al. 2013). The Nile Crocodile is also a commercially exploited species that is protected under the Convention on International Trade in Endangered Species (CITES; International Union for Conservation of Nature [IUCN] 2011) and is increasingly recognized as a useful indicator for ecosystem monitoring and sustainable use conservation programmes. In Africa, the Nile Crocodile is declining in abundance, and its range is dwindling, due to habitat loss mainly attributed to siltation, fragmentation, and pollution (Leslie and Spotila 2001). Human-induced habitat loss is thereby exerting pressure on Nile Crocodile populations (Zisadza-Gandiwa et al. 2013). Thorbjarnarson (1996) indicated that crocodilian populations are threatened by overuse of eggs, hunting, the skin trade, habitat loss, and pollution. In some areas, particularly in Zimbabwe, Nile Crocodiles are persecuted by humans as they prey on livestock, resulting in human-crocodile conflict (McGregor 2005; Fergusson 2010).

Monitoring of Nile Crocodile populations is critical in many conservation areas and also as a way of evaluating the effectiveness of conservation efforts (Jablonicky 2013). However, of the many surveys of crocodilians throughout Africa, only a small percentage facilitates estimation of population trends because of temporal, spatial, and methodological inconsistencies (Lainez 2008). For example, while nocturnal spotlight surveys and eyeshine counts are regarded as the most commonly used techniques for evaluating crocodile populations and trends over time, these techniques can underestimate populations because of inaccessibility of some areas and the cryptic nature of crocodiles (Hutton and Woolhouse 1989). Where environmental variables like water level and topography constrain the use of nocturnal spotlight surveys, daylight ground surveys would be ideal (Lainez 2008).

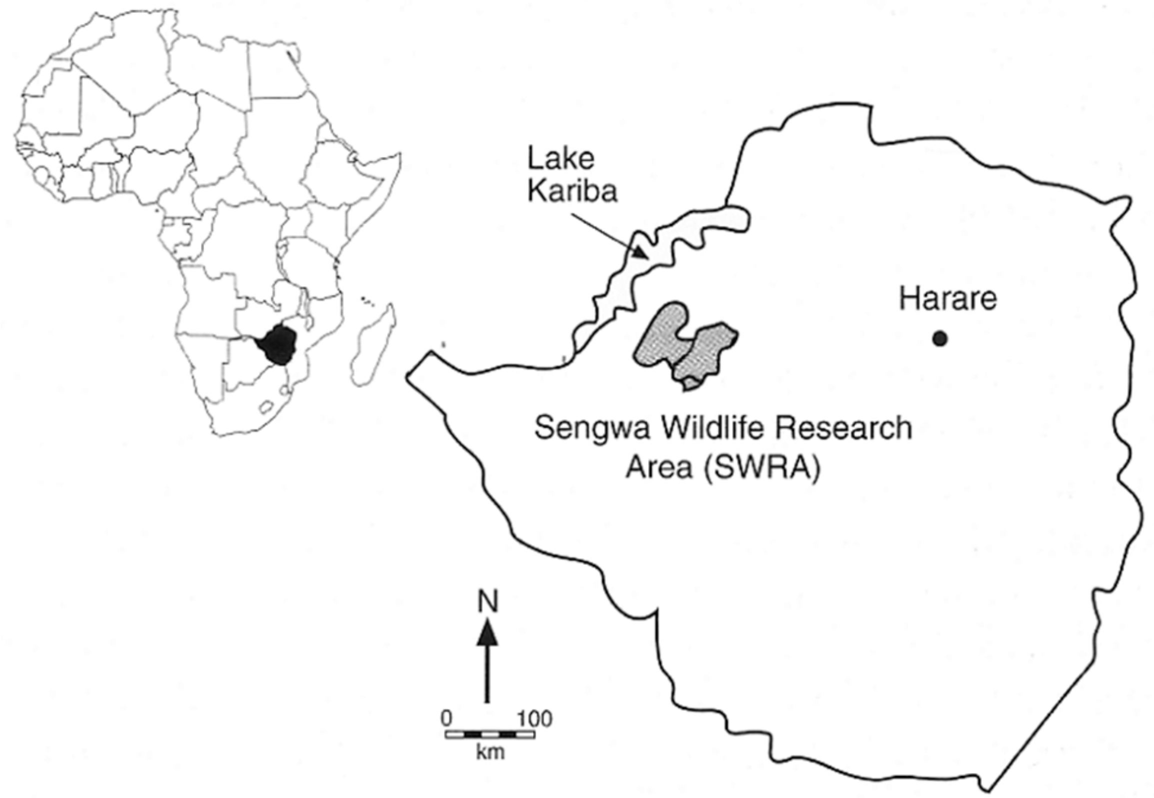

Figure 1. Location of Sengwa Wildlife Research Area in northwest Zimbabwe.

A number of surveys for Nile Crocodiles have been conducted in past years and information on population status of this species, particularly in southern and east Africa, is available (e.g., Hutton and Woolhouse 1989; Hutton 1984; Lainez 2008). However, wildlife surveys in Sengwa Wildlife Research Area (SWRA), northwest Zimbabwe, have routinely neglected to include Nile Crocodiles. Only a study by Coulson (1990) provided a checklist of the amphibians and reptiles in SWRA where the Nile Crocodile was identified to occur in some isolated pools along the Sengwa River. Knowledge of the distribution patterns, abundance and population structure of Nile Crocodiles can provide valuable information on habitat use and life-history parameters (Ferguson 2010). The objectives of this study were to determine population abundance, structure, and spatial distribution of the Nile Crocodile using day surveys in SWRA.

Materials and Methods

Study area.—The SWRA, northwest Zimbabwe, lies between 28°03′ and 28°20′E and 18°01′ and 18°13′S, (Fig. 1) covering an area of 373 km^2. It is bounded by communal lands on all but the northern side, where it shares a border with Chirisa Safari Area, a state protected hunting area (Mapaure 2013). It experiences three climatic seasons: a single rainy season that extends from November to April, a cool season from May to July and a hot dry season from August to October (Mazvimavi 2010). Annual precipitation is between 600 and 700 mm (long-term mean = 670 mm). Mean annual temperature is 22.2° C.

The SWRA is drained by four major rivers: the Kove, Lutope, Manyoni, and Sengwa (Fig. 2). Manyoni and Lutope rivers are heavily silted, only holding water during the wet season and drying out during the dry season. The perennial Kove River is very narrow with dense vegetation on its banks, whereas the wider Sengwa River holds water in isolated pools throughout the year. The general direction of the drainage is northwards, with the Sengwa River eventually draining into Lake Kariba (Tafangenyasha 2000).

Data collection.—We surveyed for crocodiles on two rivers, the Kove (7 km) and Sengwa (29 km), in late April and early May 2014 using a daytime ground survey method. Nile Crocodiles are amphibious in nature; hence we deemed that a ground survey was an appropriate method as it allows crocodile counting both in water and on land. Nocturnal spotlight surveys, the most commonly used technique for evaluating crocodile populations and trends over time, could not be used in

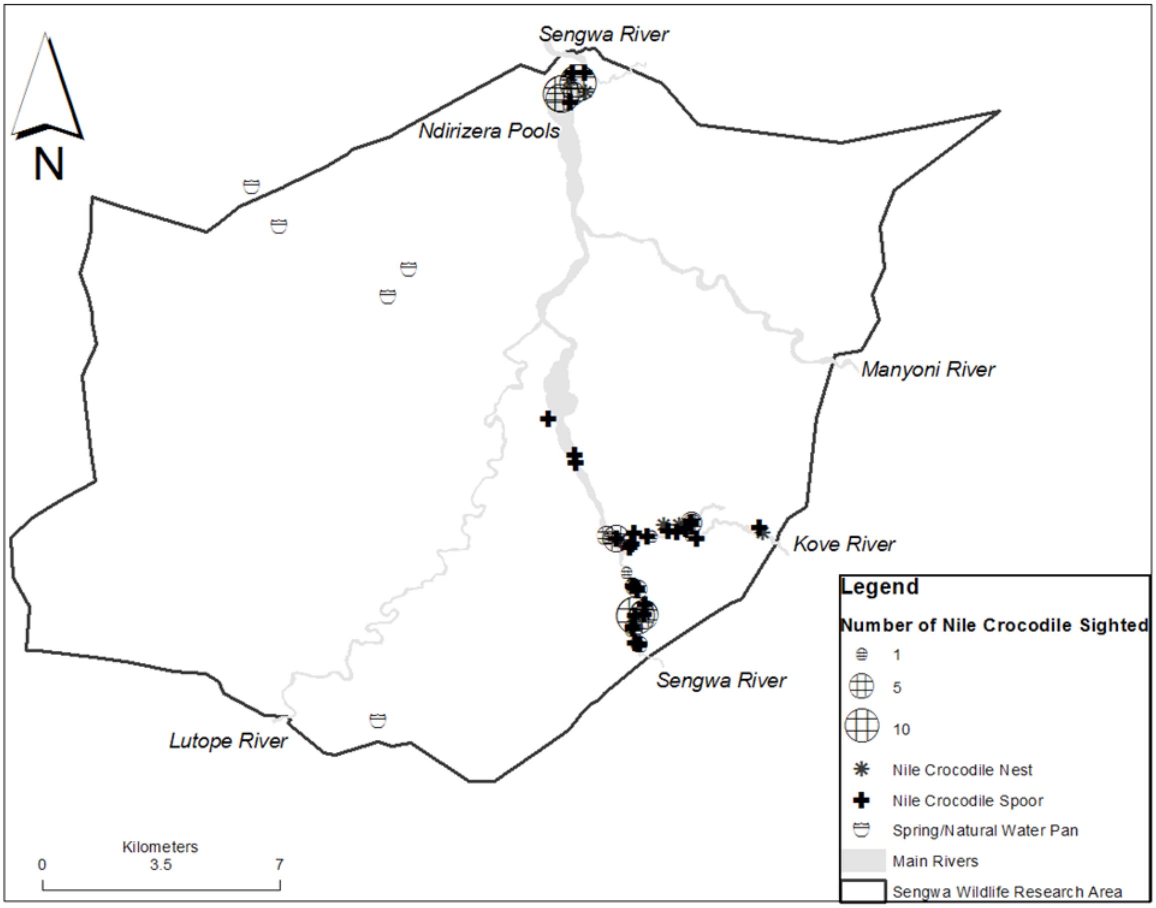

Figure 2. Major rivers in Sengwa Wildlife Research Area, northwest Zimbabwe and the spatial distribution of Nile Crocodile (*Crocodylus niloticus*) sightings along the Kove and Sengwa rivers.

our survey due to river access difficulties (Cherkiss et al. 2006). Furthermore, we preferred daylight surveys to night surveys to enable better detection of crocodile spoor and nests, which is difficult at night. Nile Crocodiles are easier to count and estimate size while basking on land during the day rather than at night (Richard Fergusson, unpubl. report).

We collected data from 0800 to 1430 for three and five consecutive days in the Kove River and the Sengwa River, respectively. We used direct observations to count and estimate the size of crocodiles using binoculars (8 × 40 magnification) with a team comprising of three observers and one recorder. We recorded crocodile sightings (total number of crocodiles, spoor/dung, and nest sites), and we logged their positions into a Garmin Geographic Positioning System (GPS) 60 receiver unit (Garmin Ltd, Olathe, Kansas, USA). Moreover, we considered crocodiles counted at the same location in and out of water as one sighting. We categorized crocodile nests as active (containing viable eggs and showing signs of use) or non-active (containing no eggs, currently abandoned by the adult female; Pooley 1969).

We estimated crocodile size classes based on total length (TL). Thus, we classified crocodiles with TL < 1 m as juveniles, between 1.1 and 2 m as sub-adults, and > 2 m as adults. We distinguished juveniles by their small TL relative to adults and sub-adults (Shacks 2006; Zisadza-Gandiwa et al. 2013; Garcia-Grajales et al. 2012). We used the same recorder and observers throughout the survey to maintain bias consistency. As long as a bias is consistent, the population index will remain relative to the true population count, and inferences can be made from the population index in subsequent years of surveys to establish population trends (Hutton and Woolhouse 1989).

Data analysis.—We calculated the total number of crocodiles and the encounter rate (number crocodiles/km of river) for each of the river sections surveyed. We used descriptive statistics to summarize crocodile population, spoor/dung, and nest abundance. In addition to crocodile encounter rates, and we also calculated nest abundance (number of nests/km of river) following Zisadza-Gandiwa et al. (2013). We used a Chi-square

Table 1. Length of river (km), number of crocodiles, and encounter rate (ER in crocodiles/km) of Nile Crocodiles (*Crocodylus niloticus*) along the Sengwa and Kove rivers, in the Sengwa Wildlife Research Area, northwest Zimbabwe.

River	Length	Number	ER
Sengwa	29 km	69	2.38
Kove	13 km	13	1.86
Total / Mean ER	36 km	82	2.28

(χ^2) goodness of fit test to determine if there were significant differences in crocodile encounter rates and nest abundance between the Kove and Sengwa rivers. We also performed a Chi-square (χ^2) test of independence of variables to determine if there were significance differences in population structure between the Sengwa and Kove rivers. Analysis of the variation in nature and level of clustering, together with Hotspot analysis of crocodile occurrence along the two rivers, was computed in Getis-Ord Gi* statistic (*Z*; Getis and Ord 1992) using algorithms in ArcGIS 10.1 (Esri, Redlands, California, USA). For all tests, $\alpha = 0.05$.

Results

We recorded 82 crocodiles in the Kove (16.0%; n = 13) and Sengwa (84.0%; n = 69) rivers, with encounter rates of 1.86 and 2.38 crocodiles per km, respectively (Table 1). The overall mean encounter rate (both rivers) was 2.28 crocodiles per km. We found a significant difference in abundance of crocodiles between the Kove and Sengwa rivers ($\chi^2 = 36.90$, df = 1, $P = 0.001$). Moreover, we recorded eight nests (active and non-active) along the Sengwa and Kove rivers (Fig. 3). Active nests constituted 62.5% (n = 5) and non-active nests 37.5% (n = 3) of the total nests observed. We identified and recorded more active nests in the Kove River 80.0% (n = 4) than in the Sengwa River 20.0% (n = 1). We identified 64 spoors (average encounter rate = 1.78 spoors/km) and at both rivers, with 44 identified in the Sengwa River (1.52 spoors/km) and 20 in the Kove River (2.86 spoors/km). There was a significant differences in nest abundance between the Sengwa and Kove rivers (χ^2 = 8.26, df = 1, $P = 0.004$). Regarding size class distribution, we recorded more juveniles than sub-adults and adults in the two study rivers (Table 2). There was a significant difference in population structure between the Sengwa and Kove rivers ($\chi^2 = 6.36$, df = 2, $P = 0.042$).

Table 2. Population size class estimates of Juvenile (< 1 m), Sub-adult (1.1–2 m), and Adult (> 2 m) Nile Crocodiles (*Crocodylus niloticus*) recorded in the Sengwa and Kove rivers, in the Sengwa Wildlife Research Area, northwest Zimbabwe.

River	Juveniles	Sub-adults	Adults
Sengwa	34	20	15
Kove	7	0	6
Total	41	20	21

Figure 3. Eggs of the Nile Crocodile (*Crocodylus niloticus*) in an active nest along the banks of the Sengwa River in Sengwa Wildlife Research Area, northwest Zimbabwe. (Photographed by Exeverino Chinoitezvi).

Nile Crocodiles were mostly clustered along Sengwa River with only a few being randomly distributed (Fig. 2). More specifically, crocodiles in the Sengwa River showed a clustered distribution pattern while in the Kove River they were randomly distributed. We found a clustered crocodile distribution pattern at the Ndirizera Pools close to the Chirisa-Sengwa boundary. There was an uneven distribution of spoors and nests in both rivers. The area between the Ndirizera pools up to the Sengwa-Lutope confluence was not a preferred habitat for crocodiles. The Getis Ord Gi* statistics indicated that there were significant Hotspots, with a Getis Ord Gi* *Z* score of > 2 and cold spots with a Getis Ord Gi* *Z* score of < 2 for crocodiles in the Sengwa River and the Kove River respectively (Fig. 4).

Discussion

This study examined the abundance, population structure, and spatial distribution of Nile Crocodiles in SWRA in northwest Zimbabwe. Our results suggest a greater population of crocodiles in the Sengwa River than in the Kove River. This is likely due to the lower number of pools present in the Kove River and the ruggedness and overall lower quality habitat of the river. It is possible that habitat alteration, fragmentation, and siltation contributed to the reduction in habitat quality in the Kove River, which in turn negatively impacted crocodile abundance and population size. In contrast,

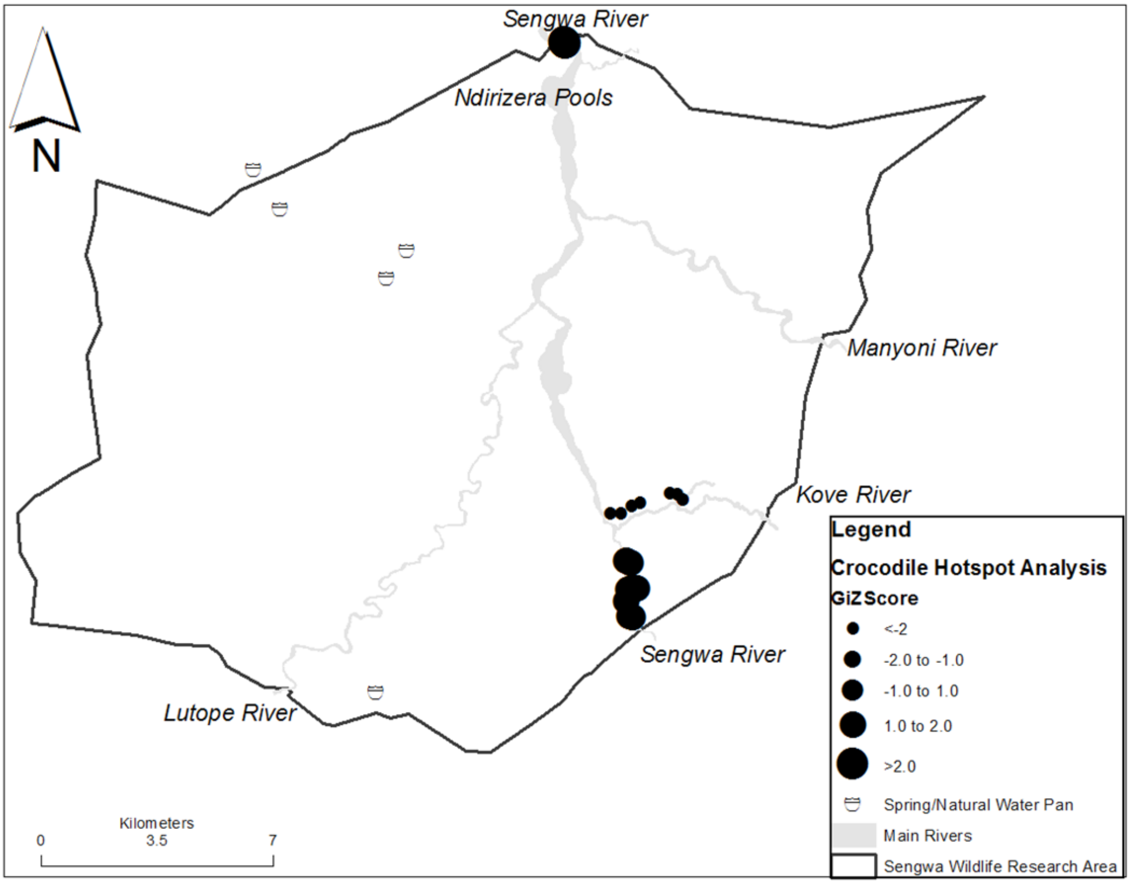

Figure 4. Getis Ord Gi* Hotspot results for Nile Crocodiles (*Crocodylus niloticus*) in Sengwa Wildlife Research Area, northwest Zimbabwe.

the availability of large pools in the Sengwa River most likely positively impacted crocodile abundance and population size in the river. Habitat degradation related to human activities such as stream bank cultivation, illegal fishing and hunting, and pollution has been suggested as the likely cause for low Nile crocodile population densities in lotic systems (Gandiwa et al. 2013; Jablonicky 2013; Zisadza-Gandiwa et al. 2013). The larger part of the Kove River is closer to the park boundary and hence may experience more disturbances, which may result in increased mortality, unlike the Sengwa River where the major habitat is in the protected area.

There was a similarity in the population structure of Nile Crocodiles between the Sengwa and Kove rivers, with the two rivers biased towards juveniles. A relative abundance of juveniles in SWRA suggests a healthy and growing crocodile population. The higher frequencies of juveniles, especially in the Sengwa River, could be coincident with the post-hatching period (Zisadza-Gandiwa et al. 2013), when we conducted our study. Prior studies indicate stable class distributions are characterized by a high proportion of small crocodiles and few large individuals, which is typical of crocodilian populations (Wallace et al. 2013; Bourquin and Leslie 2011). Therefore, our study suggests the population structure of Nile Crocodiles in the Sengwa River is tending towards stability.

An earlier study by Fergusson (2010) in Mozambique suggested that differences in river length, width, and availability of suitable habitats between rivers could likely account for differences in the population structure of Nile Crocodiles. Elsewhere, Calverley (2013) and Calverley and Downs (2014a), reported higher proportions of sub-adult and adult crocodiles in lakes and rivers in the Ndumo Game Reserve, South Africa. However, Shacks (2006) recorded no significant differences in the population structure of Nile Crocodiles in Northern Panhandle, Botswana. These variations can be explained by differences in river habitats (Ferguson 2010) and habitat use (Bourquin and Leslie 2011), and also differences in survey methods used (e.g., day and night surveys; ground, boat, or aerial surveys; Fergusson 2010).

In our study, we surveyed in April and May, which could have resulted in fewer observations of crocodiles than other times of year as the rivers were still flowing and water volumes still high as compared to sampling in June/July or later in the dry season when water levels are lower. Furthermore, we used ground and day survey methods, which may have led to the non-detection of crocodiles still submerged in water or occurring further from the banks. However, despite the limitations of our survey methods, this study provides valuable information on which future studies can build and conservation agencies can use for species management plans. We recorded eight Nile Crocodile nests in the two rivers, which were distributed some few meters away from the river pools. However, the Kove River had more active nests than the Sengwa River despite the latter being longer and wider. Although we encountered few nests in both rivers, the Kove River seems to provide more preferable crocodile breeding sites than the Sengwa River. Despite the higher numbers of active nests along the Kove River, the river was characterized by lower abundances of juvenile and sub-adult crocodiles. This suggests a high movement (post-hatching dispersal) of juvenile crocodiles from the Kove River to the Sengwa River, given that the Kove River also acts as a tributary of the Sengwa River.

Surprisingly, we observed higher crocodile spoor encounter rates in the Kove River where fewer crocodiles were sighted. We attribute this to higher crocodile activity (e.g., foraging) in the river itself during surveys, as the Kove River was characterized by few large pools with associated basking sites. In addition, the Kove River had a significantly larger percentage of adult crocodiles (46%) sighted in the study that would perhaps leave larger spoor more readily detected by observers. We also do not exclude the possible effect of dense vegetation along the Kove River, which likely reduced the detectability of smaller crocodiles.

The spatial distribution patterns observed in this study indicate an uneven distribution of Nile Crocodile clusters, with most hotspots located on the Sengwa River near the boundaries of SWRA with Chirisa Safari Area. This suggests there are more preferred crocodile habitats in the Sengwa River relative to the Kove River. Though the uneven distribution of crocodiles in the Sengwa River may be attributed to the presence of pools along the river (e.g., crocodiles had a clustered distribution at the Ndirizera Pools), it reflects the complex interactions of organisms with their environment (Calverley and Downs 2014b; Wallace et al. 2013). Cold-moderate crocodile spots were punctuated along both rivers, suggesting some disturbances of river habitat along its continuum (Calverley and Downs 2014b) in and outside the park. The Kove and Sengwa rivers extend through the adjacent communities where stream bank cultivation, stream gold panning, river dredging, and siltation is rampant (Mapaure 2013), which can lead to habitat alteration and fragmentation. Some old crocodile dung identified at the Sengwa-Lutope confluence may indicate that crocodiles once used the area but due to habitat alteration, they temporarily moved to other habitats.

In some areas, especially in Africa, human-crocodile conflict has become a major conservation issue (Fergusson 2010). Accordingly, management of humans and crocodiles has become the major focus of programs in several countries, replacing the previous emphasis on sustainable use through ranching and trophy hunting (Amarasinghe et al. 2015). Emphasis has been on identifying and containing the hotspots of problematic crocodiles. In this study, we identified cold-moderate spots and hotspots of Nile Crocodile clusters. High concentrations or hotspots ($Z > 2$) were located at the Ndirizera Pools along the Sengwa River, with cold-moderate spots located in the Kove River. Intermediate (non-hotspot) sections were observed along the Sengwa River. Thus, we infer that Nile Crocodile hotspots pose a threat to adjacent peripheral communities and their livestock. Our findings on nesting in the Kove River strengthen the need for inclusion of cold-moderate spots in the conservation of crocodiles, as they may provide suitable breeding grounds.

Overall, we found 82 Nile Crocodiles (average encounter rate = 2.28 Nile Crocodiles per km) in the Kove and Sengwa rivers. Variation was recorded in population size and structure of Nile Crocodiles characterized with a predominant juvenile population, and differences in crocodile clusters and abundance between the two study rivers. Differences in length, width and availability of suitable habitats between the two rivers may account for differences in crocodile population structure and distribution, with the influence of sampling time having a likely impact on the high juvenile population numbers observed. It is possible the two rivers share the same crocodile population; hence, hotspot clusters pose a threat to adjacent human communities and livestock. River habitat alterations mainly due to human activities should be explored for their impact on feeding and breeding ecology and movement patterns of crocodiles in this protected area.

The current study provides valuable information on the population size, structure, and distribution of Nile Crocodiles in SWRA. These data can be used for effective ecosystem management, law enforcement, and the development of a conservation action plan and strategy of Nile Crocodiles for the SWRA and adjacent areas. We recommend continued monitoring and research (using both day and night surveys) so as to examine long-term population trends and spatial dispersion of Nile Crocodiles in SWRA.

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Literature Cited

Amarasinghe, A.A.T., M.B. Madawala, D.M.S.S. Karunarathna, S.C. Manolis, A. de Silva., and R. Sommerlad. 2015. Human-crocodile conflict and conservation implications of Saltwater Crocodiles (*Crocodylus porosus*) (Reptilia: Crocodylia: Crocodylidae) in Sri Lanka. Journal of Threatened Taxa 7:7111–7130.

Bourquin S.L., and A.J. Leslie. 2011. Estimating demographics of the Nile Crocodile (*Crocodylus niloticus* Laurenti) in the panhandle region of the Okavango Delta, Botswana. African Journal of Ecology 50:1−8.

Calverley P. 2013. The conservation ecology of the Nile Crocodile (*Crocodylus niloticus*) at Ndumo Game Reserve in North Eastern KwaZulu-Natal and the Rio Maputo Floodplain in South Eastern Mozambique. Ph.D. dissertation. University of KwaZulu-Natal, Pietermaritzburg, South Africa. 232 p.

Calverley P.M., and C.T. Downs. 2014a. Population status of Nile Crocodiles in Ndumo Game Reserve, Kwazulu-Natal, South Africa (1971–2012). Herpetologica 70:417–425.

Calverley P.M., and C.T. Downs. 2014b. Habitat use by Nile crocodiles in Ndumo Game Reserve, South Africa: a naturally patchy environment. Herpetologica 70:426–438.

Cherkiss , M.S., F.J. Mazzotti and K.G. Rice. 2006. Effects of shoreline vegetation on visibility of American Crocodiles (*Crocodylus acutus*) during spotlight surveys. Herpetological Review 37:37–40.

Coulson, I.M. 1990. A preliminary check list of the amphibians and reptiles of the Sengwa Wildlife Research Area. Transactions of the Zimbabwe Science Association 64:49–53.

Fergusson, R. 2010. Survey of Crocodile Populations in Mozambique 2010. Volume 2, Part 5. Ministry of Agriculture, Maputo, Mozambique.

Gandiwa, E., I.M.A. Heitkönig, A.M. Lokhorst, H.H.T. Prins, and C. Leeuwis. 2013. Illegal hunting and law enforcement during a period of economic decline in Zimbabwe: a case study of northern Gonarezhou National Park and adjacent areas. Journal for Nature Conservation 21:133–142.

Garcia-Grajales, J., A. Buenrostro-Silva, and P. Charruau. 2012. Growth and age of American Crocodiles (*Crocodylus actus*) in La Ventanilla Estuary, Oaxaca, Mexico. Herpertological Conservation and Biology 7:330–338.

Getis, A., and J.K. Ord. 1992. The analysis of spatial association by use of distance statistics. Geographical Analysis 24:189–206.

Hutton, J.M. 1984. Population Ecology of the Nile Crocodile, *Crocodylus niloticus*, Laurenti 1768, at Ngezi, Zimbabwe. Ph.D. dissertation. University of Harare, Harare, Zimbabwe. 502 p.

Hutton, J.M., and M.E.J. Woolhouse. 1989. Mark recapture to assess factors affecting the proportion of a Nile Crocodile population seen during spotlight counts at Ngezi, Zimbabwe, and the use of spotlight counts to monitor crocodile abundance. Journal of Applied Ecology 26:381–395.

International Union for Conservation of Nature (IUCN). 2011. IUCN Red List of Threatened Species. Version 2011.2. www.iucnredlist.org.

Jablonicky, A.C. 2013. Spatial distribution of the Nile Crocodile (*Crocodylus niloticus*) in the Mariarano River system, Northwest of Madagascar. M.Sc. thesis. University of Southern California, Los Angeles, California, USA. 54 p.

Lainez, D. 2008. Nile Crocodile Database. World Conservation and Monitoring Centre, Cambridge, UK.

Leslie, A.J., and J.R. Spotila. 2001. Alien plants threaten Nile Crocodiles (*Crocodylus niloticus*) breeding in the Lake St Lucia, South Africa. Biological Conservation 98:347–355.

Mapaure, I. 2013. A preliminary simulation model of individual and synergistic impacts of elephants and fire on the structure of semi-arid miombo woodlands in North-western Zimbabwe. Journal of Ecology and the Natural Environment 5:285–302.

Mazvimavi, D. 2010. Hydrological changes over time of annual rainfall in Zimbabwe. Hydrological and Earth System Sciences 14:2671–2679.

McGregor, J. 2005. Crocodile crimes: people vs wildlife and the politics of postcolonial conservation on Lake Kariba, Zimbabwe. Geoforum 36:353–369.

Nyirenda, V. 2015. Spatial variability of Nile Crocodiles (*Crocodylus niloticus*) in the lower Zambezi River reaches. Herpetological Conservation and Biology 10:874–882.

Pooley, A.C. 1969. Preliminary studies on the breeding of the Nile Crocodile *Crocodylus niloticus*, in Zululand. The Lammergeyer 10: 22–44.

Shacks, V. 2006. Habitat vulnerability for the Nile Crocodile in the Okavango Delta, Botswana. M.A. thesis. University of Stellenbosch, Stellenbosch, South Africa. 86 p.

Tafangenyasha, C. 2000. Sengwa Wildlife Research Area Millennium Vision. Department of National Parks and Wildlife Management, Harare, Zimbabwe.

Thorbjarnarson, J.B. 1996. Reproductive characteristics of the order Crocodylia. Herpetologica 52:8–24.

Wallace, K.M, A.J. Leslie, T. Coulson, and A.S. Wallace. 2013. Population size and structure of the Nile Crocodile (*Crocodylus niloticus*) in the lower Zambezi Valley. International Journal of Fauna and Flora 43:457–465.

Zisadza-Gandiwa, P., E. Gandiwa, J. Jakarasi, H. van Der Westhuizen, and J. Muvengwi. 2013. Abundance, distribution and population trends of Nile Crocodile (*Crocodylus niloticus*) in Gonarezhou National Park, Zimbabwe. Water South Africa 39:165–169.

Mercy Sai graduated with a B.Sc. (Honours) degree in Wildlife and Safari Management from Chinhoyi University of Technology, Zimbabwe. She has a strong interest in herpetology and human-crocodile conflict in aquatic systems. (Photographed by Exeverino Chinoitezvi).

Beaven Utete is a Wildlife Researcher, Lecturer, and Research Fellow at the Chinhoyi University of Technology in the School of Wildlife, Ecology, and Conservation with interests in aquatic ecology, fisheries, small mammals, and reptiles. He has a strong interest in the betterment of the livelihoods of peripheral communities living adjacent to fisheries and wildlife rich areas in Zimbabwe. (Photographed by Olga Kupika).

Exeverino Chinoitezvi is employed by the Zimbabwe Parks and Wildlife Management Authority, under the Scientific Services Department. He holds a Higher National Diploma in Wildlife Management and a Certificate in Geographic Information Systems, Remote Sensing and Global Positioning Systems from Mushandike College of Wildlife Management and Scientific & Industrial Research Development Centre (SIRDC), respectively. Currently he is studying towards a B.Sc. (Honours) degree in Wildlife Ecology and Conservation at Chinhoyi University of Technology, Zimbabwe. His research interests include wildlife evaluation techniques, spatial modelling, wildlife population dynamics, and plant ecology. (Photographed by Edson Marime).

Gilbert Hope Moyo is employed by the Zimbabwe Parks and Wildlife Management Authority as a Principal Ecologist at Sengwa Wildlife Research Institute. He holds a B.Sc. (Honours) degree in Agriculture and a M.Sc. degree in Tropical Resource Ecology both from the University of Zimbabwe. His current responsibilities include overseeing research efforts related to wildlife, fisheries, and natural resource utilization and conservation in Sengwa Wildlife Research Area and adjacent areas. He is also a visiting lecturer at Mushandike Wildlife Management College, Zimbabwe, and has been a field supervisor to a number of students from different universities undertaking their research work in Sengwa Wildlife Research Area and other protected areas in Zimbabwe. (Photographed by Exeverino Chinoitezvi).

Edson Gandiwa is a Professor of Wildlife Conservation and Management and an Executive Dean in the School of Wildlife, Ecology and Conservation at Chinhoyi University of Technology. Edson received his B.Sc. (Honours) degree from the National University of Science and Technology, Zimbabwe, M.Sc. degree from the University of Zimbabwe, and Ph.D. degree from Wageningen University, the Netherlands. In recent years, his research has focused on conservation biology, protected area management, human-wildlife interactions, media framing of wildlife conservation, and plant ecology. (Photographed by Patience Zisadza-Gandiwa).