



The Ruvuma

Expedition report, May 2015

Ecological Initiatives
Arusha Tanzania



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Background to survey

The Ruvuma River

The Ruvuma River forms the border between Tanzania and Mozambique (see information box), is one of the regions largest river systems, and at 800km long and draining an area of 155,500km², the Ruvuma provides both people and wildlife a permanent and reliable source of water in an otherwise dry region. The catchment of the Ruvuma River is predominantly the highlands east of Lake Nyasa (also known as Lake Malawi) but is also joined by two major arteries from northern Mozambique, the Lugenda and the Luchulingo rivers. The Ruvuma is bordered by a mosaic of protected areas: in Northern Mozambique the Niassa Game Reserve, covering an area of 42,000 km² of which 160 km is along the southern bank of the Ruvuma River; on the Tanzania side, a combination of forest reserves, game reserves and wildlife management areas forms an area of habitat protection of approximately 19,000km².

Information Box 1: A history of why the Ruvuma is the border between Tanzania and Mozambique¹

The Ruvuma River, or Rovuma as it was previously known, separates the countries of Tanzania and Mozambique. Whilst this large geographical feature seems like an obvious landmark for a border, its history is slightly more complicated. In 1886, a European border commission was set up to delineate the borders of what was then dominions of the Sultanate of Zanzibar, this sultanate was focused on the ocean and trade so did not consider the hinterland to be of any major territorial consequence. The boundary commission, dominated by the major European powers excluded Portugal, a nation that had already claimed territorial lands in what is now Mozambique. Since the sultanate extended south of the Ruvuma, a 'spat' now developed with Portugal ignoring the boundary commission and negotiating directly with the Sultanate, while the German Government laid claim to all lands under the Sultans control. In January 1887 the Portuguese broke of negotiations with the Sultanate in Zanzibar and sent gunboats to attack areas of the sultanate south of the Ruvuma near Palma causing "considerable damage to property and prestige". The Germans then responded by sending their own gunboats to Kionga Bay. The German-Portuguese conflict was finally resolved in 1894 when the 'Kionga triangle', an area of only 215 square miles south of the Ruvuma was conceded by the Portuguese to Germany. This area remained in German hands, all be it with further commissions and discussion, until after the First World War when the border was finally settled on the Ruvuma. This was not the end. The Ruvuma, like many rivers, changes its course, so there was constant discussion as to whether the 'thalweg' (the line of the river at its deepest point) or the bank formed the border, and several arguments broke out over the sovereignty of islands in this large river. This discussion continues today with many arguing that the river is a poor boundary as it artificially separates several tribal groups such as the Makonde who live together as both Tanzanian and Mozambique nationals.

The aims of this survey where to explore this little know region, specifically to gather much needed data for the Tanzania Bird Atlas and Mammal Atlas. The paucity of data in this area (see map 1) is due to lack of roads and challenging topography, making a river bound expedition the only viable option. This survey aimed to survey the atlas squares 3711c, 3711d, 3711b and 3811a (see map 1 and description of how Atlas systems work below).

¹ McEwan. A.C. 1971. International boundaries of East Africa. *Oxford Press*

Biodiversity Conservation

For the past half-century or more, global conservation goals have focused on saving endangered species and establishing protected areas, which now cover approximately 10% of the earth's land surface. While this protected area network creates a 'sink' of genetic diversity, many species of vertebrate, especially the larger mammals, continue to decline. Tanzania is no different and this decline in some areas is not surprising, as many of the core protected areas include only a small portion of the annual migratory or dispersal ranges of large herbivores. In other words, these areas often only protect a fraction of the greater ecosystems required to support such mammal populations.

Information box 2. Tanzania - Country Facts

Land Area	94.7 million ha.
Woodland (and forest)	35.3 million ha
Population	38.3 million
Population Growth	2.8%
GDP (USD)	933 per person
Largest income source	Agriculture (80% population)
Biocapacity	1.2 Global ha per person (below global average)
Ecological Footprint	1.2 Global ha per person (below global average)

In order to sustain biodiversity and to efficiently manage ecosystems, it is essential to monitor and reduce wildlife loss outside of core-protected areas by encouraging local participation in conservation efforts. Data collection and monitoring is one of those processes, which are crucial to increasing our knowledge of vertebrate distributions and thus targeting conservation efforts towards vital landscapes, such as migratory corridors. The quantification and distribution of species outside protected areas and the determination of the factors governing wildlife population trends are therefore necessary for the implementation of successful conservation policies within Tanzania.



Tanzanian Bird and Mammal atlas

Tanzania Bird Atlas

The earliest handbooks did not include maps, just mention of the few localities from where specimens had been collected and these were often very few indeed. One of the earliest regional handbooks to incorporate maps was *The Birds of the Belgian Congo*² that used maps for some species to show continental as well as regional distribution. Museum specimens carried details of their origins and as collections were enlarged such data were used to create distribution maps by “joining up the dots”. *Mackworth-Praed & Grant*³ used this method in their African Handbook of Birds, the maps being rather small and generally little more than thumbprints in the margins of the text. Meanwhile, in Europe mapping based on far larger collections was becoming more sophisticated, the first grid based book on bird distributions was *The Atlas of Breeding Birds in Britain and Ireland*⁴ to which nearly 15,000 people contributed. The predecessor to this monumental work using amateur enthusiasts to collect records was an Atlas of the British Flora (Perring & Walters 1962). Although a handful of other flora had been mapped using grids by individual botanists working in limited areas. Since the 1960s many countries (and far smaller units) across the world have created grid based bird atlases using a variety of scales to suit the size of the country, region or county being mapped and the number of observers available to meet the required target.

In Africa, bird atlases have been published with resolutions as coarse as 1 degree for the Sudan⁵ and as fine as 1/8th of a degree for Swaziland⁶. However, at the 5th Pan-African Ornithological Congress it was agreed that to ensure conformity across the continent the basic recording unit should be the 1/2° x 1/2° square. The East African Natural History Society established a mapping scheme for East Africa in the late 70s. It soon became apparent that coverage in Kenya was far in advance of Uganda and Tanzania and the emphasis shifted to efforts in individual countries. In Tanzania initial mapping was based upon the now standard quarter degree square but the first field cards designed in 1985 included for monthly data and an abundance code. The rationale for the former was the requirement for seasonality records and that most observers were resident and thus able to contribute regular data. Gathering abundance data in such large areas is problematic but it was felt at the time that an effort should be made in this regard and this has proved useful in identifying sites of importance for water birds where conservation values relate to numbers

The Tanzanian bird atlas and Tanzanian mammal atlas both have conservation management objectives at the core of their philosophy, providing bird and mammal distribution data free of charge to land managers and government agencies, allowing them to make better policy decisions and to include environmental management at every level of planning

Ideally an Atlas will cover a fixed time period to allow comparisons with future surveys, highlighting any population changes and establishing trends. By incorporating a year field the Tanzania Atlas allows for this and population trends in reporting rates have already been used for conservation purposes⁷.

Initially the locality field was used simply to define the square but this has evolved to allow site based species list for individual forests, lakes, protected areas etc. Creating species lists, abundance codes and viability codes for protected areas has been further enhanced by adding a field to the database that allows ready access of data for any designated National Park or Game Reserve. Initially no allowance was made for day dates but these have been added to allow analysis of migration patterns. No specific field for counts

² Chapin, 1932. The Birds of the Belgian Congo

³ *Mackworth-Praed & Grant*, 1952-1973. A Handbook to the Birds of Africa,

⁴ Sharrock, 1976. The Atlas of Breeding Birds in Britain and Ireland.

⁵ Nikolaus, 1987.

⁶ Parker, 1994.

⁷ (Morrison 2008, Baker 2008).

was incorporated in the early years of the project but these are now deemed of importance, especially for water birds⁸, adding yet another field to the database.

At the time of writing there are 1,023,001 records entered on the bird atlas database. 30,699 of these are breeding season records and 9,842 are egg months, the ultimate goal for breeding season definition. These records have come from almost 500 contributors and include some literature data deemed accurate enough to place within an Atlas square.



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Tanzania Mammal Atlas

The Tanzania Mammal Atlas, since it officially started in November 2005, aimed to help Tanzania meet its obligations under the International Biodiversity Conservation Action Plan for its mammal species. To achieve this, its focus was to strengthen national institutions and increase monitoring capacity and conserve mammal biodiversity by:

1. developing capacity to monitor mammal distribution and status in areas where little information is available
2. establish protocols to monitor small and cryptic species
3. collecting all existing information in a centralized database with data on the distribution status and, where possible, abundance, for all mammals excluding rodents, bats, insectivores and marine mammals given the difficulty of monitoring such species.

Overall, the project made significant progress. Its database continued to expand to 21,600 sightings covering 87 of our target species (Appendix 2). Moreover, a historical database for mammals has also been established with about 10,600 sightings of 70 species. The coverage is much improved although there is still a bias towards protected areas where most survey work is undertaken.



⁸ (Baker 1996, Baker & Baker 2002)

Survey aims and objectives

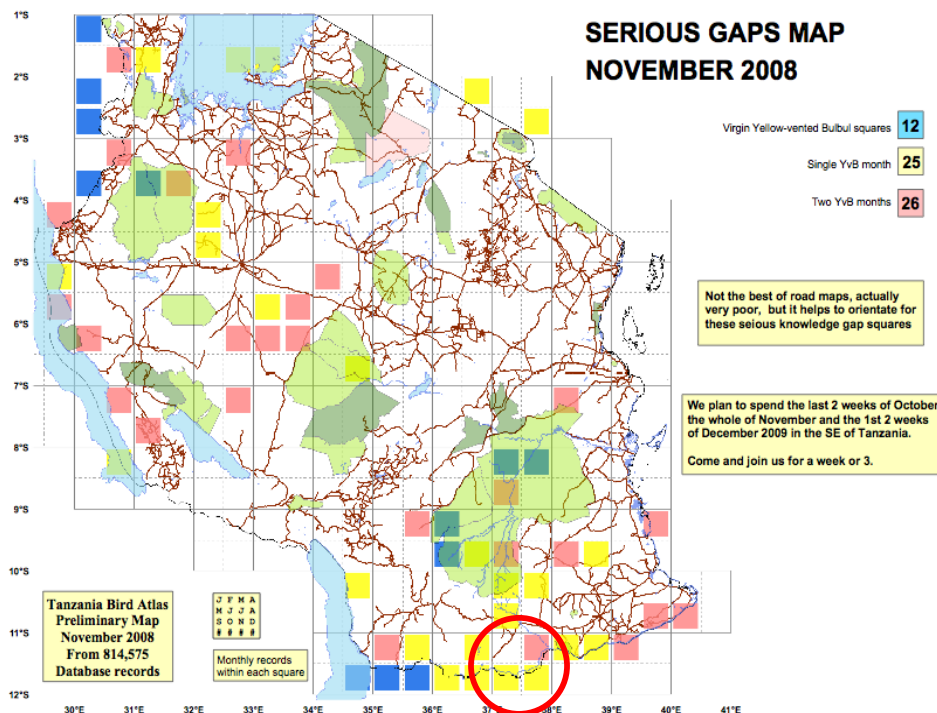
In order to establish what are known as ‘knowledge gaps’, we use the bird atlas map of Yellow-vented Bulbul (YVB), (see map 1), that is a common and widespread generalist bird of central southern Africa. This bird is a classic ecological indicator and is only absent from high montane forest and extreme desert. If we analyse its presence or absence within Tanzania, we are able to see the overall coverage of records. By doing this it is easy to perceive the project’s specific goals, which are now to fill these gaps in our knowledge. By using negative data we are able to see the gaps for specific species and the months in which the gaps appear.

The objectives and study aims of this project are to support the ongoing effort of the Tanzania Bird Atlas and Tanzanian Mammal Atlas by collecting data through private sector support. Following the survey all the data collected is collated and supplied free to both projects. Both projects in return acknowledge the support of the survey team and the private donors in written documentation and in writing. The authors (see appendix) also intend to publish the data that will give full acknowledgment to the private supporters of this expedition.

Study area

All national atlas based projects work on a quarter degree square basis, in distance terms this equates to a 50km x 50km square. In collaboration with the coordinators of the TBA and TMA the authors initially identified a section of the Ruvuma river from 36 30 E to 38 E (see map 1 and map 2. below).

Map 1: Tanzania Bird Atlas – Map of Tanzania



The red circle indicates the survey area. The areas in light green are game reserves (Selous Game Reserve is shown clearly to the north of the survey area), the areas in dark green are national parks. The ¼ degree squares are colour coded to show areas that lack data, in our case two yellow squares and a pink square indicating there is data in this area collected during only one visit.



Map 2: Survey area along the Ruvuma River



Habitat types

The Habitat is mainly Miombo woodland of varying structure, height and species composition. The miombo woodlands are comprised of three dominant Genus; *Combretum* - *Brachystegia* - *Pericopsis*. Depending on aspect and soil type, the dominant species include: *Combretum colinum*, *Combretum adenogonium*, *Brachystegia spiciformis*, *Pericopsis angloensis*, *Diplorynchos kondokapa*, *Xeroderris stuhlmanii*, *Tamarindus*

indica and *Pterocarpus tintorius*. Much of the Miombo bordering the river and adjacent rivers is closed canopy gallery woodland dominated by *Syzygium* Spp.

For ecological purposes the area can be spilt into five main habitat types, shown in order of percentage cover;

Woodland: Dominated by *Brachystegia speciformis*,

Woodland / Grassland: Dominated by *Acacia polyacatha*, *Acacia tortillis* and *Balanites aegyptica*.

Closed thicket: Comprising *Terminalia* spp., *Comberetum* spp. and *Commiphora* spp.

Complex Thicket: Comprising *Acacia* spp., *Terminalia* spp. and *Commiphora* spp.

Riverine woodland: Dominated by *Syzygium* spp.



Methodologies

Mammal survey

Rapid faunal assessments can use different methods depending on environmental conditions and costs; therefore, the choice of a proper and efficient methodology is fundamental to maximize the cost–benefit ratio. Both direct and indirect methods can be used to survey mammals, but usually track census is the most effective method for detecting richness, followed by camera trapping and direct faunal count.

The purpose of this survey was to make a mammal checklist within the study area rather than finding animal population abundance estimates and densities that can be derived from a variety of aerial and foot

survey techniques (distance and line transect sampling methods) and more intensive mark-recapture methodologies. Aerial methods are excellent for bigger mammals in open areas such as savannahs, wetlands and open water and like most surveys they improve with sampling intensity and sampling quality (aircraft and observer capacity). Where visibility is limited (such as forests and woodlands) or in mixed habitat (forest-savannah mosaics), and time is short, the best results are obtained with line-transect foot surveys. Surveys on foot provide a good idea of realities on the ground; it allows the sampling of smaller mammals too and the assessment of human pressures (poaching and habitat degradation) in all types of habitats, in a way that aerial surveys and mark-recapture surveys cannot.

1. Observation

Direct observations are to be carried out at all times within the survey area (map 2) which include the atlas squares 3711c, 3711d, 3711b and 3811a.

2. Camera traps – small / medium sized mammals

Camera trapping provides an important non-invasive tool for assessing presence of animal species in an area. Due to the lack of time no qualitative data (patterns of abundance throughout space and time, activity patterns, habitat use and reproductive information) will be collected but the camera trapping will focus on animal presence. Camera traps will be placed along animal trails during the night only.

3. Baiting – small / medium sized nocturnal mammals

A very useful technique to identify species in an area is through baiting: 2x2m wet soil beddings are set up during the night in the study area and checked for prints and scat the following day. Baiting is very useful to attract nocturnal animals as well as cryptical ones difficult to survey with direct methods. The type of bait can greatly affect the type and numbers of the catch (Willan, 1986b). To attract carnivores we will use dagà (local dry fish).

As the focus of the mammal survey is to identify animal species in the area rather than abundance, camera traps will be baited too.

4. Prints

Prints provide the most detailed information on the identity and the activities of animals in the wild. Although in nature it is difficult to find two individuals of the same species with identical prints, there are “ideal” prints and patterns that help in the identification.

Species can be recognised by general characteristics, however, each individual's spoor has its distinctions due to the age, mass, sex of the animal as well as the terrain. While the spoor of most of the larger mammals reveals the particular species to which they belong, those of smaller animals may indicate only the broader genus, family or order. Therefore, the smaller the animal and the more difficult it becomes to classify it. The clearest prints tend to be left in damp, slightly muddy earth, wet sand, on dirt roads or paths although one has to consider that the size could appear slightly bigger. Visualizing the shape of prints in soft sand is always difficult because the edges blur and, similarly, hard ground may only reveal claw marks.

5. Droppings

Faeces are amongst the most useful of these auxiliary signs as some are very specific (eg those of elephants are large and rounded). However, not all are easy to identify. Antelope tend to have similar shaped droppings, pellet-like, with a point at one end and an indentation at the other, so it can be hard to identify a particular species from this sign alone. In these cases checking distributions and giving a rough size of the animal (small, medium, large) is the best one can do.

Most mammal carnivores leave narrow, cylindrical droppings and they often reveal what an animal eats. Omnivores such as baboons show hair as well as seeds, carnivores show bone and hair. Hyaenas, and sometimes lions, produce droppings that are dry to a whitish crystalline form from high calcium content of their bone diet, whereas a civet's are characterized by a mixture of millipede shells, fruit pips, insect husks and fur and bone from tiny mammals they feed on.

Many animals use their faeces to mark their territories and a few latrines were found during the survey (rock and bush hyraxes, civettries). In these cases the animal, or more animals, return to the latrine which shows huge quantities of waste.

Bird survey

1. Observation

General observations were carried out at all times within the survey area (map 2) which include the atlas squares 3711c, 3711d, 3711b and 3811a. This includes all the habitat types encountered; riverine, woodland, grassland, wetlands and cultivated areas. Species are identified by sight and by call; the latter being particularly the case for nocturnal birds and some of the more inconspicuous passerines. All raptors will be geo-referenced and added to the Tanzanian Bird Atlas, this data is also added to the Africa Raptor Database.

2. 500m geo-referenced species counts to habitat link

In order to survey all of the habitat types bordering the river, regular stops will allow the team to conduct 500m geo-referenced counts. These counts will make a note of habitat, disturbance and all species of birds recorded within 500m.



Results

The expedition was able to access the river in the area planned, south of Tulingane at S11.68814 - E37.38838 and was also able to navigate through the Sunda Rapids (an area we knew based on studying both 1:50,000 and satellite maps could be a problem) to the Lukiwika Game Reserve. Over a period of eight days the team covered 152 km, with the longest distance in a day of 33km and the shortest 6km (in the Sunda gorge) (see map 3).

Over the eight-day period the team recorded 131 species of birds based on 347 individual day records and made a number of important observations, including 3 records for Pel's Fishing Owl, 300+ records of Rock Pratincole, 2 records of White-backed Night Heron and the confirmation of the presence of White-fronted Plover. The team recorded 110 records of mammals of which 34 sight records, 2 by call only and 74 by spoor, 22 of which were identified from dropping. Of note was a marked lack of Elephant spoor in an area previously known to hold significant populations of this conspicuous mammal. The survey's records of Cape Clawless Otter have extended previous range maps for this species.

Species accounts

Rock Pratincole *Glareola nuchalis*

Known from the Rufiji River and rocky islands on Lake Victoria⁹ the team expected to at the very least encounter this species on the Ruvuma based on ad hoc historical records. During day 2-3 we recorded several hundred pairs and in some areas pairs occurred every 100m. In these areas we also recorded several juvenile and sub adult birds. Whilst subjective, the concentrations of Rock Pratincole seemed to be in areas where the river is rocky and wide where rocks are rarely submerged even during annual flooding. Where annual flooding submerges large areas of the river, such as the Sunda rapids no Rock Pratincole were recorded even though at first glance it is ideal habitat.

White-fronted Sandplover *Charadrius marginatus*

A mainly coastal species, White-fronted Sandplover is known to extend inland along major rivers. Several pairs were observed in slow flowing areas and on sand bars in the centre of the river during day 1-2. This species was not observed beyond day 2 when the river was rocky and faster flowing.

Pel's Fishing Owl *Scotopelia peli*

A rare large Owl found only along slow flowing rivers. Whilst known from several rivers in the Selous Game Reserve, this species was previously unrecorded from the Ruvuma river where we made 3 observations during the survey, two as we disturbed a bird from a roost by the river and one calling at night. This large enigmatic species is often heard if present and offers some idea of how poorly known this river is.

White-backed Night Heron *Gorsachius leuconotos*

A rare and localised species of heron known to be secretive, occurring in riparian habitats along major rivers, mangrove and lakeside vegetation. Rarely recorded due to its nocturnal nature and habit of roosting in shaded vegetation overhanging water. The survey team had three separate sightings of this species in riverside vegetation.

⁹ Britton, P.L.(ed.)1980. *Birds of East Africa*. Nairobi: EANHS.

Map 3: Survey Transect.



Options for the future – improved conservation of the Ruvuma

We see two options for increasing the conservation value of this area, both of which add much needed economic benefit to this part of Tanzania.

Option 1. From a landscape conservation perspective, the vast and untapped Selous Niassa Wildlife Corridor (SNWC) has great wildlife potential, and designated protected areas through a combination of Village Land Forest Reserves and Wildlife Management Areas (WMA). A major tourism investment would have a good chance of creating some long lasting conservation impacts. This main corridor area has been well studied and chosen for its Elephant movement between 2003 onwards although bearing in mind that this was when our Elephant population was at its highest for a generation. The WMA structure allows for direct investment, keeps the land under local ownership (which is politically savvy), covers huge areas. Its worth noting that Due to the land laws it is not possible, or at least extremely difficult, to convert WMAs to a higher conservation status such as a National Park. The impact could be very high and certainly at a landscape level, one well constructed investment in say Kimbanda WMA could well attract a second, increasing likelihood of regular inbound flights and the opening up of the other WMAs to tourism.

Option 2. Parts of the area we surveyed in combination with Lukwika - Lumesule could, in theory, be quite easily converted to a National Park, especially the Game Reserve as it is currently gazetted as GR. The only problem is that it's a fairly small area so its greater conservation aims, such as that of larger migratory mammals would be low unless there were some quite serious improvements in Niassa GR. This option could create a small but ever increasingly isolated National Park, potentially too small for viable Elephant populations and certainly isolated from the Selous Game Reserve to the north.

Consultants



The team from left to right; Gian, Marc, Alessandra and Jo.

Mammal specialist

Alessandra Soresina

Alessandra has worked on a number of wildlife projects around the world. In Saadani Game Reserve in Southern Tanzania, she was involved in a mammal monitoring project which led to Saadani being upgraded to a National Park. In 2001 she setup the lion project in Tarangire National Park, northern Tanzania, and for over 5 years Alessandra has concentrated her efforts on lion – human interactions. In this time she has made a huge contribution to what is known about lions in and around the Tarangire ecosystem. One of her major goals was implementing the radio-tracking program in Tarangire, which has allowed conservationists and national park management to fully understand Lion movements in the Tarangire ecosystem. After setting up a snow leopard project in the Himalayas with the Università degli Studi di Siena, she is now involved in mammal monitoring projects in Mozambique, Tanzania, Gabon and Botswana which are essential to the implementation of new protected areas.

Bird Atlas Specialist

Marc Baker

Marc is the owner and director of Ecological Initiatives Ltd, a Tanzanian company working on supporting forestry and wildlife conservation in Tanzania. Based in Arusha, Marc has worked in conservation and ecotourism since 1998. Initially as an ornithologist for the United Nations Development Program – Global Environmental Fund cross border biodiversity project from 1998 – 2000 conducting a range of biodiversity

surveys in Tanzania and Kenya. As a wildlife specialist Marc works on a wide variety of ecological issues, such as wildlife management, out of protected area tourism viability and carbon forestry for Danida (Danish Development Agency), Care International, the Wildlife Division of Tanzania and the Tanzania bird atlas.

Jo Anderson

Biologist and conservationist St. John (Jo) Anderson moved to East Africa in 1995 shortly after graduating from Oxford University. He has since conducted wildlife research and environmental work throughout East Africa, has guided climbs of Mount Kilimanjaro more than 50 times, and has lead specialist travel groups on safaris in Tanzania, Kenya, Rwanda, Botswana, Mozambique, South Africa, Uganda, and Zambia. Jo is a founding partner in Carbon Tanzania, which recently became the first organization in Tanzania to develop a community-led forest-based carbon offset project, working with the hunter-gatherer Hadza people of Northern Tanzania. He lives with his wife and two children in Arusha, Northern Tanzania.

Adventure sport specialist

Gian Schachenmann

Gian holds a degree in ecology and fisheries management. Gian has worked on Rubondo Island in Lake Victoria, and built bushcamps in Tarangire and Serengeti National Parks. He also spent a great deal of time in the remote areas of Loliondo, where he has guided walking safaris and captured some of the finest wild dog photographs. Gian has formal training and certification as a walking safari guide, is a member of the Interpretive Guides Society, and has a pure love of adventure. In his free time, Gian can be found building canoes in his backyard, climbing volcanoes, or adventuring across Tanzania on his motorbike or paramotor.



Budget

ITEM	COST/DAY (USD)	Days/unit	TOTAL COST(USD)
Vehicle	120	13	1800
Fuel	0.4/km 1500km		600
Food	10usd pppd	13	520
Survey team expenses	150	13	1950

AS			
MB	150	13	1950
JA	150	13	1950
GS	150	13	1950
OPERATING COSTS			
Flight**		1	1200
Canoes	450	4	1800
TOTAL			13,720

*This figure includes all data collection, production of the report in both hard and digital format. All hidden costs such as production materials, survey equipment and field equipment.

** Required flight is for Alessandra Soresina only.

Appendix I: Bird Species recorded by day and location.

The survey recorded 130 species of birds from 347 records.

Date	Ref	Spp	Lat	Long
22/11/2014	On river	Little Bee-eater Open-billed Stork African Skimmer Bateleur Wire-tailed Swallow Hammerkop Violet-backed Starling Yellow-vented Bulbul Red-eyed Dove White-headed Plover Little Stint White-fronted Sandplover Common Sandpiper Trumpeter Hornbill Pied Kingfisher Malachite Kingfisher Black Cuckoo Red-chested Cuckoo Greenshank Green-backed Heron Little Egret Brown-hooded Kingfisher Giant Kingfisher Water Thick-knee Common Waxbill Yellow-billed Stork Tropical Boubou Eurasian Bee-eater Yellow-billed Kite Ring-necked Dove Egyptian Goose Pied Wagtail Chestnut-bellied Kingfisher White-fronted Bee-eater Terrestrial Brownbul Tawny-flanked Prinia Red-cheeked Cordon-bleu Rock Pratincole Purple Heron Black-and-white Shrike Flycatcher Grey Heron		
22/11/2014	Sq Boundary	Little Sparrowhawk	11.61304	37.50343
23/12/2014		African Golden Oriole Water Thick-knee Bronze Mannikin Yellow-billed Kite Ring-necked Dove Red-eyed Dove Village Weaver Little Bee-eater Bohm's Bee-eater		

	Purple-crested Turaco		
	Pied Kingfisher		
	Pied Wagtail		
	Barred Owlet		
	White-browed Robin Chat		
	Yellow-vented Bulbul		
	White-fronted Sandplover		
	Yellow-billed Stork		
	White-headed Plover		
	Dickenson's Kestel		
	Barn Swallow		
	Green Pigeon		
	Lesser Masked Weaver		
	African Golden Weaver		
	Black Cuckoo		
	Bohm's Bee-eater		
	Water Thick-knee		
23/11/2014	On river		
	Scarlet-chested Sunbird		
	Wire-tailed Swallow		
	African Golden Weaver		
	Lesser Masked Weaver		
	Black Sparrwohawk		
	Yellow-vented Bulbul		
	Pied Wagtail		
	Hadada Ibis		
	Grey Go-away Bird		
	African Finfoot		
	Trumpeter Hornbill		
	European Swift		
	Rock Pratincole		
	Emerald Cuckoo		
	Giant Kingfisher		
	White-winged Tern		
	African Golden Oriole		
	Tropical Boubou		
	Common Sandpiper		
	Brown-hooded Kingfisher		
	Great White Egret		
	Egyptian Goose		
	Red-chested Cuckoo		
	Emerald-spotted Wood Dove		
	Bateleur	11.60498	37.62499
	Martial Eagle	11.60498	37.62499
	Yellow-billed Stork		
	African Broadbill		
	Osprey	11.62446	37.58601
	Green-backed Heron		
	Rufous-bellied Heron		
	Eurasian Bee-eater		
	Piping Cicticola		
	Red-backed Shrike		
	African Skimmer		
	Pel's Fishing Owl	11.58962	37.64303
	Bohn's Spinetail		
	Gymnogene	11.57631	37.66312
	Palm Swift		
	Gabar Goshawk		
	White-fronted Bee-eater		
	Purple-crested Turaco		

		Water Thick-knee		
		Wahlberg's Eagle	11.56414	37.69815
		Tawny-flanked Prinia		
		Little Bee-eater		
		Tropical Boubou		
		Green Pigeon		
		Southern Banded Snake Eagle	11.55641	37.72702
		Common Drongo		
24/11/2014	500m count	Knob-billed Duck	11.55213	37.73671
		African Skimmer		
		Tropical Boubou		
		White-browed Robin Chat		
		Yellow-vented Bulbul		
		Terrestrial Brownbul		
		Purple-crested Turaco		
		Piping Cisticola		
		Tropical Boubou		
		White-headed Plover		
		Greenshank		
		Common Sandpiper		
		African Broadbill		
		White-browed Coucal		
		Sulphur-breasted Bushshrike		
		Crested Francolin		
		Brown-hooded Kingfisher		
		Saddle-billed Stork		
		Common Drongo		
		Emerald-spotted Wood Dove		
		Trumpeter Hornbill		
		Crowned Hornbill		
		Palm Swift		
		Water Thick-knee		
		Pied Wagtail		
		White-bellied Sunbird		
		Broad-billed Roller		
		Black-backed Puffback		
		Grey-backed Camaroptera		
		Bateleur		
		Dickenson's Kestel		
		Wahlberg's Eagle		
		Yellow-bellied Greenbul		
		African Golden Oriole		
		African Golden Weaver		
24/11/2014	On river	Steppe Buzzard	11.54228	37.7543
		Dark Chanting Goswhawk	11.54228	37.7543
		Bateleur	11.54228	37.7543
		Bohm's Bee-eater		
		Common Sandpiper		
		Pied Kingfisher		
		Pel's Fishing Owl	11.53676	37.75746
		Rock Pratincole		
		Grey Heron		
		Hadada Ibis		
		Green Wood Hoopoe		
		Osprey	11.51611	37.78036
		White-backed Vulture		
		Southern Banded Snake Eagle	11.51611	37.78036
		Bronze Mannikin		
		Half-collared Kingfisher		

24/11/2014	On river	Rock Pratincole Pied Wagtail Giant Kingfisher Pied Kingfisher Purple-crested Turaco Hammerkop Great White Egret Yellow-vented Bulbul Terrestrial Brownbul White-headed Plover Common Sandpiper White-fronted Bee-eater Little Bee-eater Greenshank Green-backed Heron European Swift Little Swift Palm Swift		
25/11/2014	500m count	Half-collared Kingfisher Peregrine Falcon Water Thick-knee European Hobby Pel's Fishing Owl Brown-necked Parrot Rock Pratincole Yellow-vented Bulbul White-headed Plover Palm Swift Red-chested Cuckoo Black-backed Puffback Collered Palm Thrush Livingstone's Flycatcher Trumpeter Hornbill Half-collared Kingfisher Village Weaver African Golden Weaver Malachite Kingfisher Helmeted Guineafowl Yellow-brested Apalis Scarlet-chested Sunbird White-bellied Sunbird Bohm's Bee-eater Hammerkop African Broadbill Tawny-flanked Prinia Yellow-fronted Canary Emerald-spotted Wood Dove Ring-necked Dove Orange-winged Pytilia Violet-backed Starling Spotted Flycatcher Village Weaver Common Drongo Pied Wagtail African Firefinch	11.37821	37.81377
25/11/2014	On river	African Fish Eagle Martial Eagle Bateleur Cliff Chat	11.36783 11.36783 11.36783	37.82679 37.82679 37.82679

26/11/2014	On river	Bronze Mannikin	11.29092	37.87094
		Lesser Striped Swallow		
		Wire-tailed Swallow		
		Violet-backed Starling		
		African Hawk Eagle		
		Giant Kingfisher		
		Common Sandpiper		
		Black-crowned Tchagra		
		Green Pigeon		
		Red-eyed Dove		
		Yellow-vented Bulbul		
26/11/2014	500m count	Hammerkop	11.30186	37.86703
		Purple-crested Turaco		
		African Hobby		
		Black-headed Oriole		
		Bateleur		
		White-headed Plover		
		Pied Kingfisher		
		Tropical Boubou		
		Freckled Nightjar		
		Water Thick-knee		
		Egyptian Goose		
		Violet-backed Starling		
		Yellow-fronted Canary		
		Yellow-fronted Tinkerbird		
		Barred Owlet		
		African Wood Owl		
		Emerald-spotted Wood Dove		
Hooded Vulture				
27/11/2014	On river	Helmeted Guineafowl	11.26247	37.91135
		Brown Snake Eagle		
		Rock Pratincole		
		African Skimmer		
		White-headed Plover		
		Water Thick-knee		
		African Golden Weaver		
		Lesser Masked Weaver		
		White-backed Night Heron		
		Black-crowned Night Heron		
		Green-backed Heron		
		Black Heron		
		Grey Heron		
		African Fish Eagle		
		Cattle Egret		
		Yellow-billed Stork		
		Woolly-necked Stork		
		Black Coucal		
		African Hobby		
		White-fronted Bee-eater		
		Little Bee-eater		
		Half-collared Kingfisher		
		Malachite Kingfisher		
Giant Kingfisher				
27/11/2014	500m count	Long-tailed Cormorant		
		White-browed Robin Chat		
		Hammerkop		
		White-headed Plover		
		Yellow-billed Stork		
Pied Kingfisher				

		Little Egret		
		African Skimmer		
		Saddle-billed Stork		
		Egyptian Goose		
		Fiery-necked Nightjar		
		Barred Owlet		
		Freckled Nightjar		
		Green Pigeon		
		Water Thick-knee		
		Ring-necked Dove		
		Emerald-spotted Wood Dove		
		Black-backed Puffback		
		Trumpeter Hornbill		
		Knob-billed Duck		
28/11/2014	On river	White-backed Night Heron		
		Half-collared Kingfisher		
		Giant Kingfisher		
		Pied Kingfisher		
		Great White Egret		
		Grey Heron		
		African Golden Weaver		
		Lesser Masked Weaver		
		Hammerkop		
		Yellow-billed Stork		
		African Skimmer		
29/11/2014	500m count	Rock Pratincole		
		Giant Kingfisher	11.27237	38.17319
		Palm Swift		
		Greenshank		
		Three-banded Plover		
		African Broadbill		
		Woolly-necked Stork		
		Yellow-brested Apalis		
		Bohm's Bee-eater		
		Yellow-vented Bulbul		
		Red-eyed Dove		
		Emerald-spotted Wood Dove		
		East Coast Batis		
		Purple-crested Turaco		
		Dark-backed Weaver		
		Violet-backed Starling		
		Livingstone's Flycatcher		
		White-bellied Sunbird		
		Green Sandpiper		
		Long-crested Eagle		
		Pied Wagtail		
		African Golden Weaver		
		African Hawk Eagle		
		Bateleur		
		Malachite Kingfisher		
		Eastern Nicator		
		Hooded Vulture		
		Eurasian Bee-eater		
		Half-collared Kingfisher		
		White-backed Vulture		
		Great White Egret		
		Brown-hooded Kingfisher		
		Pied Kingfisher		
		African Fish Eagle		

Helmeted Guineafowl

Appendix II: Geo-referenced mammal list, 26 species from 110 records.

latitude	longitude	date	mammal	type	number	fresh /old	Comment
-11.61295099	37.50321801	22/11/2014	elephant	t	1a 1j	f	
-11.61413401	37.50332999	22/11/2014	cape clawless otter	t			
-11.608954	37.52093098	23/11/2014	elephant	d		o	
-11.606437	37.525018	23/11/2014	vervet monkey	s	1		
-11.615872	37.55497098	23/11/2014	elephant	d		o	
-11.61639897	37.55595502	23/11/2014	vervet monkey	s	5		
-11.61864398	37.56116403	23/11/2014	elephant	d		o	
-11.62090902	37.56675996	23/11/2014	hippo	d		f	
-11.62446404	37.57327496	23/11/2014	elephant	d		o	
-11.62078799	37.59271704	23/11/2014	hippo	t		f	
-11.61035797	37.621632	23/11/2014	vervet monkey	s	2		
-11.57880102	37.65484798	23/11/2014	elephant	d		o	
-11.57504903	37.66773499	23/11/2014	hippo	s			
-11.57250898	37.67528398	23/11/2014	bushbuck	t			
-11.56127203	37.70829703	23/11/2014	elephant	d		o	
-11.55194901	37.73677002	23/11/2014	buffalo	t			
-11.55206803	37.73672299	23/11/2014	buffalo	t			
-11.55147099	37.73623802	23/11/2014	lion	t		f	
-11.54979402	37.73677999	23/11/2014	bushbuck	d		f	
-11.55109598	37.73626199	24/11/2014	waterbuck	d			
-11.55197298	37.734207	24/11/2014	waterbuck	d,t			
-11.55100697	37.73710596	24/11/2014	aardvark	t		f	
-11.53267398	37.76142103	24/11/2014	bushbuck	s	1		
-11.51778596	37.77853704	24/11/2014	yellow baboon	s	3		
-11.51611403	37.78036597	24/11/2014	elephant	t,d		o	mozambique side
-11.51259799	37.78395602	24/11/2014	elephant	d		o	mozambique side
-11.50956097	37.78578102	24/11/2014	elephant	t,d		f	mozambique side
-11.506934	37.78598503	24/11/2014	hippo	t			
-11.506934	37.78598503	24/11/2014	bushbuck	t			
-11.50334302	37.78589702	24/11/2014	elephant	d		o	
-11.48832198	37.78874896	24/11/2014	elephant	d		o	
-11.47722702	37.78123199	24/11/2014	yellow baboon	s			
-11.47722702	37.78123199	24/11/2014	hippo	s	1		
-11.43868603	37.782385	24/11/2014	hippo	s	>10		
-11.43126897	37.785592	24/11/2014	hippo	s	1		
-11.43012601	37.78547801	24/11/2014	cape clawless otter	t			
-11.41694304	37.79422201	24/11/2014	elephant	d		o	
-11.41616503	37.79517503	24/11/2014	bushbuck	s	1		
-11.383415	37.81469498	24/11/2014	hippo	s	11		
-11.37937602	37.81213799	24/11/2014	hippo	t		f	
-11.37869599	37.81212701	24/11/2014	hippo trail fresh	t		f	
-11.37835	37.81352	24/11/2014	hippo	s,t		f	
-11.37835	37.81352	24/11/2014	cape clawless otter	t		f	

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-11.37835	37.81352	24/11/2014	elephant	t,d		o
-11.37835	37.81352	24/11/2014	bushbuck	t		f
-11.37835	37.81352	24/11/2014	waterbuck	t		f
-11.37835	37.81352	24/11/2014	lesser bushbaby	c	1	
-11.37837597	37.81191101	25/11/2014	sable	t		o
-11.37803	37.81157	25/11/2014	zorilla	t		f
-11.37803	37.81157	25/11/2014	white tailed mongoose			
-11.37803	37.81157	25/11/2014	vervet monkey			
-11.37803	37.81157	25/11/2014	waterbuck			
-11.37832602	37.81184102	25/11/2014	waterbuck	t		f
-11.377805	37.81040797	25/11/2014	greater kudu	t		o
-11.37222801	37.81705298	25/11/2014	hippo	s	>10	
-11.367997	37.82702702	25/11/2014	yellow baboon	s	10	
-11.36772903	37.82684497	25/11/2014	elephant	d		o
-11.36772903	37.82684497	25/11/2014	hippo	t		f
-11.367551	37.82685804	25/11/2014	lion	t		f
-11.36107598	37.82715099	25/11/2014	bush hyrax	s		
-11.34825703	37.82858999	25/11/2014	hippo	s	1	
-11.33666804	37.82933104	25/11/2014	hippo	d , t		f
-11.31643396	37.83001903	26/11/2014	cape clawless otter	t		f
-11.31403699	37.83025296	26/11/2014	cape clawless otter	t		f
-11.30682101	37.85609202	26/11/2014	bush hyrax	s	5	
-11.30679603	37.85610401	26/11/2014	yellow baboon	s	3	
-11.30679997	37.85610099	26/11/2014	klipsringer	s	1	
-11.28840596	37.87524903	26/11/2014	greater kudu	t		
-11.29094	37.8709	26/11/2014	hippo	s	1	
-11.29094	37.8709	26/11/2014	lesser bushbaby	s	1	
-11.28967498	37.87378698	26/11/2014	tree hyrax	s		
-11.28967398	37.87377197	26/11/2014	bush squirrel	s	2	
-11.27766204	37.896283	27/11/2014	hippo	s	9	
-11.25813397	37.91792801	27/11/2014	yellow baboon	s	1	
-11.26487997	37.999282	27/11/2014	hippo	s	>10	
-11.26148396	38.00568896	27/11/2014	elephant	d		o
-11.26148396	38.00568896	27/11/2014	buffalo	t,d		o
-11.27218899	38.04592998	27/11/2014	hippo	s	>10	
-11.276864	38.06252799	27/11/2014	hippo	t		
-11.27351199	38.07664404	28/11/2014	hyaena	t		f
-11.27349498	38.07686498	28/11/2014	duiker	d		
-11.27402002	38.07724401	28/11/2014	greater kudu	d		o
-11.27339498	38.07635796	28/11/2014	cape clawless otter	t		f
-11.27335601	38.07694	28/11/2014	leopard	t		f
-11.27278604	38.07716296	28/11/2014	cape clawless otter	s	1	
-11.27003099	38.08193503	28/11/2014	hippo	t		f
-11.25614	38.11067297	28/11/2014	waterbuck	s	3	
-11.25614	38.11067297	28/11/2014	elephant	d		o
-11.25768998	38.11535996	28/11/2014	elephant	d		o
-11.26029097	38.12098598	28/11/2014	hippo	t		f
-11.26084501	38.12295204	28/11/2014	hippo	t		f

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-11.26483798	38.127144	28/11/2014	elephant	d		o
-11.26606199	38.12885902	28/11/2014	elephant	d		o
-11.27091503	38.13617701	28/11/2014	hippo	t		
-11.27091503	38.13617701	28/11/2014	yellow baboon	s	2	
-11.27584904	38.14070097	28/11/2014	hippo	t		
-11.27950304	38.14182297	28/11/2014	hippo	s	>10	
-11.272564	38.16389898	28/11/2014	hippo	s	>10	
-11.272334	38.173179	29/11/2014	chequered elephant shrew	s	1	r. cirnei macrurus
-11.272334	38.173179	29/11/2014	lion	c		
-11.272334	38.173179	29/11/2014	waterbuck	s	5	
-11.272334	38.173179	29/11/2014	bushbuck	s	1	
-11.272334	38.173179	29/11/2014	tree squirrel			
lukwika-limesule game reserve		29/11/2014	impala	s		
lukwika-limesule game reserve		29/11/2014	warthog	s		
lukwika-limesule game reserve		29/11/2014	banded mongoose	s		
lukwika-limesule game reserve		29/11/2014	buffalo			
lukwika-limesule game reserve		29/11/2014	greater kudu			
lukwika-limesule game reserve		29/11/2014	elephant			
lukwika-limesule game reserve		29/11/2014	sable			
