CONSIDERATION OF PROPOSALS FOR AMENDMENT OF APPENDICES I AND II

Proposals concerning export quotas for specimens of Appendix-I or -II species

A: PROPOSAL

Maintenance of the Tanzania population of *Crocodylus niloticus* Laurenti, 1768 in Appendix II subject to an export quota of 1100 for 1998, 1100 for 1999 and 1100 for 2000.

B: PROPONENT

The United Republic of Tanzania

C: SUPPORTING STATEMENT

1. Taxonomy

1.1	Class:	Reptilia
1.2	Order:	Crocodylia
1.3	Familiy:	Crocodylidai
1.4	Species:	*Crocodylus niloticus* Laurenti 1768
1.5	Scientific synonyms:	None
1.6	Common names:	
	English:	Nile crocodile
	French:	Crocodile du Nil
	Spanish:	Crocodrilo del Nilo
	Swahili:	Mamba
1.7	Code numbers:	A-306.002.001.006

2. Biological Parameters

2.1 Distribution

Two species of crocodiles occur in Tanzania. The slender snouted crocodile (*Crocodylus cataphractus*) has a limited range. It is almost confined to Lake Tanganyika in western Tanzania.

The Nile crocodile (*Crocodylus niloticus*) is wide spread and occurs throughout Tanzania. The species occurs in most fresh water lakes, rivers, swamps and man made dams. Several surveys including by Graham and Parker (1968), Hirji (1986), Hutton and Katalihwa (1988), Games and Severre (1989), Games and Severre (1990), Games and Severre (1993), Games and Severre (1995), and Games and Severre (1996) have shown that the Nile crocodile occurs in large river systems including;

(i) The Selous river system, which includes the Kilombero, Luwegu, Ruaha, Rufiji, Njombe and Matandu rivers.

(ii) The Rukwa system, which includes the Kavuu, Rungwa river with Lake Rukwa and Lake Chada.

(iii) The Lake Victoria system which includes the Grumeti and Mara rivers with Lake Victoria

(iv) The Lake Malawi system, which includes the Ruhuhu and Kiwira rivers with Lake Malawi.

(v) The Pangani system, which includes the river Pangani, Lake Mbuya, etc.

(vi) The Lake Tanganyika system, which includes Lake Tanganyika and the Malagarasi, Ugalla, and

(vii) The Ruvuma system, which comprises of the main Ruvuma river.

The swamps/wetland system includes the Kilombero, Moyowosi/Gombe, Ugalla, Mara and Pangani.

All those water bodies with the Nile crocodile occur throughout the country. Some water systems are restricted to national Parks in which consumptive use practices are prohibited.

2.2. Habitat availability

Crocodiles occur in stable habitats many of which are in National Parks and Game Reserves. Consumptive use practices are not allowed in National Parks (National Parks Ordinance Cap.412 of 1959). The crocodile management plan allows for collection of eggs/hatchlings from river/lake systems occurring in Game Reserves. Use of adult crocodile for skins is not allowed in Game Reserves.

The crocodile habitats in Game Reserves and National Parks are fully protected. All aquatic habitats in the protected areas are managed to encourage the increase of crocodiles. It should be noted that protected areas cover about 25% of Tanzania land surface .

Crocodile protection is also encouraged in Controlled and Open Areas. Habitats in these areas may not be fully protected since human activites like agriculture are practiced. But in the light of the current strategy of intergrating local communites with conservation degradation of habitats, including that of crocodiles, has significantly been reduced.

Law enforcement activities now receive significant attention from government. Extension services in conservation and involvenment of local communities in conservation all add up in ehancing protection of habitats for corocodiles

2.3 Population status

Tello (1985) estimated a total of 74,000 crocodiles. Hirji (1986) recommended to cull 1000 crocodiles from Lake Rukwa indicating an abundance of crocodiles in the lake.

Aerial surveys conducted in the Selous Game reserve indicate that the crocodile population is stable and infact increasing (Hutton and Katalihwa (1988), Games and Severre (1989), Games and Severre (1990), Games and Severre (1993) report stable and increasing numbers of crocodile populations in most parts of the country particularly in the Selous Game Reserve. Games and Severre (1995) have come up with a population size of 40,000 - 80,000 crocodiles for the Selous Game Reserve.

Games and Severre (1996) confirm that the average crocodile densities for the Ruaha river have remained constant since 1988. They ascertain that average crocodile densities for all rivers and lake Tagalala in the Selous Game Reserve show a remarkable increase. They also confirm that the Rufiji lakes in the Selous Game Reserve have a very high concentration of crocodiles and Lake Tagalala must be harbouring the highest size of population in Africa. Their survey showed a density of about 50 crocodiles per kilometer of shoreline. This was almost double the density observed in 1995.

Table 1. A summary of crocodile densities in the Selous Game Reseserve from aerial survey estimates:

PLACE	GRAHAM/ PARKER 1963	HUTTON/ KATALIHWA 1988	GAMES/ SEVERRE 1989	GAMES/ SEVERRE 1989	GAMES/ SEVERRE 1990	GAMES/ SEVERRE 1991	GAMES/ SEVERRE 1992
Ulanga (Upper Rufiji)	1.95 3.51	0.98	3.15	2.89	2.26	2.6	5.55
Lower Rufiji			6.75	11.83	10.49	10.1	19.98
Lake Tagalala				18.07	23.38	28.2	46.07
Ruaha		1.56	1.77	1.57	1.68	1.6	1.67
Kilombero		0.28	(7.74)	2.86	3.54	3.2	5.6
Upper Luwegu			2.74				
Lower Luwegu		0.33	1.64				

Table 2. Crocodile numbers in the Rufiji Lakes

LAKE	1991	1993	1995	1996
Tagalala	181	304	319	599
Manze	71		366	120
Nzerekera	79		139	187
Siwando	43		250	127
Mzizima	14		113	59

Rivers outside the Selous Game Reserve:

Crocodile densities on the Great Ruaha and around Rubondo Island National Park have increased (Games and Severre, 1996). Both of these areas have national park status and crocodiles are therefore 100% protected.

Crocodile densities in the Grumeti River have also increased (Game and Severre, 1996).

2.4 Population trends

Data from the most recent surveys (Games and Severre, 1993; Games and Severre 1996) within and outside the Selous Game Reserve indicate a stable and indeed a growing population (Tables 1, and 2). This scenario is a result of increased Law enforcement effort and minimal

disturbance to crocodiles and the in habitat. Using night counts for correction factors the lower Rufiji alone has upper and lower estimates of 4861 and 3950 crocodiles respectively (Games and Severre, 1993). A survey done recently indicates that crocodiles in the Selous Game Reserve river and lake systems have increased (Games and Severre, 1996). But Games and Severre (1996) are mindful that the pilots who flew the aircrafts and the survey crews are experienced resulting in spotting of more crocodiles. Games and Severre (1996) observe that more sightings seen in the October, 1996 survey indicate real increase in the population visible from the air. This augurs well with the observations from the October, 1995 survey where the Selous is estimated to harbour 40,000 - 80,000 crocodiles (Games and Severre, 1995).

2.5 Geographic trends

Crocodiles occur throughout the country as discussed in item 2 - of this document

2.6 Role of the species in the ecosystem

Crocodile hatchlings are prey to prodators. Adult crocodiles are predators. The Nile Crocodile is therefore an integral part of ecosystem dynamics in their areas of occurrence.

In areas outside protected areas the species interacts negatively with human beings. It is a potential threat to human life and his property.

2.7 Threats

Live specimens have not be exported from Tanzania. Tanzania ensures that all crocodile products are exported under strict rules and regulations that address the reguirements of CITES. Threats borne out of trade are therefore non-existent.

Crocodiles occurring in protected areas enjoy full protection from enhanced law enforcement activites. In Controlled and Open areas where crocodiles co-exist with human beings crocodiles are reknowned for damage directed to man and property. In cases where human beings have been killed it has been necessary for the local communities to find and kill the crocodiles. The current thinking in trying to curb this threat is to intergrate local communities with

crocodile based commercial activities. This allows for local communities to get direct benefits from such activities. In any case the Wildlife Conservation Act. Na.12 of 1974 offers full protection to the species irrespective of its areas of occurrence.

3. Utilization and Trade

3.1 National Utilization

Trade in crocodiles, parts or derivaties thereof do not occur within Tanzania. Tanzania has a policy and Management plan for crocodiles. This document clearly stipulates that utilization involves sport hunting and ranching. A wild quota, for skins, such as this one being asked for, is also recognized and is requested at each meeting of the conference of the parties. The policy and management plan is reviewed after every specific period of time. In the coming review some changes are envisaged in keeping with the changes in conservation strategies, for example involvement of local communities in aspects related to crocodile conservation.

Five crocodile ranches are operational in Tanzania. Two are based in Dar Es Salaam, two at Ifakara and one (new), at Pangani. Ranch owners are given permission to collect eggs or hatchlings from the wild for stocking purposes. Most areas of collection include the Selous Game Reserve which holds the most spectecular crocdile population in Africa. Table 3 shows the number of crocodiles in each of the ranches as at December 1996.

Table 3: Numbers of Crocodiles in Ranches

NAME OF RANCH	LOCATION	NUMBER OF CROCODILES IN RANCH DECEMBER, 1996	NUMBER OF EGGS/HATCHLINGS ON PERMIT FOR COLLECTION 1996
Hambo Crocodile Village	Dar es Salaam	250	1000
Kaole Mamba Ranch	Bagamoyo, Coast	220	-
Mamba Ranch Ltd	Pangani Tanga	New Ranch	2000
Teule Arts and Crafts	Ifakara, Morogoro	21	1000
Tumaini Arts and Crocodile Farm	Ifakara, Morogoro	140	2000

The purpose of exporting the wild crocodile skins is to accord Tanzania the opportunity to undertake conservation in keeping with the contemporary paradigm of IUCN/The World Conservation Union, the Conservation policy and laws of Tanzania that resources need be used wisely. Apparently vision has it that in order for resource conservation strategies to thrive, each species and in this case the Nile crocodile, must pay for its continued survival. Government subvents money to where it gets money back.

The other reason is to support crocodiles ranches which do not have access to a healthy loan environment.

It is also the strong obligation of the government to address problem crocodiles. Crocodiles mostly outside protected areas threaten and negatively impact on human life and property. People are maimed or killed in rural areas across the country. In any case problem crocodiles would have to be killed. But it is the strong belief of Tanzania that skins from these crocodiles be sold and part of the revenues accruing from this activity need be ploughed back to conservation and enhance human development throuh accessing direct benefits to local communities.

Ranch owners are allocated a quota of crocodiles from the wild. They employ experts who accompany them to harvest areas (where problem crocodiles occur). A wildlife official also accompanies the crew to ensure that harvesting is done according to the Wildlife Conservation Act No.12 of 1974 and its subsequent supplements. The crew is also joined by individuals who know specific areas where problem crocodiles exist. Skinners are also employed by the ranch owners. Skinners and the other workers come from villages where crocodiles are a problem. Crocodiles are shot in the head and skinned.

The government collects hunting permit and export permit fees from the ranch owners for each crocodile killed.

The ranch owner also employs local communities when collecting eggs and hatchlings for the ranch.

Skins are sold to markets outside Tanzania. The trade therefore earns the nation the much needed foreign currency.

No stockpiles of skins exist in Tanzania.

As indicated earlier on in this document crocodiles are ranched in Tanzania. Five ranches exist as depicted in Table 3. Ranch owners now collect eggs/hatchlings with the company of people from villages. It is believed that local communities need get direct benefits from activities based on crocodile utilization to allow them give full support to conservation. A report on how to get local communities more appropriately involved is in preparation. The battomline is to enhance ranching operations through involvement of local communities.

3.2 Legal International Trade

Table 4: A summary of crocodile skins entering the world market

YEAR	CROPPING	CONTROL		SPORT HUNTING	
		AGREED QUOTA	ACTUAL EXPORT	AGREED QUOTA	ACTUAL EXPORT
1987		2000	1456	100	?
1988		2000	1804	100	8
1989		2000	1980	100	43
1990		1000	1000	100	40
1991		1000	819	100	26
1992		400	400	100	59
1993		200	120	100	28
1994		200	-	100	-
1995		1000	698	100	?
1996		1000		100	?

(FROM: TANZANIA CITES ANNUAL REPORTS)

Most of the skins exported were from the wild. However, Kaole Mamba Ranch exported 200 skins in 1995 from their ranch. Other ranches are yet to export ranched specimens. Ranching operations in Tanzania could not take off effectively mostly as a result of inadequate revenue, lack of appropriate exposure to ranch owners in appropriate technology, etc. Most ranches are coming up to shape and more exports are expected to enter the market soon.

3.3 Illegal Trade

In 1989 Tanzania launched a crack down on poachers, traders and dealers in wildlife products. This operation lasted for 18 months with tremendous success of almost stamping out poaching for most species. Another operation was put in place in 1994 the waves of which still halt poaching for most species. Tanzania will continue to strengthen law enforcement activities to foster conservation efforts and ensure sustainability in the use of wildlife resources. It is worth reporting that no records of illegal trade local or international occurs in Tanzania.

3.4 Actual potential trade impacts

The proposed ammendment will allow for provision of jerking up the socio-economies of the ranch owners and local communities. Ranch owners will in the near future be able to export ranched specimens and do away, except when necessary, with exports from wild specimens. Trade will therefore remain to enhance the survival of the species in the wild through involvement of the local communities in wild crocodiles based activities.

3.5 Captive breeding or artificial propagation for commercial purposes (outside country of origin)

Specimens have not been exported to other countries in support of captive breeding or ranching operations.

4. Conservation and Management

4.1 Legal status

4.1.1 National

The Wildlife Conservation Act No.12 of 1974 and its sub-sequent ammendments and/or supplements ensure proper and appropriate protection to wildlife. The Nile crocodile is offered legal protection under the same law. The legislation offers 100% protection to crocodiles occuring in national parks as non-consumptive use is the only means of exploitation.

Game Reserves cover about 12% of Tanzania's surface area. No one is allowed to enter into a Game Reserve without permission prior sought and obtained from the Director of Wildlife. In addition no crocodiles are taken from Game Reserves in support of trade. Wild skins are taken only from outside protected areas. Eggs or hatchlings can, however, be collected from selected Game Reserves in

support of ranches. The legistations are well respected by the wildlife authorities, the police and judiciary. Crocodiles can only be killed under a licence issued by the Director of Wildlife except when it involves protection of human life.

A policy for crocodile management and a management plan are also in place. The policy advocates for proper management of the Nile Crocodile aiming to:-

(a) increase or maintain their numbers (protection)
(b) use them sustainably
(c) reduce numbers where appropriate (control)
(d) manage crocodiles, where appropriate, for the benefit of local communities.

Trade in the species is regulated through issuance of hunting permits against quotas endorsed by CITES. All skins prior to export are inspected and tagged. Law enforcement officials ensure that final inspection is done at the point of exit prior to export of specimens.

4.1.2 International

A team appointed by the IUCN/Crocodile Specialist Group visited Tanzania from 25 September - 1 October, 1994. A scientist appointed by the same specilialist group has participated in crocodile aerial surveys, and in cooperation with officials in Tanzania a report such as the one attached herewith has been done for each survey. Most of the recommendations made by both parties have been put to use.

CITES as an International instrument offers protcetion to the species. Tanzania abides to the articles, resolutions and decisions made at meetings of the convention.

Tanzania has participated fully in the negotiation and conclusion of the Lusaka Agreement, a treaty which aims to reduce and ultimately eliminate illegal trade in wild fauna and flora. Tanzania has ratified the treaty. Officials from Tanzania will be members to the Task Force of the Agreement as soon as it is operational in the very near future.

Tanzania has signed and ratified the convention on Biodiversity.

Cabinet papers leading to the accession of other treaties in conservation have been prepared.

All these instruments advocate for wise use of resources and denounce illegal use of wildlife resources including crocodiles. Since Tanzania abides to the articles, resolutions and decisions of the treaties it is evident that illegal trade in the products or derivatives of the Nile Crocodile has no room within and out of Tanzania.

4.2 Species Management

4.2.1 Population Monitoring

There is a programme in place to monitor the abundance and distribution of the Nile Crocodile in Tanzania. Aerial surveys have been done in 1963, 1988,1989,1990,1993,1995 and 1996. Accompanying certain aerial surveys are night counts for correction factors. The monitoring programme is continuous. The pilots and crew have remained mostly constant to minimize errors. In most cases a member appointed by IUCN/SSC/Crocodile specialist Group has been on the surveys.

4.2.2 Habitat Conservation

The habitat of the species is 100% protected in National Parks.

For certain areas when full protection of the habitat is needed its status (of the area) of a Game Reserve is raised to that of National Park. Areas adjoining Katavi National Park are in the process of being raised to a National Park status (a continuum to Katavi).

Similarly Game Controlled Areas are offered more protection by having their status raised to Game Reserves. It must be borne in mind that no entrance is allowed into National parks and Game Reserves without permission from the appropriate authorities. Infact no consumptive use of wild fauna and flora or destruction of soil properties is allowed in National Parks.

It is now a habit in Tanzania to allocate activities to specific areas within protected areas according to management plans. For any economic based activity it is common practice that an environmental Impact Assessment

is undertaken as a prerequisite to authorising its undertaking.

4.2.3 Management Measures

Crocodiles for wild skins are harvested outside protected areas (National Parks and Game Reserves). Limits of harvets from the wild are controlled through adherence to quotas issued at each meeting of the conference of the parties to CITES.

The following procedure is observed in allowing for crocodile harvesting:

(i) The number of people granted crocodile hunting permits was once limited, out of lack of people's knowledge on the value of crocodile products. The quota was available under Resoulution Conference 5.21. But from 1990 crocodile ranching commenced in Tanzania following endorsement by the Conference of the parties in 1992. Crocodile quotas from the wild are given to those who own ranches to help top up on their meagre resources in support of the ranching operations.

(ii) Crocodile hunting in the wild is supervised by wildlife officials. Skins deemed to be of low standard after hunting cannot be discarded.

(iii) All skins from crocodiles hunted in the wild are inspected and issued with certificates of ownership by respective Regional Wildlife Officers. This is to ensure that crocodiles on quota for a particular year are not hunted in the wild in the following year.

(iv) Crocodile skins are tagged and respective export documents are issued under the normal CITES procedures.

(v) All skins are checked by Wildlife Officers prior to shipment at International Airports.

Ranching opperations are also in place. Population sizes in the wild are estimated by a reputable team of wildlife officials with a member from outside the country appointed by the IUCN/SSC/Crocodile Specialist Group.

Quotas are proposed by use of data and information from surveys. Information on negative impacts of crocodiles to human life and property is also used. Meetings of the conference of the parties to CITES decide on levels of annual quotas to be taken from the wild. The ranching annual quota of 28,000 eggs or hatchlings to be put into the ranches was endorsed at the 8th conference of the parties in 1992. Export quotas are decided by the capability of a ranch owner.

The policy and management plan of the Nile crocodile in Tanzania spells out clearly that each ranch owner must return 5% of eggs/hatchlings back to the wild once while the hatched crocodiles are young but can survive in the wild.

A mission in 1994 to Tanzania of members the IUCN/SSC/Crocodile Specialist Group has recommended that local communities be intergrated with crocodile conservation activities. A report on a study done to this effect will soon be concluded.

4.3 Control measures

4.3.1 International Trade

The Wildlife Conservation Act. No.12 of 1974 and its suppelements provide for control of wildlife specimens going out or coming into Tanzania. Road blocks and inspections at airports and railway stations are some of the checks and balances in place. Every wildlife specimen being transported must be accompanied with authentic documents.

4.3.2 Domestic measures

Aerial surveys and night counts by boat are undertaken as described in this document. Information from the surveys is used to estimate quotas which are requested and endorsed by meetings of the conference of the parties to CITES.

The CITES Secretariat has early this year (1996) held a training seminar for Eastern and Southern African countries in Tanzania. A seminar was also conducted for traders in wildlife products. Training

involved areas like capture, handling, crating and transport of wildlife specimens.

In 1991 the Crocodile Specialist group Vice Charman for Africa conducted a training seminar on crocodile harvesting and ranching in Tanzania.

The section on Extension Services in the Widlife Division visits areas where wildlife products are collected and educate the people on sustainable use of resources by and for local communities.

The policy and Management plan for the Nile Crocodile spells out the way foward in ensuring sustainable use of crocodiles.

The legislation of Tanzania offers tough penalties to anyone found quilty in handling wildlife specimens.

Crocodile numbers are on the increase in Tanzania. This is a strong indicator that enforcement activities are successfully conducted. In addition cases for illegal dealings in crocodile products are not known to occur.

5. Information on similar species

The slender snouted crocodile (*Crocodylus cataphractus*) is confined to lake Tanganyika in Western Tanzania. The status of this population is not known. However, any kind of utilization of this species is not allowed. The species simply does not enter the market and records on its parts or derivatives to have been in the market do not exist.

Potential difficulties in distinguishing between parts or derivaties of this species (the Nile Crocodile) and similar species will not be an issue in Tanzania.

The proposed ammendment will not lead to an increase in trade in the species concerned. Infact the quota requested is at the level of the quota allowed at COP 9 for 1995 and 1996. Since control measures for harvesting and export of specimens (local and international) are in place endorsement of this quota will not result in unsustainable trade in similar species.

6. Other Comments

6.1 Concern by the range states

Twenty five African countries tabled a request for downlisting of the Nile crocodile from Appendix I to II of CITES in Brussels in 1984. This was out of concern that the Nile crocodile is not endangered. It was believed that the Nile Crocodile was placed in Appendix I as a measure to protect the American alligator which was infact endangered.

At the 5th meeting of the COP Malawi presented a proposal to downlist Nile Crocodile populations in African countries including Tanzania but for use under a quota system. This proposal was endorsed and Tanzania continued getting an acceptable quota until 1991 upon request at each meeting of the COP. But for the years 1992 - 1994 the quota was decreased to a level of 500, 300 and 300 respectively for wild skins. Tanzania was not impressed by this decision. A special request for 3000 crocodiles was sent to the Secretary General of CITES but with no success.

Many countries with Nile Crocodile populations in Africa have incessantly pointed out that the species should be in Appendix II of CITES. Utilization of the abundant wild crocodile population of the Nile crocodile would increase government revenue and employement and other benefits to local communities.

6.2 The Nile Crocodile as Problem Animal:

In many parts of Tanzania outside protected areas crocodiles are causing damage and loss of human life and property. Table 5 is a presentation on crocodile/human conflict across the country.

Table 5: Presentation on crocodile/human conflict across the country

TANZANIA PROBLEM CROCODILE DATA												
REGION	**DISTRICT**	**VILLAGE**	**RIVER/ LAKE**	**YEAR**	**CROCS KILLED**	**PEOPE**		**CATTLE**		**GOATS**		**SHEEP**	
						Wound	Killed	Wound	Killed	Wound	Killed	Wound	Killed
KIGOMA	Kigoma		Tanganyika Malagarasi	1995		2	9	0	0	0	0	0	0
	SUB-TOTAL			**1995**		**2**	**9**	**0**	**0**	**0**	**0**	**0**	**0**
IRINGA	Iringa		Mtera	1994-1995	0	0	1	0	0	0	0	0	0
	Mufindi	Mpanga	Ruaha	1992-1993	7	5	4	0	0	0	0	0	0
	Ludewa		Ruvuvu	1993	4	2	6	0	0	0	0	0	0
	Iringa	Mtambika	Rukosi	1994	0	0	0	0	0	0	1	0	0
			Ruaha	1993	6	4	4	3	0	7	4	2	0
		Pawaga	Ruaha	1995	0	0	0	0	0	0	0	0	0
	Iringa Rural		Ruaha & Mtera Dam	1995	0	6	4	0	0	0	0	0	0
			Ruaha & Mtera Dam	1996	0	2	1	0	0	0	0	0	0
	SUB-TOTAL			**1989-1996**	**17**	**19**	**20**	**3**	**0**	**7**	**5**	**2**	**0**
RUVUMA	Nyasa	Luwekei	Nyasa	1989	6	0	7	0	0	0	0	0	0
		Ngumbo	Nyasa	1990	6	0	0	0	0	0	0	0	0
		Luwekei	Nyasa	1991	22	0	4	0	0	0	9	0	0
		Ruhuhu	Nyasa	1992	6	0	1	0	0	0	0	0	0
		Ruhuhu	Nyasa	1993	2	0	0	0	0	0	0	0	0
		Ruhuhu	Nyasa	1994	1	0	3	0	0	0	0	0	0
		Ruhuhu	Nyasa	1995	0	0	0	0	0	0	0	0	0
	Tunduru	Sunda/ Lunda	Ruvuma	1989	0	0	0	0	0	0	0	0	0
		Sunda/ Lunda	Ruvuma	1990	0	0	0	0	0	0	0	0	0
		Sunda/ Lunda	Ruvuma	1991	0	0	0	0	0	0	0	0	0

		Sunda/ Lunda	Ruvuma	1992	0	0	0	0	0	0	0	0	0
		Sunda/ Lunda	Ruvuma	1993	2	0	0	0	0	0	0	0	0
		Sunda/ Lunda	Ruvuma	1994	2	0	6	0	0	0	0	0	0
		Sunda/ Lunda	Ruvuma	1995	13	0	2	0	2	0	0	0	0
	Songea	Mtonya	Luwegu	1989	6	0	1	0	0	0	0	0	0
	SUB-TOTAL			**1989-1995**	**66**	**0**	**24**	**0**	**2**	**0**	**9**	**0**	**0**
MWANZA	Magu	Kalemera	Simiyu	1989-1990	1	0	1	0	1	0	0	0	0
		Misungwi	Simiyu	1991	1	0	1	0	0	0	0	0	0
			Simiyu	1992	0	0	0	0	0	0	0	0	0
		Itumbili	Simiyu	1993	0	0	0	0	0	0	0	0	0
		Kalemera	Simiyu	1994	2	1	0	0	1	0	0	0	0
		Ijincha	Simiyu	1995	0	0	0	0	1	0	2	0	0
	Sengerema	Katunguru	Simiyu	1989	1	0	0	0	0	0	0	0	0
		Kasunza	Victoria	1990	0	0	1	0	0	0	0	0	0
		Kakobe/ Nkome	Victoria	1991	22	0	2	0	1	0	0	0	0
		Kakobe/ Regeta	Victoria	1992	0	0	2	1	0	0	0	0	0
		Rubango	Victoria	1993	1	0	3	0	0	0	0	0	0
		Rubango	Victoria	1994	6	0	1	1	0	0	0	0	0
		Maranga	Victoria	1994	0	0	0	1	0	0	0	0	0
		Buyagu	Victoria	1995	1	0	0	0	0	0	0	0	0
	Kwimba	Siwenge	Victoria	1990	1	0	0	0	0	0	0	0	0
		Sumbuga	Victoria	1990	0	0	0	0	0	0	0	0	0
		Tumbuko	Victoria	1991	0	0	1	0	0	0	0	0	0
		Tumbuko	Victoria	1992	1	0	0	0	0	0	0	0	0
		Mitego	Victoria	1993	0	0	0	0	0	0	0	0	0
		Mitego	Victoria	1994	0	0	1	0	0	0	0	0	0
	Mwanza	Lucherere	Victoria	1994	2	1	0	0	0	0	0	0	0
		Busegema	Simuyu	1990	0	0	0	1	0	0	0	0	0

	Ukerewe	Busegema	Simuyu	1991-1995	0	0	0	0	1	0	0	0	0
	Magu		Victoria & Simiyu	1995	0	0	0	0	2	0	2	0	0
	Sengerema		Victoria	1995	0	0	2	0	0	0	0	0	0
	Mwanza		Victoria	1995	0	2	3	0	0	0	0	0	0
	SUB-TOTAL				**39**	**4**	**19**	**4**	**5**	**0**	**2**	**0**	**0**
RUKWA	Mpanda		Ugalla	1989	8	1	4	0	1	0	0	0	0
			Ugalla	1994-1995	0	1	1	0	0	0	0	0	0
	S/wanga		Lukuma	1990	12	0	3	0	3	0	0	0	0
			Lukuma	1991	8	3	5	0	4	1	0	0	0
			Lukuma	1992	7	0	2	0	2	0	0	0	0
			Lukuma	1993	9	0	3	0	4	0	0	0	0
			Lukuma	1994	5	0	2	0	1	2	0	0	0
		Muze	Rukwa	1994	0	0	1	0	0	0	0	0	0
		Makapora	Rukwa	1995	0	1	0	0	0	0	0	0	0
		Kashu	Tanganyika	1994-1995	0	1	1	0	0	0	0	0	0
		?		1994-1995	0	1	1	0	0	0	0	0	0
			Rukwa	1995	0	4	3	0	0	0	0	0	0
			Rukwa	1996	0	0	2	0	0	0	0	0	0
	Nkasi		Tanganyika	1996	0	3	2	0	0	0	0	0	0
			Tanganyika	1996	0	3	0	0	0	0	0	0	0
	SUB-TOTAL			**1989-1996**	**49**	**18**	**28**	**0**	**15**	**3**	**0**	**0**	**0**
KAGERA	Bukoba		Kagera	1989-1993	2	0	1	0	0	0	0	0	0
		Mulaba	Victoria	1994	0	0	0	0	0	0	2	0	0
	Bukoba Rural		Victoria & Kagera	1995	0	1	3	0	0	0	0	0	0
	Biharamuro		Victoria & Burigi	1995	0	1	2	0	0	0	0	0	0
			Victoria & Burigi	1996	0	1	1	0	0	0	0	0	0
	Muleba		Victoria	1995	0	2	4	0	0	0	0	0	0
			Victoria	1996	0	1	0	0	0	0	0	0	0
	SUB-TOTAL			**1989-1996**	**2**	**6**	**11**	**0**	**0**	**0**	**2**	**0**	**0**

LINDI	Lindi		Lukuledi	1989	0	1	3	0	0	0	0	0	0
	Nachingwea		Mbwemkuru	1993	0	1	5	0	0	0	0	0	0
			Mbwemkuru	1990	0	0	1	0	0	0	0	0	0
	SUB-TOTAL			**1989-1990**	**0**	**2**	**9**	**0**	**0**	**0**	**0**	**0**	**0**
DODOMA	Mpwapwa		Mtera Dam	1989-1995	0	0	0	0	0	0	0	0	0
MBEYA	Chunya	Udinde	Kikamba	1989	1	0	3	0	0	0	0	0	0
		Semangombe	Ombaka	1990	1	0	8	0	1	0	0	0	0
			Momba	1991	4	0	5	0	1	0	0	0	0
		Udinde	Momba	1992	6	0	4	0	0	0	0	0	0
	Mbozi/ Chunya	Semangombe	Kikamba	1992	3	0	2	0	0	0	0	0	0
			Momba	1994-1995	0	0	2	0	0	0	0	0	0
			Ombaka	1994	0	0	3	0	0	0	0	0	0
	Mbalali		Ruaha	1995	0	0	1	0	0	0	0	0	0
			Ruaha	1996	0	0	1	0	0	0	0	0	0
	Mbozi		Rukwa	1995	0	0	1	0	8	0	0	0	0
			Rukwa	1996	0	3	2	0	0	0	0	0	0
	Chunya		Ruaha	1996	0	0	0	2	2	0	0	0	0
	SUB-TOTAL			**1989-1996**	**15**	**3**	**32**	**2**	**12**	**0**	**0**	**0**	**0**
MTWARA	Mtwara		Ruvuma	1989	5	18	7	0	0	0	0	0	0
			Ruvuma	1990	0	14	3	0	0	0	0	0	0
			Ruvuma	1991-1992	2	18	4	0	0	0	0	0	0
			Ruvuma	1992	0	12	2	0	0	0	0	0	0
			Ruvuma	1993	2	12	2	0	0	0	0	0	0
			Ruvuma	1994	2	24	5	0	0	0	0	0	0
		Kitaya	Ruvuma	1995	0	10	1	0	0	0	0	0	0
	Newala	Mapili	Lukuledi	1995	0	9	3	0	0	0	0	0	0
	Masasi	Lichebe	Lukuledi	1995	0	0	6	0	0	0	0	0	0
	Mtwara Rural		Ruvuma	1995	0	6	4	0	0	2	0	0	0
			Ruvuma	1996	0	4	2	0	0	0	0	0	0
	Tandahimba		Ruvuma	1995	0	2	0	0	0	0	0	0	
			Ruvuma	1996	0	0	2	0	0	0	0	0	0

	Newala		Ruvuma	1995	0	8	2	0	0	13	2	1	0
			Ruvuma	1996	0	3	0	0	0	0	0	0	0
	Masasi		Ruvuma	1995	0	6	3	0	0	0	0	0	0
			Ruvuma & Likuledi	1996	0	1	0	0	0	0	0	0	0
	SUB-TOTAL			**1989-1996**	**11**	**113**	**46**	**0**	**2**	**13**	**2**	**1**	**0**
MOROGORO	Kisaki	Mvuha	Mgeta	1989	14	7	10	0	0	0	0	0	0
			Mgeta	1990	14	0	0	0	0	0	0	0	0
	Mahenge			1991	6	3	4	0	0	0	0	0	0
	Kilosa			1992	4	4	4	7	5	0	0	0	0
	Mahenge			1993	8	0	7	5	0	0	1	0	0
	Ngerengere			1994-1995	2	1	1	0	0	0	6	0	0
	Kilosa			1994-1995	4	0	0	3	0	0	0	0	0
	Ulanga		Ipiti	1994-1995	2	0	1	0	0	0	0	0	0
	Morogoro Rural		Ngerengere	1995	0	1	1	2	0	0	2	0	0
	Kilombero		Mpanga Kilombero	1995	0	1	1	0	0	0	0	0	0
	Kilosa		Mandela	1995	0	1	0	0	0	0	0	0	0
	Morogoro Rural		Ngerenger	1996	0	0	2	0	0	0	0	0	0
	Kilombero		Mpanga Kilombero	1996	0	2	2	0	0	0	0	0	0
	Ulanga		Ipiti	1996	0	0	1	0	0	0	0	0	0
	Kilosa		Mandela	1996	0	0	1	0	0	0	0	0	0
	SUB-TOTAL			**1989-1996**	**54**	**21**	**36**	**17**	**8**	**0**	**7**	**0**	**0**
TANGA	Tanga	Pongwe		1989	0	2	0	0	0	2	0	0	0
	Korogwe	Pande		1990	0	0	2	0	0	1	0	0	0
	Lushoto	Mukaro		1991	0	1	0	0	0	0	1	0	0
	Tanga	Pande		1992	0	2	8	0	0	1	0	0	0
				1993	0	1	0	0	0	0	0	0	0
				1994	0	1	0	0	0	0	0	0	0
	Pangani			1994-1995	11	5	8	0	4	0	0	0	0

	Tanga		Mvumi	1995	0	0	2	0	0	0	2	0	0
	Muhesa		Ruvu	1995	0	0	4	0	0	0	2	0	0
	SUB-TOTAL			**1989-1995**	**11**	**12**	**24**	**0**	**4**	**8**	**4**	**0**	**0**
MARA	Musoma		Victoria	1991	3	0	2	0	0	0	0	0	0
			Victoria	1992	4	2	1	0	0	0	0	0	0
			Victoria	1993	1	0	0	0	0	0	0	0	0
			Victoria	1994	2	0	0	0	0	0	0	0	0
	Serengeti		Victoria	1989-1991	0	0	0	0	0	0	0	0	0
			Victoria	1992	3	0	0	0	0	0	0	0	0
			Victoria	1993-1994	0	0	0	0	0	0	0	0	0
	Tarime		Victoria	1989	2	0	1	0	2	0	0	0	0
			Victoria		0	0	1	0	2	0	0	0	0
			Mara	1992	3	1	1	0	6	0	0	4	0
	Musoma Rural		Victoria & Mara	1995 1996	0 0	1 0	3 2	0	0 0	0 0	0 0	0 0	0 0
	Tarime		Victoria Victoria	1995 1996	0 0	1 1	1 0	0 0	0 0	0 0	0 0	0 0	0 0
	SUB-TOTAL			**1989-1996**	**18**	**9**	**6**	**0**	**10**	**0**	**0**	**4**	**0**
COAST	Bagamoyo		Ruvu	1991-1994	2	1	4	0	0	0	0	0	0
			Ruvu	1992	2	2	0	0	0	0	0	0	0
			Wami	1993	9	0	0	0	0	0	6	0	0
			Ruvu	1994	0	3	3	0	0	0	0	0	0
			Ruvu	1994	0	4	0	0	0	0	0	0	0
			Ruvu	1989-1990	2	1	2	0	0	0	0	0	0
			Ruvu	1991	1	0	1	0	0	0	0	0	0
			Wami	1992	3	2	0	0	0	0	0	0	0
			Wami	1993-1994	0	0	6	0	0	0	0	0	0
	Rufiji	Utete		1994-1995	12	0	4	0	0	0	0	0	0
		Mtandanda			0	0	1	0	0	0	0	0	0
		Mhoro			0	0	1	0	0	0	0	0	0
		Mbwera			0	0	3	0	0	0	0	0	0
		Chumbi			0	0	1	0	0	0	0	0	0
	Bagamaoyo	Kisanke		1994-1995	13	3	1	0	0	0	0	0	0

		Mkoko			0	0	1	0	0	0	0	0	0
		Kongo			0	0	1	0	0	0	0	0	0
		Tombo			0	0	1	0	0	0	0	0	0
		Makurenge			0	0	1	0	0	0	0	0	0
	Kibaha	Kibaha		1995	2	3	10	0	0	0	0	0	0
	Kisarawe	Mkamba		1994-1995	0	0	1	0	0	0	0	0	0
		Bigwa		1994-1995	1	0	1	0	0	0	0	0	0
	Bagamoyo		Wami	1995	0	1	3	0	0	0	0	0	0
	Bagamoyo		Ruvu	1996	0	0	2	0	0	0	0	0	0
	Kibaha		Ruvu	1995	0	4	0	0	0	0	0	0	0
	Kibaha		Ruvu	1996	0	0	1	0	0	0	0	0	0
	Rufiji		Rufiji	1995	0	0	3	0	0	0	0	0	0
	Rufiji		Rufiji	1996	0	1	7	0	0	0	0	0	0
	SUB-TOTAL			**1989-1996**	**47**	**25**	**59**	**0**	**0**	**0**	**6**	**0**	**0**
TABORA	Urambo	Ugalla	Sagara	1994	0	0	6	0	0	0	0	0	0
	Urambo		Sagara	1995	0	0	6	0	0	0	0	0	0
	SUB-TOTAL			**1994-1995**	**0**	**0**	**12**	**0**	**0**	**0**	**0**	**0**	**0**
K/NJARO	Moshi		Nyumba ya Mungu	1994-1995	32	28	28	0	0	0	0	0	0
	Mwanga			1989	2	0	2	0	0	0	0	0	0
				1990-1994	0	0	0	0	0	0	0	0	0
	Same		Same	1989	2	0	0	0	0	0	0	0	0
	Mwanga			1994-1995	2	0	2	0	6	0	6	0	0
	Same		Asilia	1994-1995	1	0	2	6	0	2	0	0	0
	Moshi			1994-1995	5	5	2	0	0	0	0	0	0
	Same/ Mwanga		Nyumba ya Mungu Dam	1995	0	12	5	0	0	0	0	0	0
	Same/ Mwanga		Nyumba ya Mungu Dam	1996	0	2	4	0	0	0	0	0	0
	SUB-TOTAL			**1989-1996**	**47**	**54**	**45**	**6**	**6**	**2**	**6**	**0**	**0**
	GRAND TOTAL				**374**	**280**	**351**	**36**	**68**	**39**	**48**	**23**	**17**

Problems caused by crocodiles, as indicated in table 5 are normally reported to the Department of Wildlife. Each incidence is assessed and when action is necessary capture is attempted. Where capture is not possibble, crocodiles will be shot according to provisions of the Wildlife Conservation Act No. 12 of 1974.

All skins from control operations are deposited with the Department of Wildlife and are in turn auctioned to legal exporters under CITES regulations.

The Ministry of Natural Resources and Tourism is under pressure to find solutions to crocodile problems. The action by the Wildlife Department to attend to problem crocodiles is expensive. It becomes difficult to justify costs borne out crocodile control operations from the principal of returns and benefits. Such an activity does even enable the government to compensate the victims.

Where problems caused by crocodiles are numerous local communities will not tolerate the animals. In order to restore confidence of the local communities in crocodiles and in order to ensure that the crocodile policy and management plan achieves success, the crocodiles must be socio - economically rewarding to the people in whose land the animals thrive. If this fact is ignored poaching of crocodile will surface as an excuse for defence in real terms but at the same time under the pretext of killing for self protection. One can not overemphasize the immense loss of crocodiles from this approach.

Given the widespread population of the Nile crocodile in Tanzania, and the wastage of adult skins available from genuine control activities, Tanzania views it appropriate to request for a an export quota of crocodiles from the wild for purposes of enhancing conservation prospects of the crocodiles.

6.3 The Quota Request

The quota is requested albeit the existence of crocodile ranching operations which still need strong back up from government. A full time government official has, from 1996 been appointed to oversee ranching operations.

The offtake of eggs and hatchilings from the wild have had no negative effect on the crocodile populations (Games and Severre, 1993). Craig *et.al* (1992) also report that given that Tanzanias ranching programme has largely collected eggs and that up to 92% of the annual production can be collected without long term detrimental effects to the population, it is unlikely that all the eggs and hatchilings collected so far has an overrall negative effect to the wild population.

The proposal recognizes that:

- The corocodile habitat is stable.
- Crocodile numbers in general, especially in protected areas are increasing.
- Wild skins can only be taken from the outside protected areas.
- Crocodiles occur throughout the country and noting with great concern that they continue to be nuissance animals and can not therefore be tolerated at the expense of human life and property.
- The fact that in order for crocodiles to survive outside protected areas one must intergrate crocodile based economic activities with the development of local communities.

The United Republic of Tanzania therefore seeks support on this proposal from the 10th meeting of the conference of the parties to CITES (1000 crocodiles per year for trade in wild skins and an annual quota of 100 skins for sport hunting).

The United Republic of Tanzania,
Ministry of Natural Resources and Tourism,
Wildlife Division,
DAR ES SALAAM.

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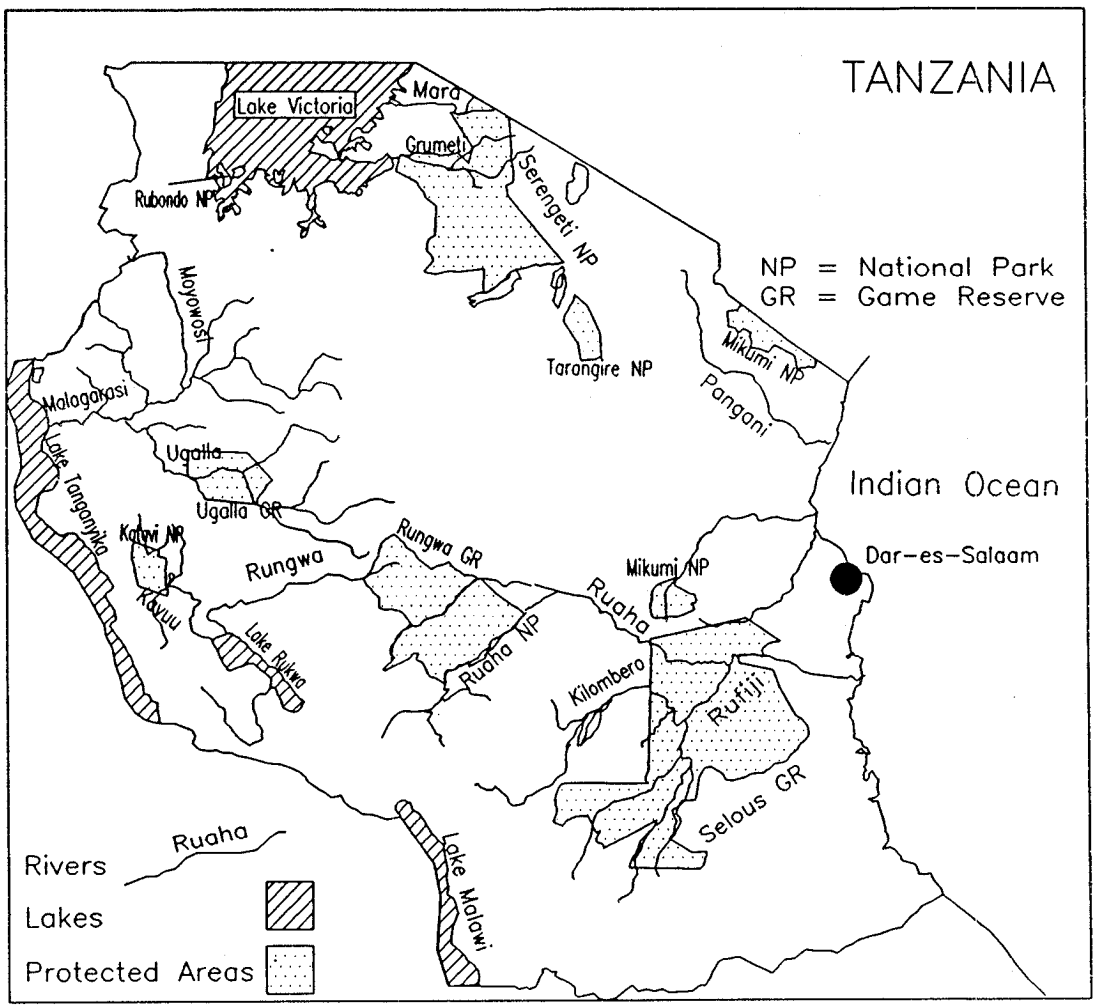
TANZANIAN CROCODILE SURVEY, OCTOBER, 1996

A REPORT TO THE DIRECTOR OF WILDLIFE

I. Games and E.L.M. Severre



APPENDIX 1: CROCODILE ESTIMATES FROM SAMPLE COUNTS

APPENDIX 2: AERIAL SURVEY WAYPOINTS

TABLES

FIGURES

EXECUTIVE SUMMARY

An aerial survey to estimate densities of crocodiles was carried out on selected rivers and lakes in Tanzania in October and November, 1996. As with previous years the survey concentrated on the Selous Game Reserve as these rivers and lakes must have one of the most impressive crocodile populations in Africa.

It appears that crocodile densities (expressed as crocodiles per kilometre of shoreline have increased in the Selous (see below). The Ruaha river, however, has remained remarkably stable.

Year	Lower Rufiji	Ulanga	Kilombero	Ruaha	L. Tagalalla
1989	6.8	3 2	-	1.8	-
1990	11.8	2.9	2.9	1.6	18.1
1993	10.5	2.3	3.5	1.7	23.4
1995	10.1	2.6	3.2	1.6	28.2
1996	19.9	5.6	5.6	1.7	46.1

The other rivers surveyed during this study also appeared to have increased densities of crocodiles. All of these are in national parks.

	Mara	Grumeti	Rubondo	Ruaha
Previous Count	0.9	0.8	0.7	1.8
1996	0.6	2.0	2.7	2.7

In summary it appears that crocodile populations within protected areas in Tanzania have increased. However, the 1995 surveys showed that there had been a decrease on selected rivers outside the protected areas.

Aerial surveys should only be regarded as rough indicators of density and hence crocodile numbers as they are subject to bias and variability.

1. INTRODUCTION

Tanzania has surveyed crocodiles since 1988 (Hutton and Katalihwa, 1988; Games and Severre, 1989, 1990, 1993, 1995) as part of its data collection activities for the proposals to CITES. Much of this work has been concentrated in the Selous Game Reserve which has the largest crocodile population in the country. Three "country wide" surveys have also been carried out, the first in 1990, to broadly define which areas were suitable for aerial survey (Games and Severre, 1990, 1993, 1995).

Partly as a result of these surveys Tanzania was allocated a quota of 1 000 wild skins for 1995 and 1996 at the 9th COP in 1994. The quota for 1997 was dependant on sufficient information being collected on the need for an additional or increased quota. In addition Tanzania has been allocated a quota of 100 skins per annum for sport hunting (Table 1). The ranching quota was set at 4 000 skins per annum in 1990 and increased to 6 000 in 1991 but to date no skins have been exported.

Table 1: CITES Allocated Wild Skin Quotas to Tanzania - 1988 to 1997

YEAR	CONTROL	HUNTING
1987	2 000	100
1988	2 000	100
1989	2 000	100
1990	1 000	100
1991	1 000	100
1992	400	100
1993	200	100
1994	200	100
1995	1 000	100
1996	1 000	100
1997		100

This survey was initiated by the Wildlife Division to continue the monitoring of selected populations and to strengthen Tanzania's case at the 10th Conference of the Parties (COP) in Harare in 1997.

The meeting will review any requests that Tanzania may have for exports over the next three year period. A report on the crocodile industry in Tanzania has been prepared for presentation at this meeting.

This current survey was essentially a "country-wide" survey of selected rivers and lakes but, as with the other surveys, it concentrated on the Selous Game Reserve. As surveys have been carried out for a number of years now an attempt was made to how worthwhile these have been in determining trends in the crocodile populations.

2. METHODS

2.1 DATA COLLECTION

Data was collected during aerial surveys and from two night counts. The night counts were used to calculate a correction factor for the aerial surveys. The tandem counting method was also used on some surveys as it gives some statistical validity to the counts. The river systems were mapped from the 1:50 000 survey maps into AutoCAD and are reproduced in the text.

2.2.1 Aerial Survey

The aerial surveys were conducted from two aeroplanes (both Cessna 182's; registrations of 5H AWF and 5H WWF) between the 27th October to the 5th November. Two aircraft were used to enable a greater coverage in the time available. Two experienced pilots were used and the crews were largely the same as the ones used in 1995.

At the 1992 CITES meeting some concern was expressed by the Crocodile Specialist Group about the repeatability of the surveys but the advent of commercially available Global Positioning Systems (GPS) shortly thereafter meant that all surveys and transects could be recorded as UTM and latitude/longitude positions. A GPS was used during the 1993 and 1995 surveys and two Trimble Transpak GPS's were available for this survey. All transect boundaries were recorded (as waypoints) and are reproduced in the appendices.

The 182 is a four seater aircraft and so it meant that there were two observers on the right hand side of the aircraft and one on the left hand side, as the pilot was not used as an observer. The pilot sometimes doubled as a GPS operator. The pilot positioned the aircraft for maximum visibility of the river. Height and speed were dictated to by safety considerations and pilot experience. On most rivers counting was carried out from both sides of the aircraft. There was no cross counting (i.e. those on the "far side" did not count or point out crocodiles to the "near side" observers). On several occasions it was possible to carry out a "tandem count" based on the work of Magnusson *et al* (1978). The treatment of these data is discussed in the next section.

Initially it was hoped that the transect boundaries from previous years could be recreated so that exactly the same sections were surveyed. However, this proved to be impossible in practical terms. It would have required one person fully conversant with the GPS and latitude/ longitude positioning to watch the instrument at all times and call out the transect boundaries to the observers. Slight variations in aircraft position would have completely confused the operation. Therefore it was decided to call out arbitrary sample boundaries (waypoints) based on the observers experience and the character of the river below. For example, a new boundary or waypoint was called out if there was a change in the character of the river from sandy to rocky or, if there was no change, a new sample boundary was called out based on time.

2.2.2 Night Count Correction

It was possible to carry out two night counts in the Selous Game Reserve - one on a known section of river (Kidai scout post to Sand Rivers camp) and the other on Lake Tagallala. The river section was flown the following day to provide some information on correction factors for the aerial surveys. Similar exercises were also carried out in 1990, 1993 and 1995.

2.2 DATA ANALYSIS

2.2.1 Sample Counts

"Traditional" sample counts require that the river is stratified prior to survey and that selected representative samples are surveyed from each of the strata (Graham, 1988). In this way an overall estimate of the river is obtained and the coefficient of variation calculated. However, the lengths of river involved in the Selous and other areas meant that, in many cases, the entire river was surveyed. This led to the possibility of stratification "after the event", as some sections of the rivers showed higher concentrations of crocodiles than others. It was hoped to relate the higher (or lower) concentrations to some biological (eg. many fishing villages) or physical feature (eg rocky areas) of the river.

Analysis of the sample counts followed the method outlined by Graham (1988) which was based on that of Jolly (1969). The coefficient of variance or CV (the standard error as a percentage of the estimate) is a measure of the precision of a count. It was estimated by first calculating S_d^2 with:

$$S_d^2 = \frac{(\sum d^2 - (\sum d)^2) \ / \ (n)}{(n - 1)}$$

where:
d = density of the samples
n = number of samples

The variance of the count (V) was then calculated by:

$$Var\ N = \left[\frac{Z^2}{n}\right] S_d 2$$

where:
Z = total length surveyed
n = number of samples

and the CV calculated by

$$CV = \left[\frac{\sqrt{V}}{N}\right]100$$

where:
V = variance of the count
N = number of crocodiles

As these were not sample counts in the true sense (ie the whole length of the river was counted) a population estimate was not directly derived from them. Densities, and fluctuation thereof over the years was considered more important.

2.2.2 Tandem Counts

Tandem counts were analyzed using the method proposed by Magnusson *et al* (1978). These data were used to estimate the population (N), observer bias, the variance (V) and the coefficient of variation (CV). The population was estimated with:

$$N = \left[\frac{(S_1 + B + 1)(S_2 + B + 1)}{(B + 1)}\right] - 1$$

the variance with:

$$V = \frac{(S_1)(S_2)(S_1 + B + 1)(S_2 + B + 1)}{(B + 1)^2(B + 2)}$$

and the CV by:

$$CV = \left[\frac{\sqrt{V}}{N}\right]100$$

where:
S_1 = crocodiles seen by the observer
S_2 = crocodiles seen by the observer/recorder
B = crocodiles seen by both.

3. RESULTS

Sections of the Rufiji river complex inside the Selous Game Reserve as well as the Ruaha, Grumeti and Mara rivers were surveyed in 1996. Parts of Lake Nyumba ya Mungu, Lake Victoria (Rubondo Island) and Mtera Dam were also surveyed (Figure 1). The surveys concentrated on the Selous Game Reserve as this has the largest crocodile population in Tanzania.

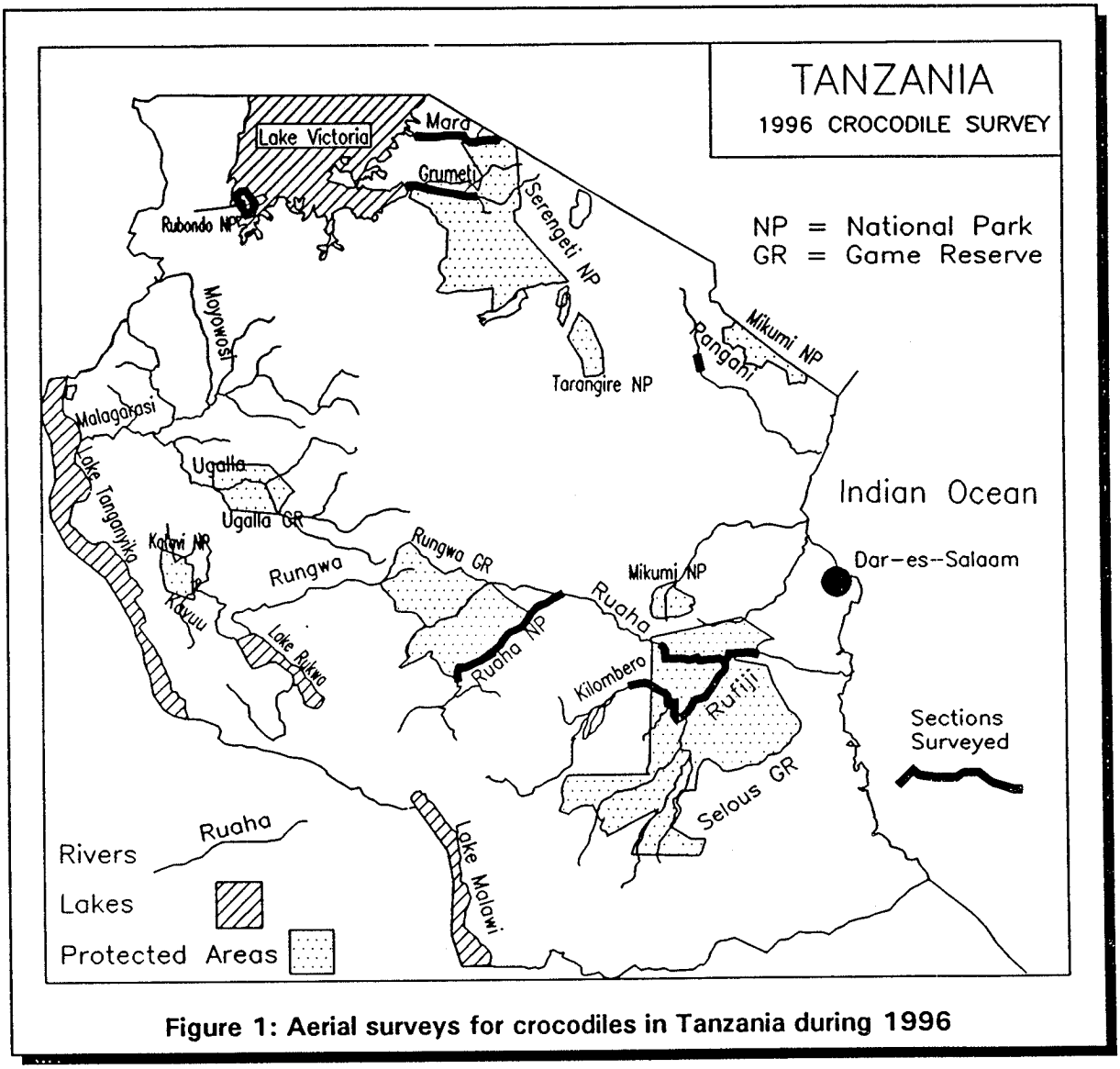


Figure 1: Aerial surveys for crocodiles in Tanzania during 1996

3.1 SELOUS GAME RESERVE

Surveys were carried out between the 27th and the 30th of October in the Selous Game Reserve (Table 2). These were over the "Selous Triangle" of rivers, namely the Lower Rufiji, the Ulanga (or Upper Rufiji), the Kilombero and the Ruaha (Figure 2). The Luwego

and Mbaragandu rivers were not surveyed as they were very shallow and unlikely to harbour many crocodiles. The five lakes connected to the Rufiji - Tagallala, Manze, Nzerakera, Siwandu and Mzizima were also surveyed.

Table 2: Aerial Surveys for Crocodiles in the Selous Game Reserve, October, 1996

DATE	SECTIONS SURVEYED	COMMENTS
27	Rufiji, Ulanga	Morning
27	Kilombero, Ulanga, Ruaha, Rufiji	Afternoon
28	Ulanga, Kilombero, Ruaha, Rufiji	Morning/ Afternoon
29	Rufiji, Ruaha	Morning
30	Rufiji	Morning

SUMMARY	
Lower Rufiji = 5 surveys; Ulanga = 3 surveys	Kilombero = 2 surveys; Ruaha = 3 surveys

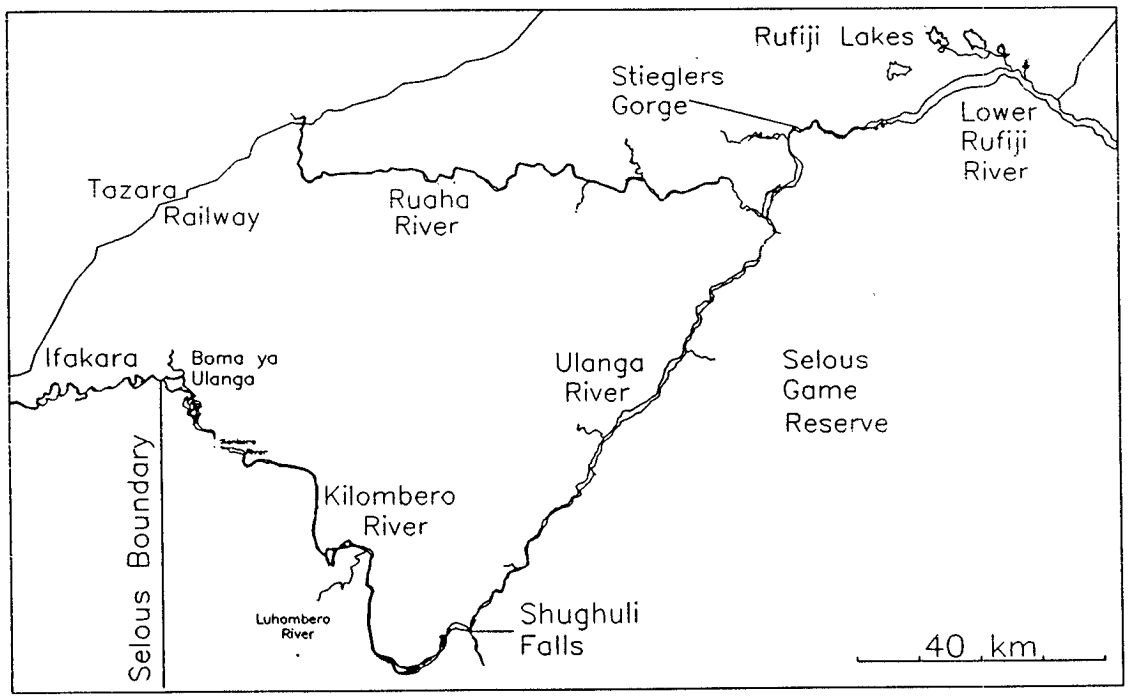


Figure 3: The "Selous Triangle"

The results of these surveys showed that the major crocodile population occurred in the Lower Rufiji and four of the associated lakes (Tagalala, Nzerakera, Mzizima and Siwandu; Table 3). The fifth lake (Manze) was almost completely dry due to changes in the hydrology of the system. However the remnant channels of this lake contained many crocodiles. The survey "samples" and their relevant densities in crocodiles per kilometre are shown in Figures 3 to 12.

Table 3: Summary of crocodile surveys in the Selous Game Reserve -October, 1996

RIVER	DENSITY	COMMENTS
Lower Rufiji	5.27	27th; Start 10:30; Cloudy and cool
	19.98	27th; Start 16:50
	18.25	28th; Start 09:15
	12.70	28th; Start 16:22; 20 sections
	15.8	29th; Start 09:00
	7.6	30th; Start 08:50; Cloudy and cool
Ulanga (Upper Rufiji)	5.55	27th; Start 10:15
	1.98	27th; Start 17:20
	3.33	28th; Start 09:25
Kilombero	5.60	27th; Start 16:50
	3.01	28th; Start 10:00
Ruaha	1.43	27th; Start 16:45
	1.67	28th; Start 09:10
	1.32	29th; Start 09:19
Lake Tagalala	46.07	29th; Start 17:15
N.B. Counts below for the Rufiji lakes are total counts and not densities		
Tagalala	599	
Manze	120	
Nzerakera	187	
Siwando	127	
Mzizima	59	

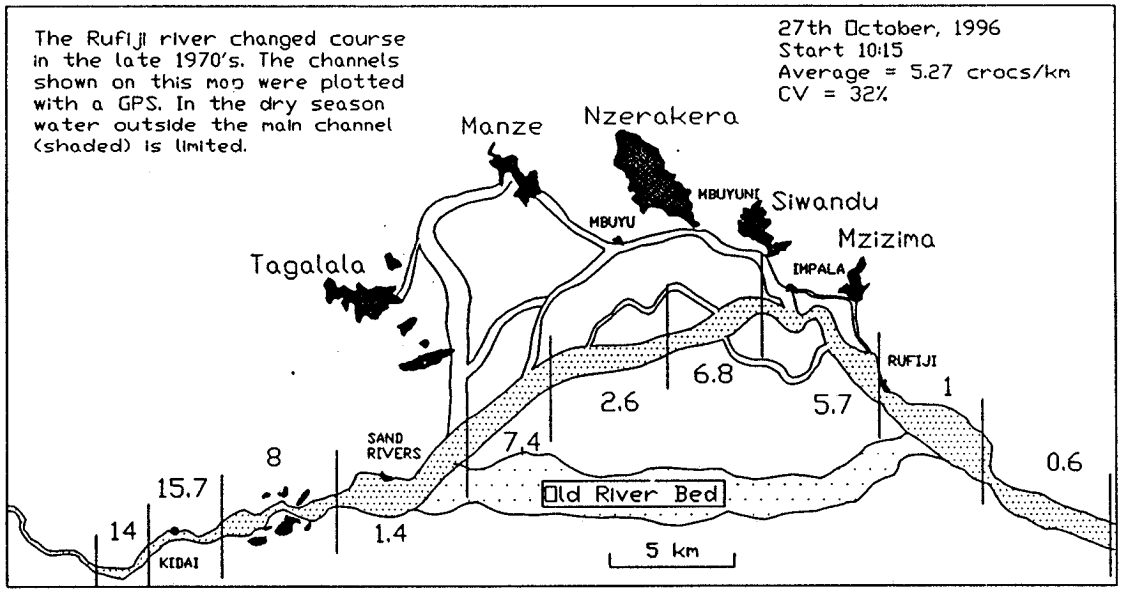


Figure 3: Lower Rufiji - Crocodile densities morning 27th October

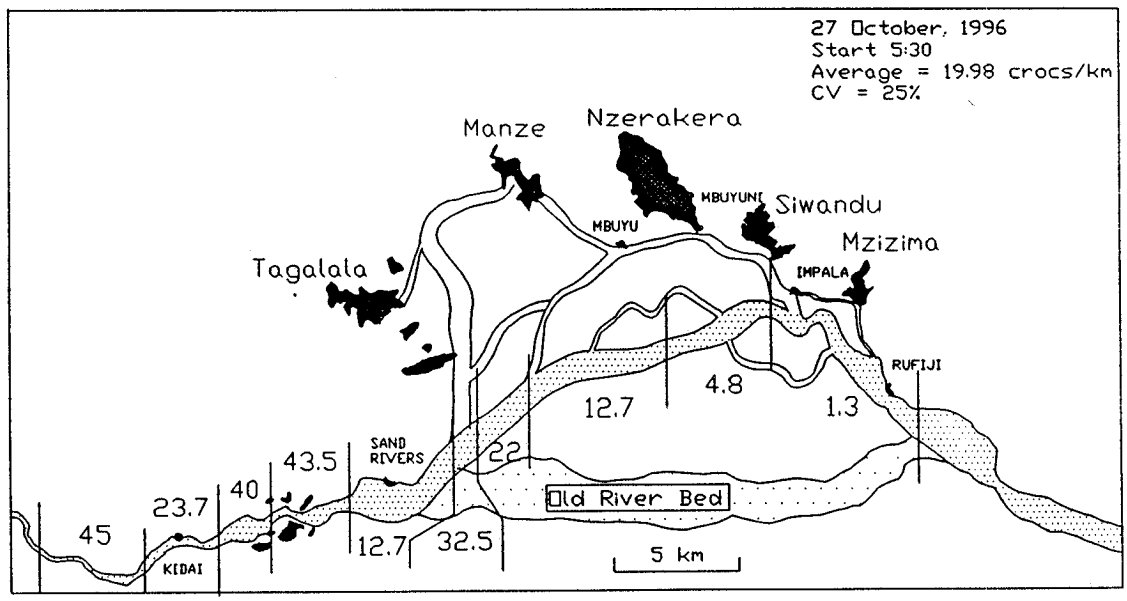


Figure 4: Lower Rufiji - Crocodile densities afternoon 27 October

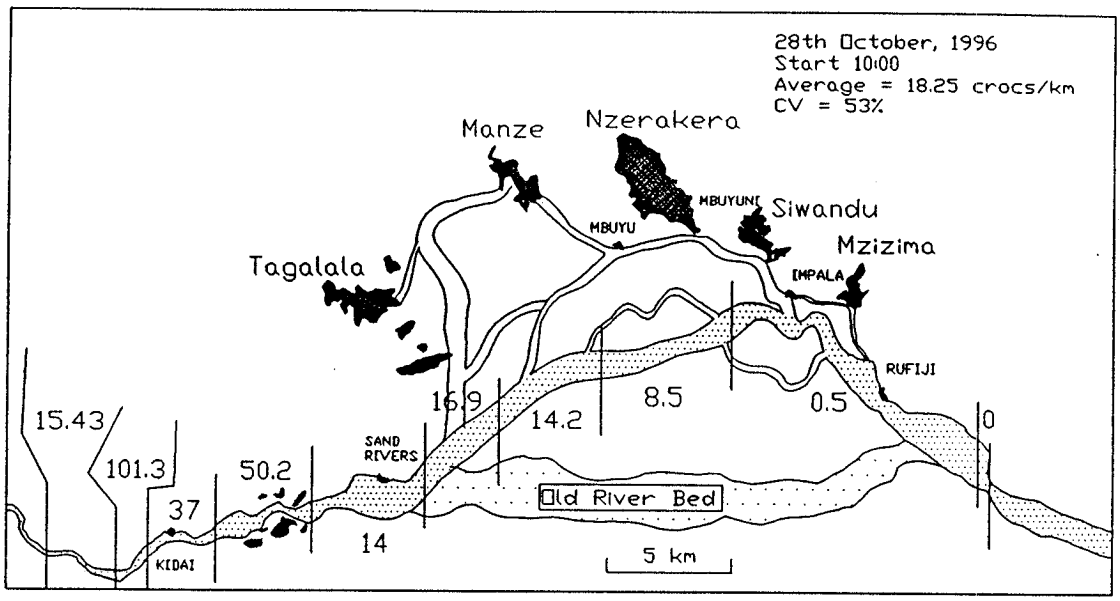


Figure 5: Lower Rufiji - Crocodile densities morning October 28th

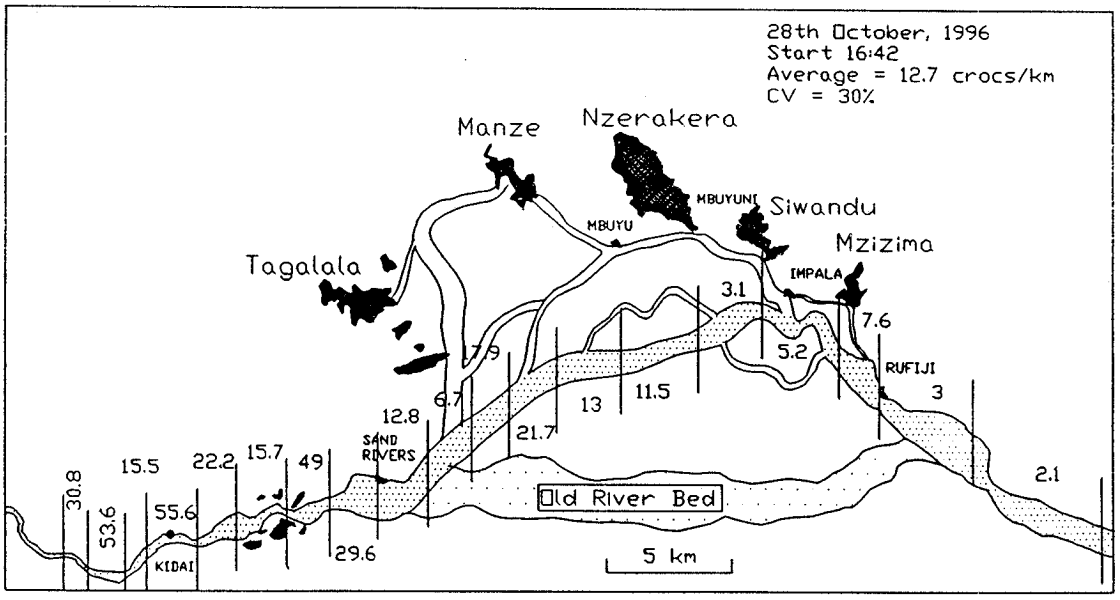


Figure 6: Lower Rufiji - Crocodile densities afternoon October 28th

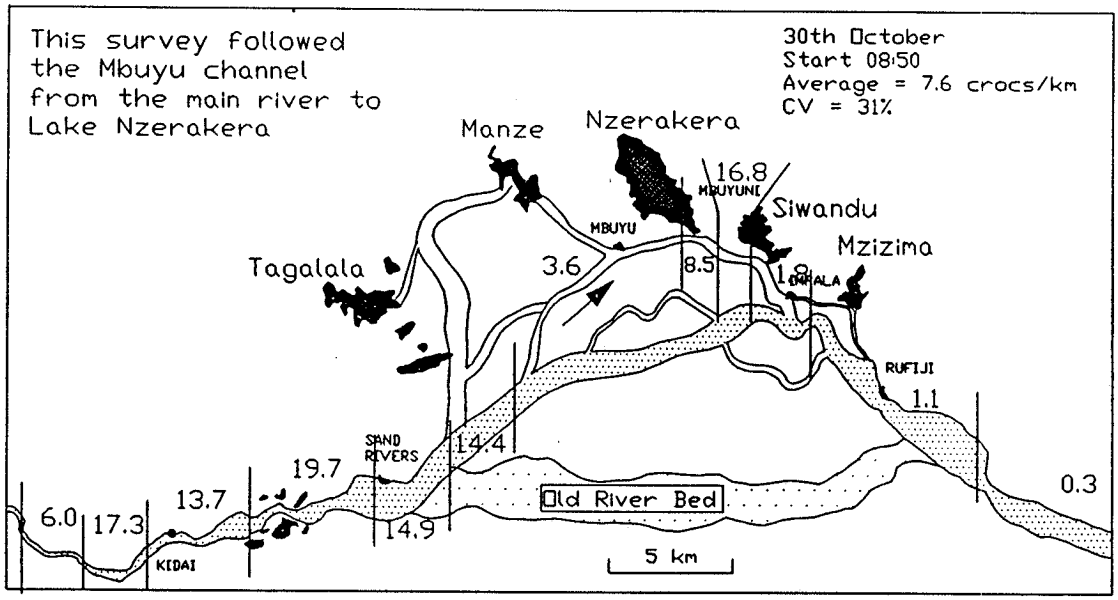


Figure 7: Lower Rufiji - "Mbuyu" channel crocodile densities

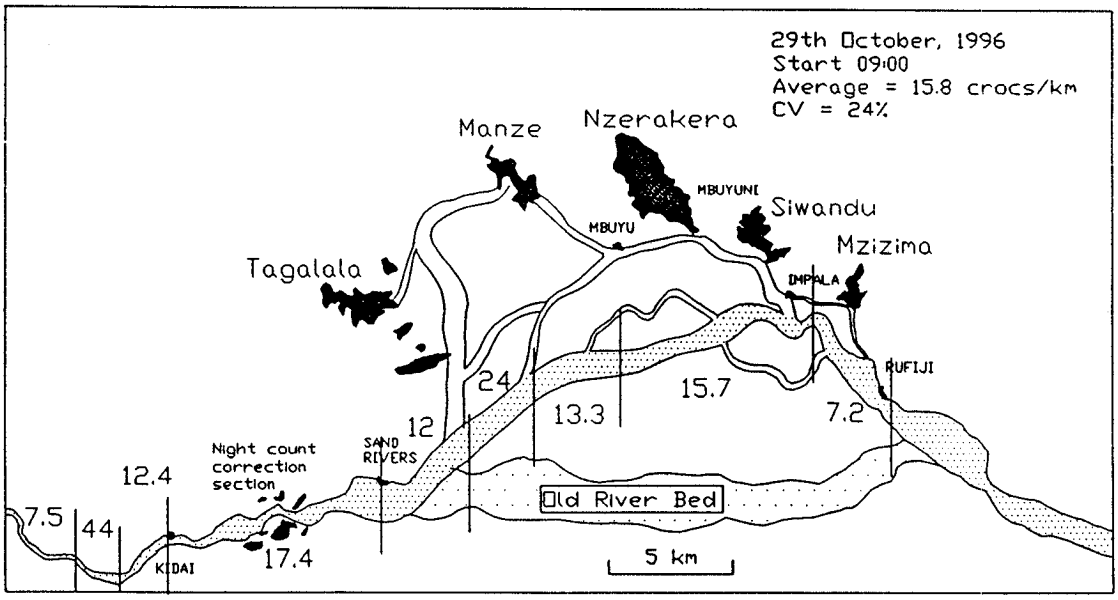


Figure 8: Lower Rufiji - Night count correction survey crocodile densities

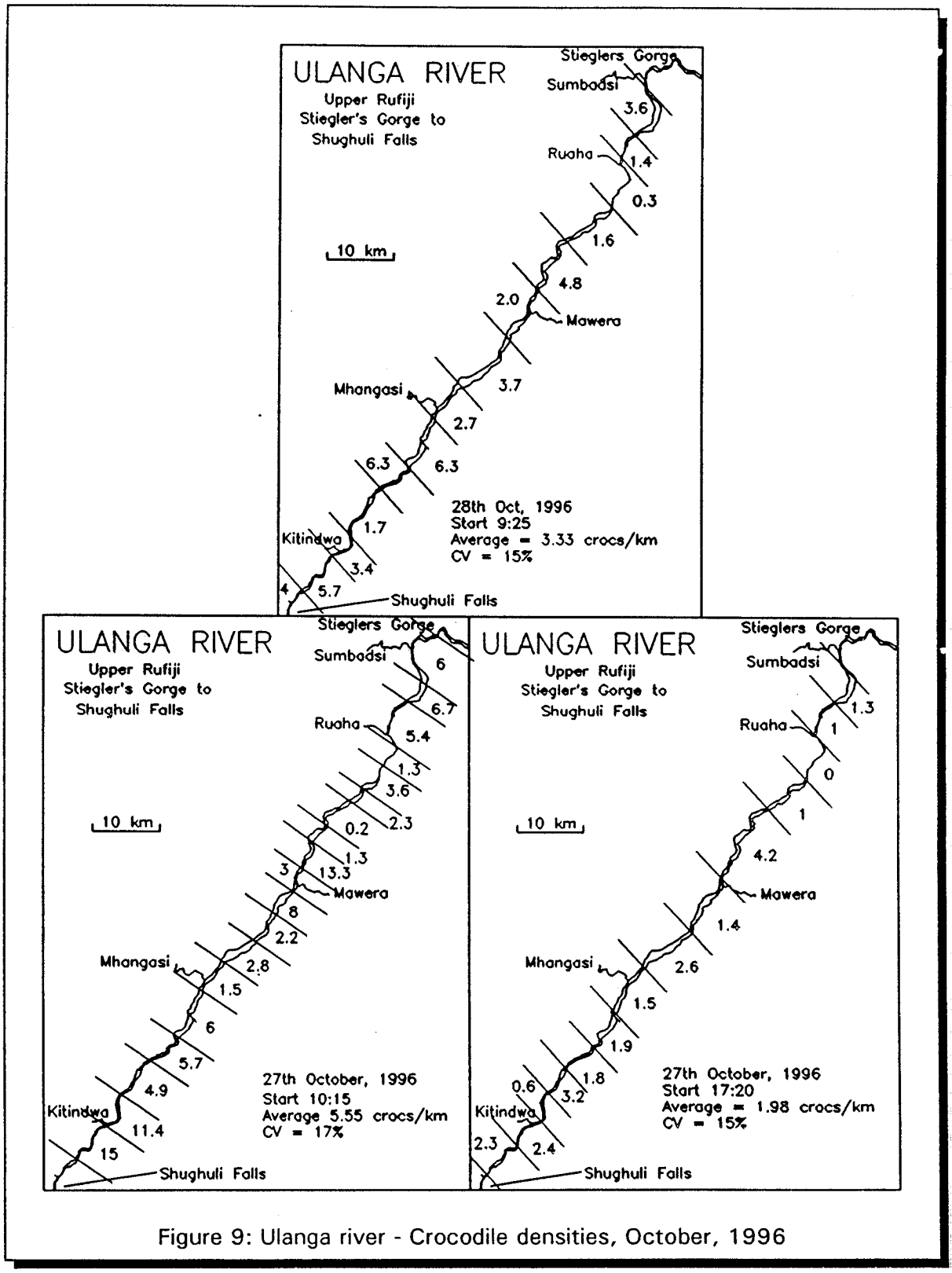


Figure 9: Ulanga river - Crocodile densities, October, 1996

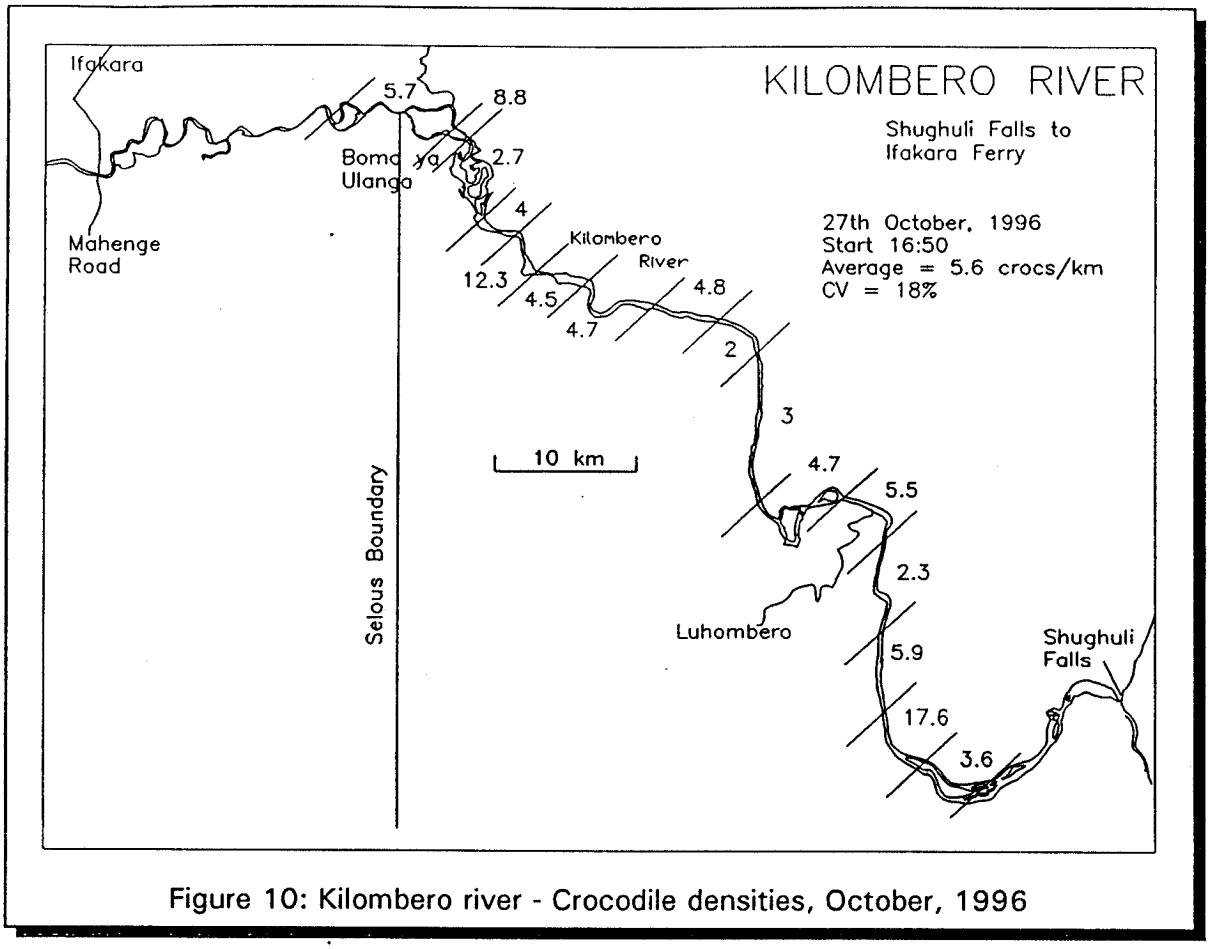


Figure 10: Kilombero river - Crocodile densities, October, 1996

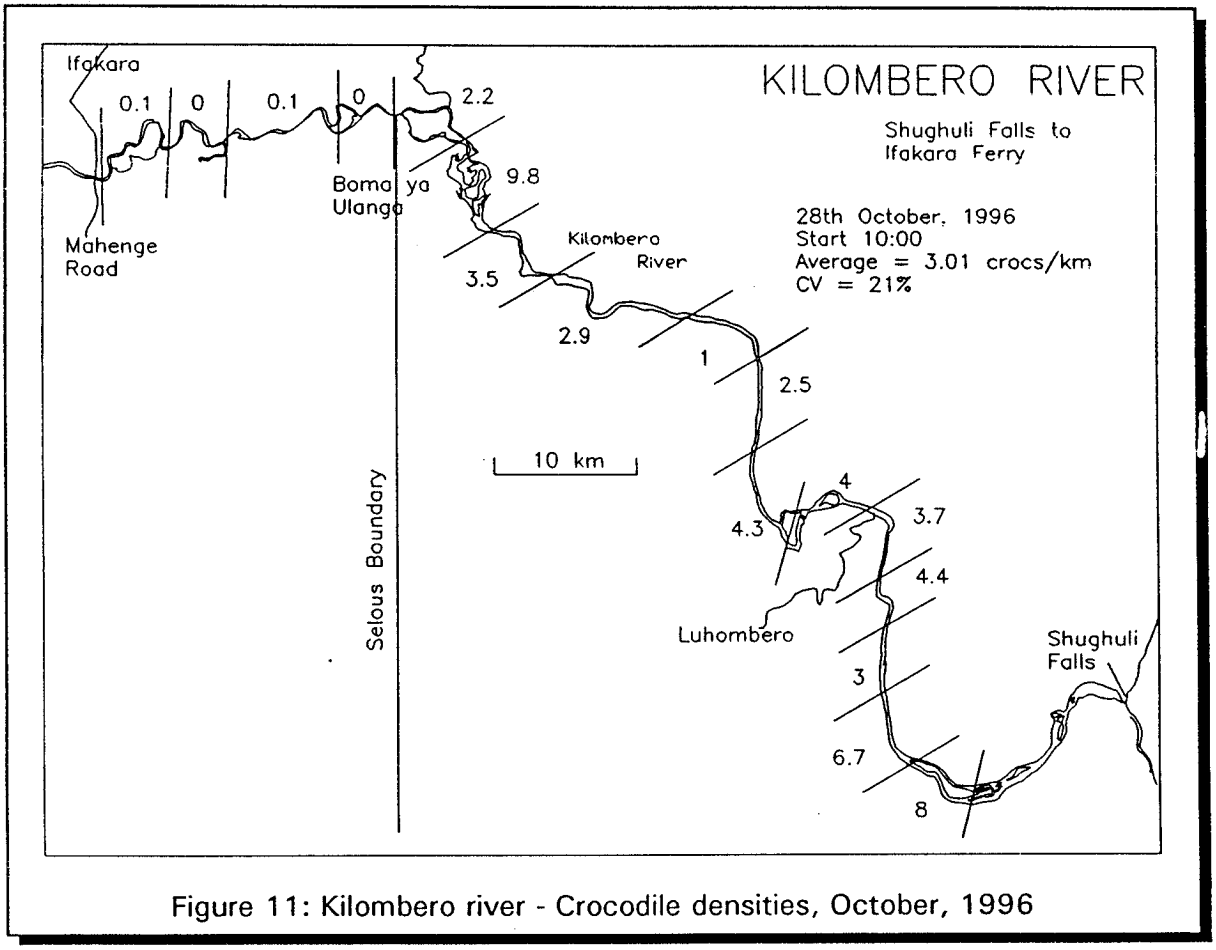


Figure 11: Kilombero river - Crocodile densities, October, 1996

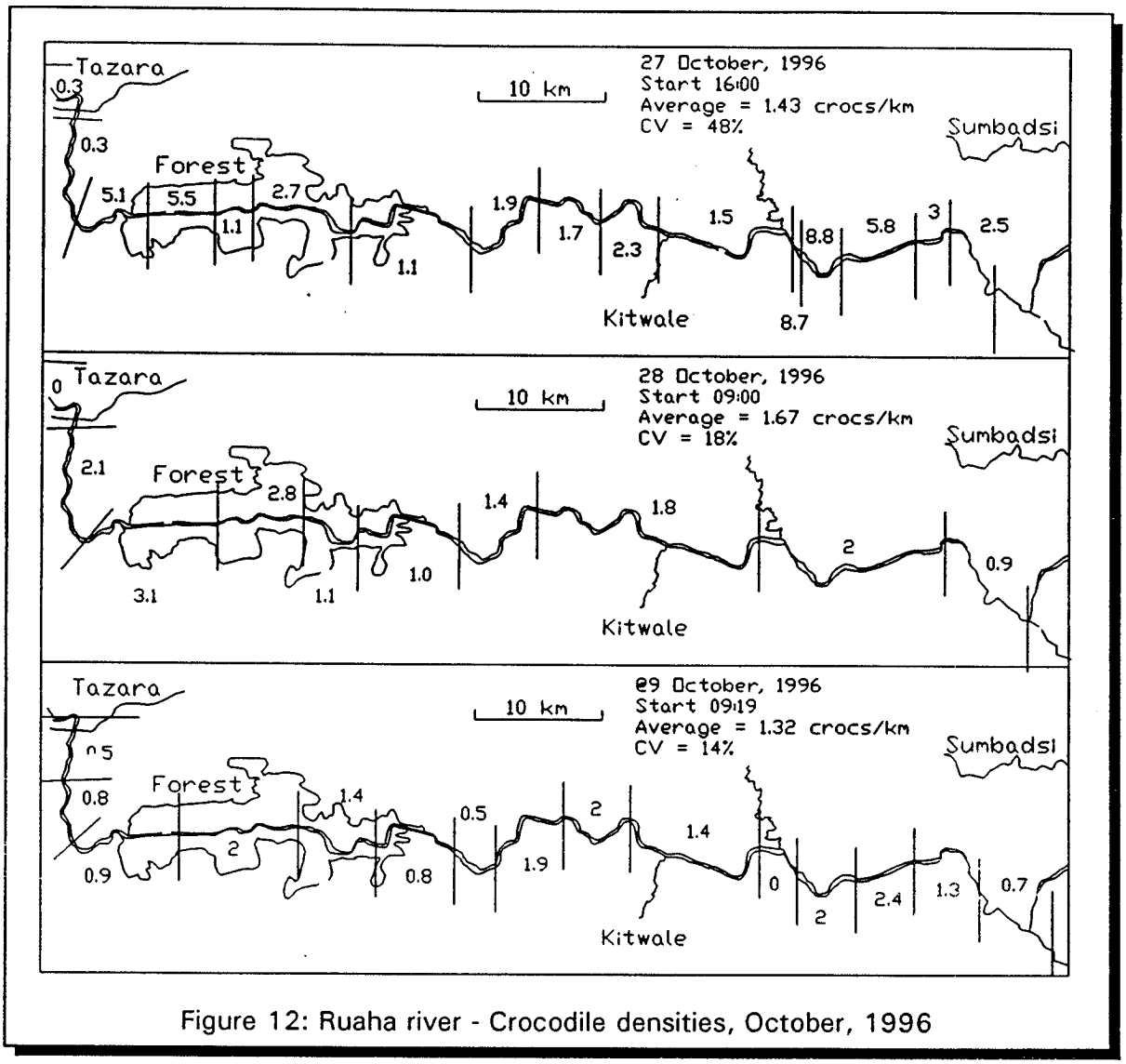


Figure 12: Ruaha river - Crocodile densities, October, 1996

3.2 OTHER RIVERS AND LAKES

Parts of the Great Ruaha river adjoining the Ruaha National Park, Mtera Dam, the Mara river, the Grumeti river, Rubondo Island (in Lake Victoria) and parts of Lake Nyumba ya Mungu on the Pangani river were surveyed (Table 4).

Table 4: Aerial Surveys for Crocodiles Outside the Selous Game Reserve,

DATE	SECTIONS SURVEYED	COMMENTS
29th; 30th	Upper Ruaha, Mtera Dam	Morning, Afternoon
29th	Rubondo	Afternoon
30th	Grumeti	Morning
30th	Mara	Morning
1st	Lake Nyumba ya Mungu	Morning

The results of these surveys are summarised below (Table 5). Figures 13 to 16 show the sections of river/shoreline surveyed and their relevant densities.

Table 5: Surveys for crocodiles in Tanzania, October 1996

RIVER	DENSITY	COMMENTS
Ruaha	2.66	Morning; Downstream Msembe Camp.
Ruaha	0.5	Late afternoon; Upstream Msembe Camp.
Ruaha	17.5	16 km stretch near Msembe
Mtera Dam	0.00	Lake unsuitable for aerial survey (Plate 10)
Grumeti	2.00	Most crocodiles at Kirawira
Mara	0.62	
Rubondo Island	2.50	Late Afternoon
Lake Nyumba ya Mungu	-	3 crocodiles seen

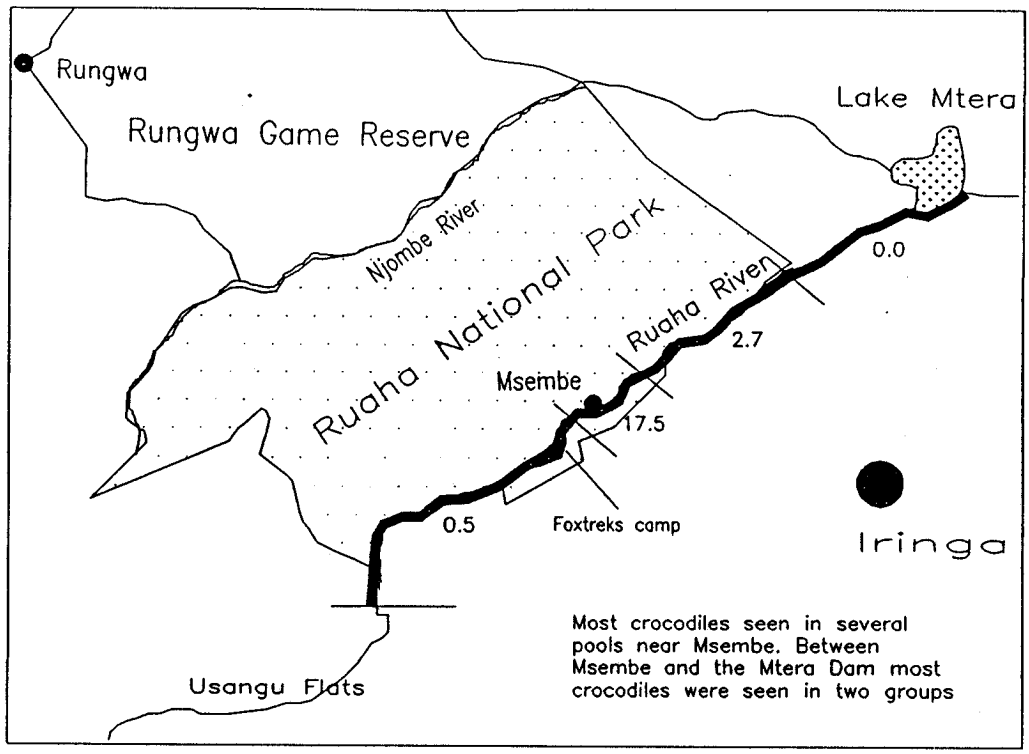


Figure 13: Ruaha river surveys in the Ruaha National Park, 1996

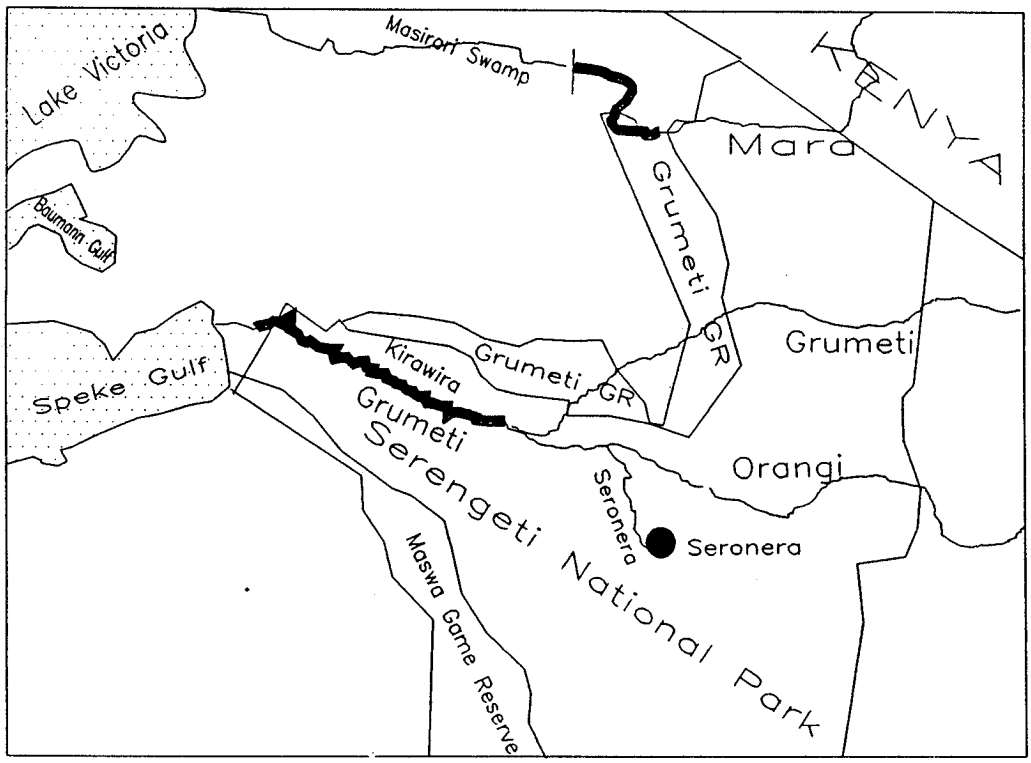


Figure 14: Surveys of the Grumeti and Mara rivers, October, 1996

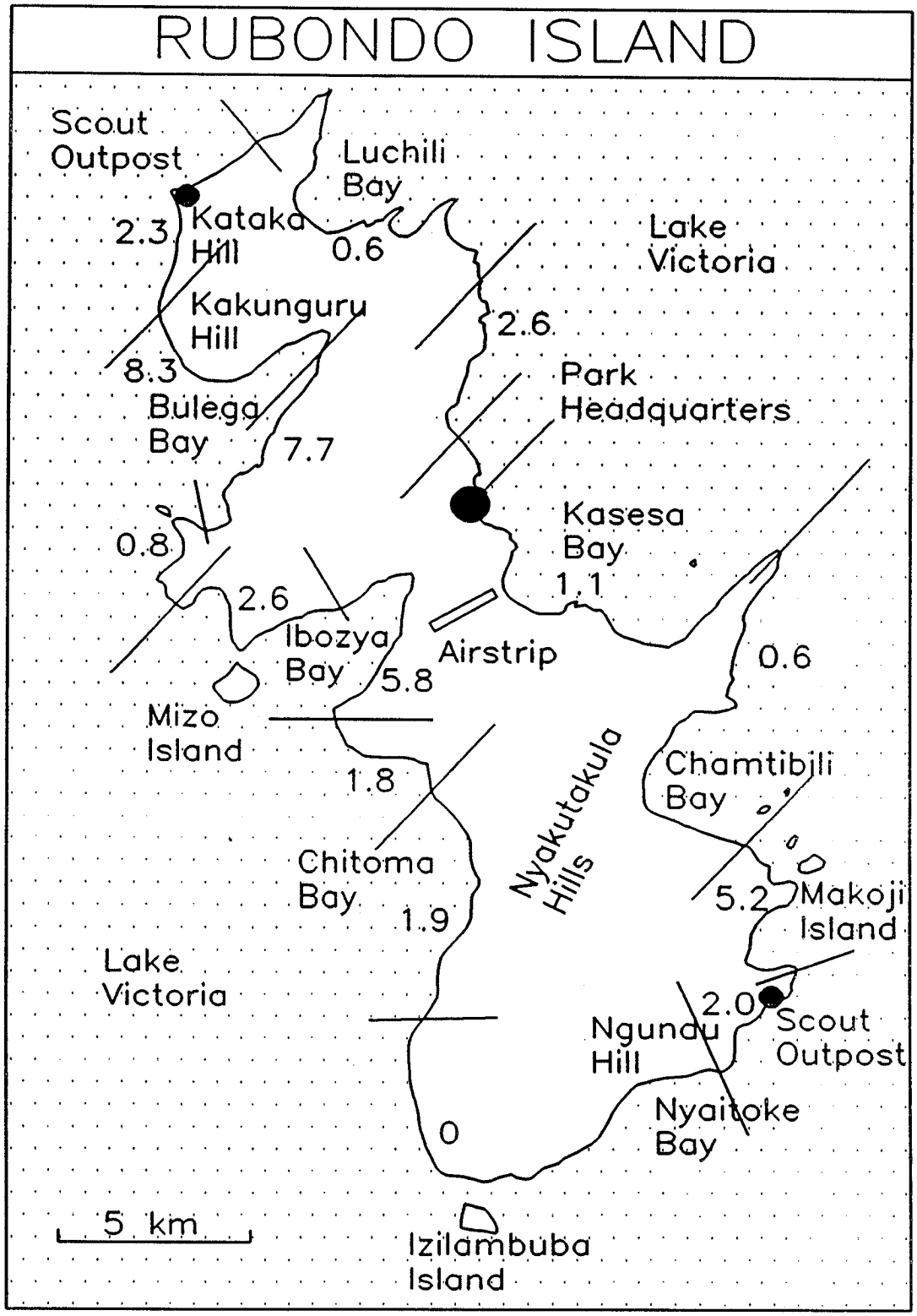


Figure 15: Rubondo Island, Lake Victoria

4. DISCUSSION

4.1 SELOUS GAME RESERVE

All available data from aerial surveys in the Selous Games Reserve was collected and is presented in Table 6. The 1988 survey took place during a high flood and the 1989 Kilombero data was much higher than other years so the original survey data was accessed and re-evaluated.

Table 6: Summary of crocodile densities in the Selous Game Reserve as estimated by aerial survey.

	Graham/ Parker 1963	Hutton/ Katalihwa 1988	Games/ Severre 1989	Games/ Severre 1990	Games/ Severre 1993	Games/ Severre 1995	Games/ Severre 1995
Ulanga (Upper Rufiji)	1.95 - 3.51	0.98	3.15	2.89	2.26	2.6	5.55
Lower Rufiji			6.75	11.83	10.49	10.1	19.98
Lake Tagallala				18.07	23.38	28.2	46.07
Ruaha		1.56	1.77	1.57	1.68	1.6	1.67
Kilombero		0.28	(7.74)	2.86	3.54	3.2	5.6
Upper Luwego			2.74				
Lower Luwego		0.33	1.64				

Notes:
- Kilombero and Lower Rufiji estimates for inside the Selous Game reserve.
- 1988 survey carried out during high flood conditions so not really comparable except for the Ruaha. This is because Ruaha is controlled by a dam so levels do not vary much.
- Rufiji lakes are drying up so only the estimate for Lake Tagallala is used.
- Lower Rufiji estimates are the best count of the day. i.e. 16:30 in 1990; 18:00 in 1993 and 17:30 in 1995
- The 1989 estimate for the Kilombero is so far in excess of the others that the original data was accessed and reworked and the implications of this discussed below.

The average densities all the rivers (except the Ruaha) and Lake Tagalalla show a substantial increase. The average densities for the Ruaha river have remained remarkably consistent since 1988. The co-efficients of variation (CV's) on almost all of these surveys were above 15%. For direct meaningful comparisons they should be below 15% (Graham, 1988). So what do these increases mean? The two main possibilities that spring to min are that:

1 there has been an increase in crocodile numbers in these rivers and lakes or

2 the pilots are better at flying surveys and the survey crews are more experienced resulting in an increased number of crocodiles seen.

We believe that the increases may be a function of both the above. However, we do believe that they indicate a real increase in the population visible from the air.

Attempts to improve the CV's by having smaller sections did not work. It is hoped to rework this data, and the data from previous years, into a form suitable for publication (time permitting) at which time the issue of reduced CV's will be addressed.

As in previous surveys very high densities of crocodiles are seen in the Lower Rufiji river and most of these are concentrated near the exit to Stiegler's Gorge. There is considerable variation in the counts. Surveys carried on cool mornings gave the lowest visible densities. Clumping of the crocodile population is another source of bias and variation in these surveys. In sand rivers such as the Rufiji the crocodiles tend to aggregate on sand banks. If the aircraft is badly positioned at the time of survey - by this we mean that the crocodile group is under the fuselage when passing over the bank - that entire group of crocodiles will be missed.

The Ulanga river densities also show considerable variation (from 1.98 to 5.55 crocodiles per kilometre). The high densities were due to large groups of crocodiles seen near the Shughuli falls and close to the Mawera river. Again the variation may have been caused by groups of crocodiles being missed owing to the position of the aircraft relative to the river.

The Rufiji lakes have a high concentration of crocodiles and the one in Lake Tagallala must be one of the most impressive in Africa. This survey showed a density of close to 50 crocodiles per kilometre of shoreline. This was almost double that seen in 1995.

Table 7: Surveys of the Rufiji lakes

Lake	1991	1993	1995	1996
Tagallala	181	304	319	599
Manze	71		366	120
Nzerakera	79		139	187
Siwando	43		250	127
Mzizima	14		113	59
Conditions	Poor		Good	Variable[1]

[1] = The ability of the pilot is crucial on the lake surveys. Tight turns close to the ground are the order of the day and the counts increase the better the pilot is. On the 1996 survey Lake Tagallala was survey by a very experienced pilot while the others were flown by a less experienced pilot.

The Kilombero river also showed an increase in average density from 3.2 in 1995 to 5.6 in 1996. The higher density recorded in this survey was only for the river inside the Selous game reserve.

The Ruaha density estimates have remained remarkable constant over the years at approximately 1.5 crocodiles per kilometre. It is interesting to note that this is true of the 1988 high water survey. This is because the Ruaha flow is regulated by the Kidatu Dam. CV's for this river are also the lowest that were calculated and are generally below 20%.

4.2 OTHER RIVERS

The densities on the Great Ruaha river and around Rubondo Island appear to have increased (Table 8). Both of these areas have national park status.

The Ruaha river in the Ruaha National Park becomes a series of pools during the dry season. Most of the crocodiles were found in a short section of the river near the Park headquarters at Msembe. The downstream section (from Msembe) had two pools with a large number of crocodiles in them while crocodiles were more uniformly distributed in the upstream section (0.5 crocodiles per kilometre). Mtera dam was survey but proved to totally unsuited to aerial survey owing to extensive weed banks.

A short section of both the Mara and Grumeti rivers were surveyed. Most of the crocodiles in the Grumeti river are concentrated in the Kirawira section. This population is well known for its feeding frenzy on the wildebeest migration. Outside of this are the densities are low. There has been an apparent increase in the densities of crocodiles on the Grumeti. The Mara river density appears to be slightly lower but probably well within any confidence limits.

Table 8: Summary and comparison of crocodile densities in some Tanzanian rivers and lakes as estimated by aerial survey.

RIVER	1990	1993	1995	1996
Mara	0.88			0.60
Grumeti	0.83			2.00
Ruaha (in Ruaha N.P.)	0.86	1.78		2.66
Rubondo Island	0.62	0.82	0.7	2.66

Three crocodiles were seen on the shores of Lake Nyumba ya Mungu. This lake is used by egg collectors and always features on the list of crocodile complaints. It is surprising that more crocodiles are not seen from the air given the good crocodile spotting conditions of this lake.

4.3 GENERAL

Aerial survey to estimate crocodile numbers is fraught with scientific and statistical difficulties. At best we feel that by attempting to standardise the time of year of the surveys, the water levels, the pilots and the observer experience we will be able to use densities as an index of increase or decline. Many biases are seen in crocodile surveys and these include observer bias, diving bias and concealment bias. All of these will lower the density estimates. For example the time of day - which will affect the number of crocodiles basking has a noticeable effect and is illustrated by the surveys over Lake Tagallala (Table 9). The late afternoon surveys are consistently more efficient than those at mid-morning. Unfortunately the long transit times and the lengths of the rivers to be surveyed means that the aircraft are over the rivers unsuitable times of day.

Table 9: Aerial Surveys of Lake Tagallala - Selous Game Reserve

DATE	TIME	NUMBERS	DENSITY
1990 (October)	11:00	181	13.92
1993 (November)	12:00	109	8.38
1993 (November)	17:30	304	23.38
1995 (October)	16:30	316	24.31
1995 (October)	17:30	366	28.15
1996 (October)	17:15	599	46.07

4.4 NIGHT COUNTS

Night counts are one way to try and measure the extent of the bias caused by the size of the crocodile (crocodiles smaller than 1.2 metres total length are seldom seen from the air), and concealment.

The night counts for the section of the Lower Rufiji between the Kidai scout outpost and Sand Rivers camp (Table 10) was compared with aerial counts of the same sections (Table 11). Under-counting from the air is evident (of course) and the effect of the time of the aerial survey is also evident. The night counts revealed an under-counting bias by a factor of two for the section between Kidai and Sand rivers.

The numbers of crocodiles seen during a night count can be as little as 10 % of the total population but is usually between 30 and 60 % (Hutton and Woolhouse, 1989).

Table 10: Night count on the Lower Rufiji - Sand Rivers Camp to Kidai Scout Post			
Section	**Distance (km)**	**Crocodiles**	**Density**
1	0.75	17	22.7
2	0.80	27	33.8
3	1.25	28	22.4
4	1.20	77	64.2
5	1.10	18	16.4
6	0.70	46	65.7
7	2.30	84	36.5
8	1.20	50	41.7
TOTAL	**9.30**	**382**	**41.1**

Table 11: Night count correction - Lower Rufiji River - Selous Game Reserve			
	NUMBERS	**DENSITY**	**CORRECTION FACTOR**
1993			
09:30	137	7.2	2.3
12:30	52	2.7	6.1
Night - Boat	317	16.7	
1995			
16:30	50	7.1	2.9
Night - Boat	145	20.7	
1996			
09:00	183	19.6	2.1
Night - Boat	382	41.1	

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CROCODILE ESTIMATES FROM SAMPLE COUNTS				
LOWER RUFIJI RIVER - Morning, 27th October, 1996				
Number of Samples = 10				
Length of Strata = 53.5 km				
Average Density = 5.27 crocs/km - Range 0.57 to 15.71 crocs/km				
COMMENTS: Stieglers Gorge to Mloka. Start 10:15; End 10:32. Plane 1.				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	3	42	14.00	196.00
2	3.5	55	15.71	246.804
3	6	48	8.00	64.00
4	7	10	1.43	2.045
5	5	37	7.40	54.760
6	5	13	2.60	6.76
7	4	27	6.75	45.563
8	7	40	5.71	32.604
9	6	6	1.00	1.000
10	7	4	0.57	0.325
SUM	53.5	282	63.17	649.861
Sampling Variance Sd^2	=		27.87	
Variance of Estimate	=		7976.65	
Square Root of Variance	=		89.31	
Co-efficient of Variation	=		32	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
ULANGA RIVER - Morning, 29th October, 1996				
Number of Samples = 19				
Length of Strata = 112 km				
Average Density = 5.55 crocs/km - Range 0.15 to 15 crocs/km				
COMMENTS: Stieglers Gorge to Shughuli. Start 10:15; End 10:50. Plane 2				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	10.5	63	6.00	36.000
2	4.5	30	6.67	44.489
3	8.5	46	5.41	29.268
4	4.5	6	1.33	1.769
5	4.5	16	3.56	12.674
6	3.5	8	2.29	5.244
7	6.5	1	0.15	0.023
8	4.0	5	1.25	1.563
9	4.5	60	13.33	177.689
10	4.0	12	3.00	9.000
11	5.0	40	8.00	64.000
12	5.0	11	2.20	4.840
13	6.0	17	2.83	8.009
14	6.0	9	1.50	2.250
15	8.0	48	6.00	36.000
16	6.0	34	5.67	32.149
17	8.0	39	4.88	23.814
18	5.0	57	11.40	129.96
19	8.0	120	15.00	225.00
SUM	112	622	100.47	843.741
Sampling Variance Sd^2 =			17.36	
Variance of Estimate =			11460.75	
Square Root of Variance =			107.05	
Co-efficient of Variation =			17	%

TANZANIAN CROCODILE SURVEY, OCTOBER, 1996

PLATES

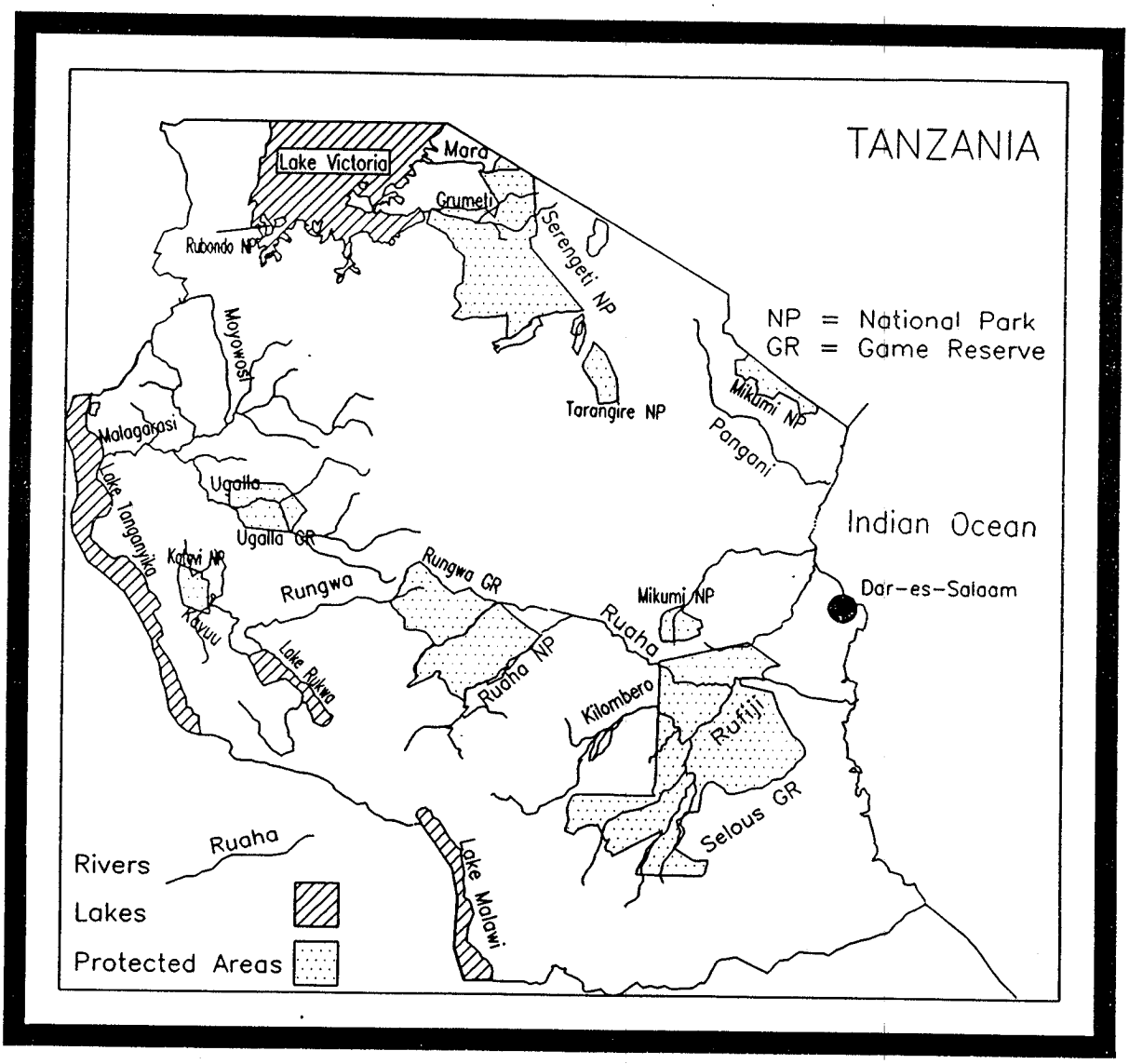


Plate 1: Lower Rufiji east of the Selous - Picture from commercial airline

Plate 2: Lower Rufiji - Old river bed on right of picture

Plate 3: Ruaha river inside Selous

Plate 4: Rapid on the Ruaha river inside Selous

Plate 5: Kilombero river middle reaches inside Selous

Plate 6: Kilombero river at Boma ya Ulanga

Plate 7: Lake Tagallala

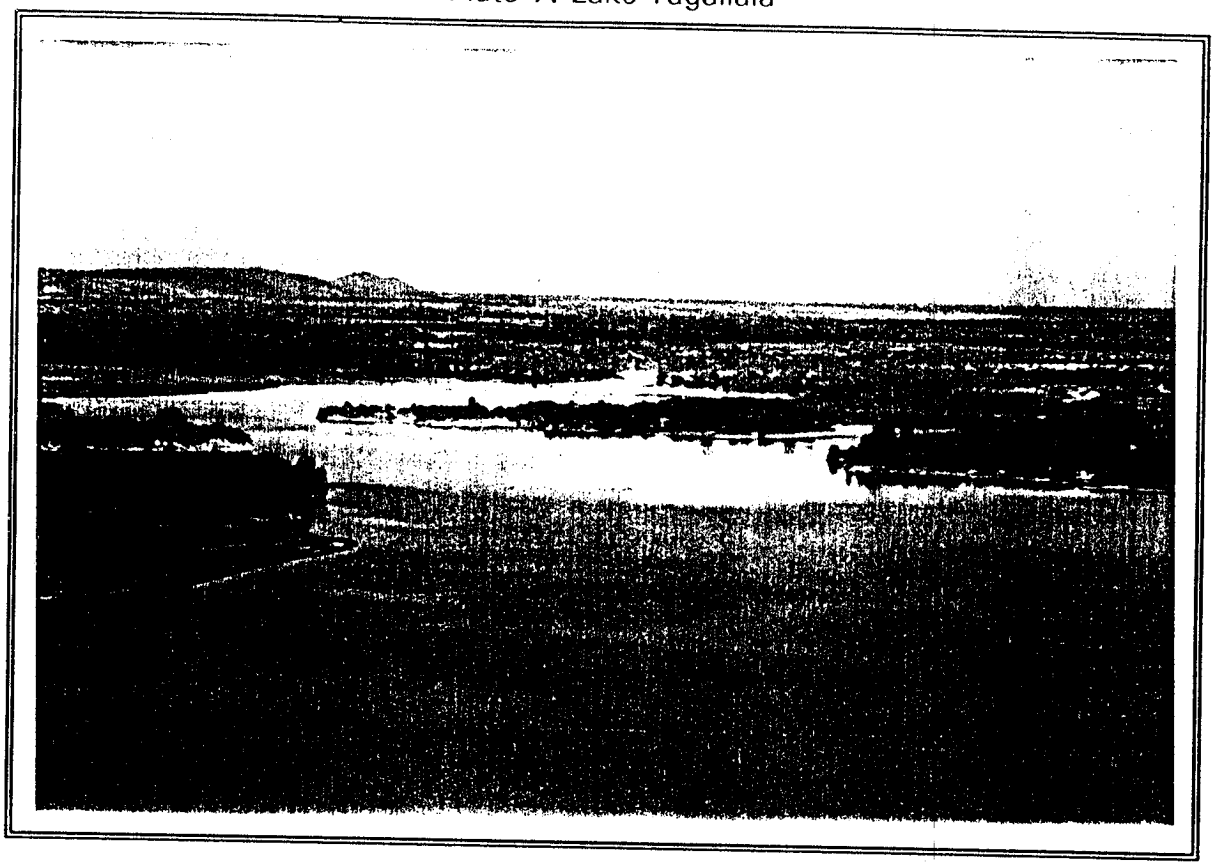


Plate 8: Ulanga river close to Stieglers gorge

Plate 9: Ruaha river inside the Ruaha National Park - Upstream from Msembe

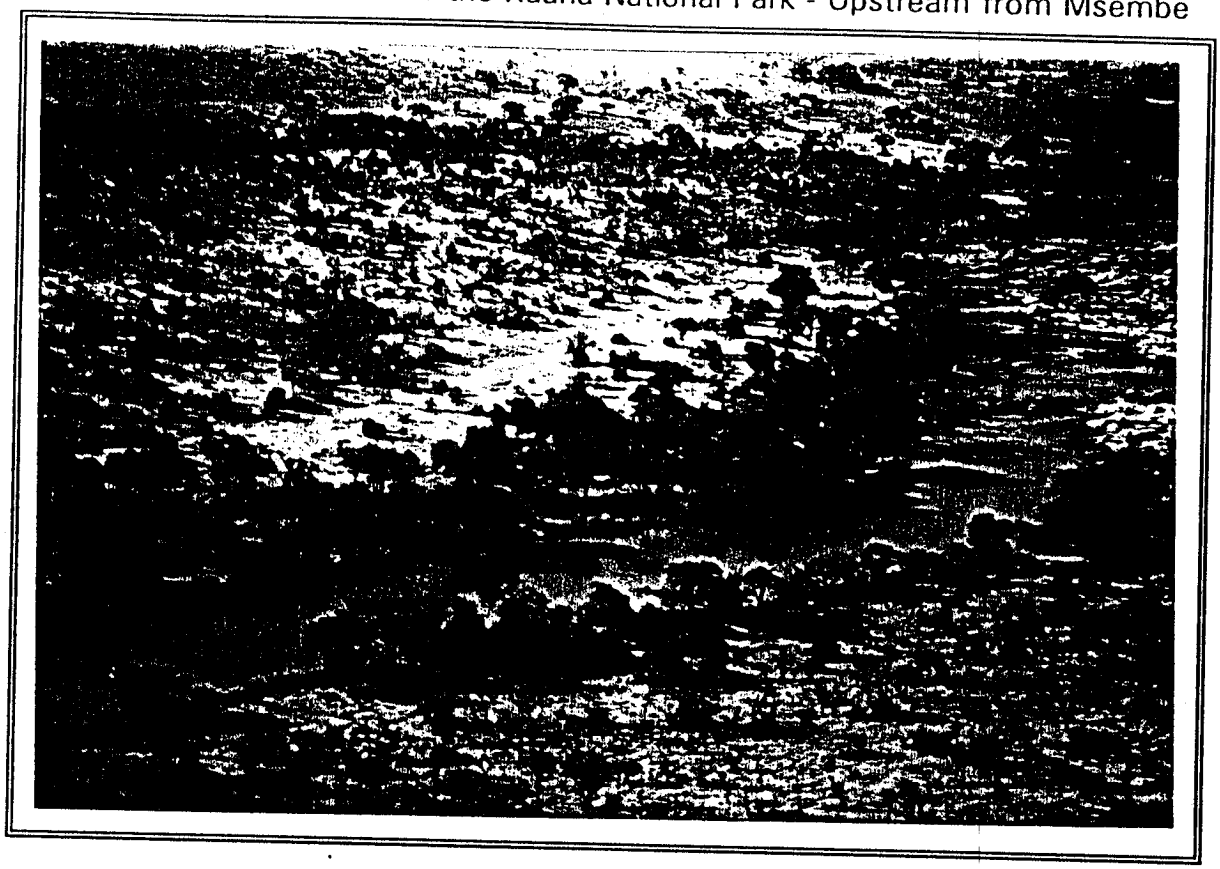
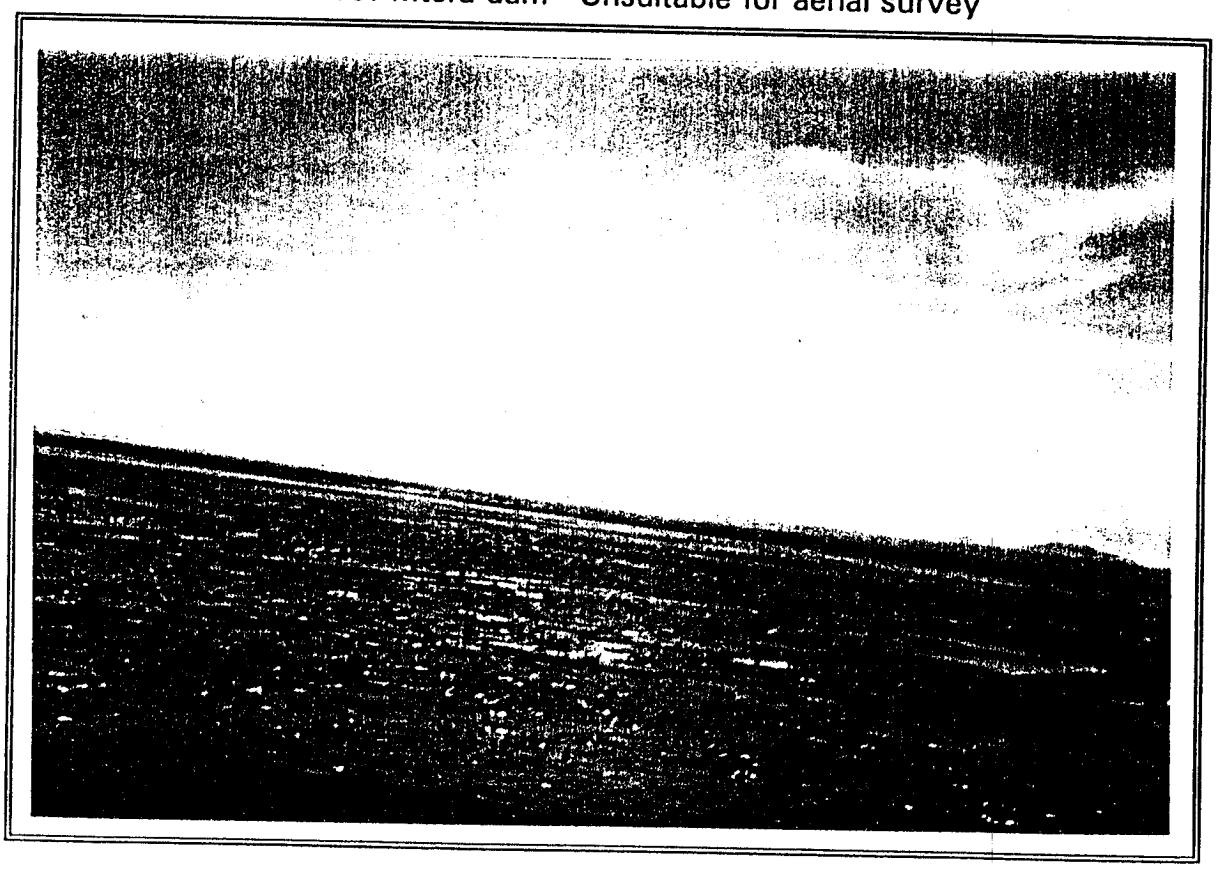
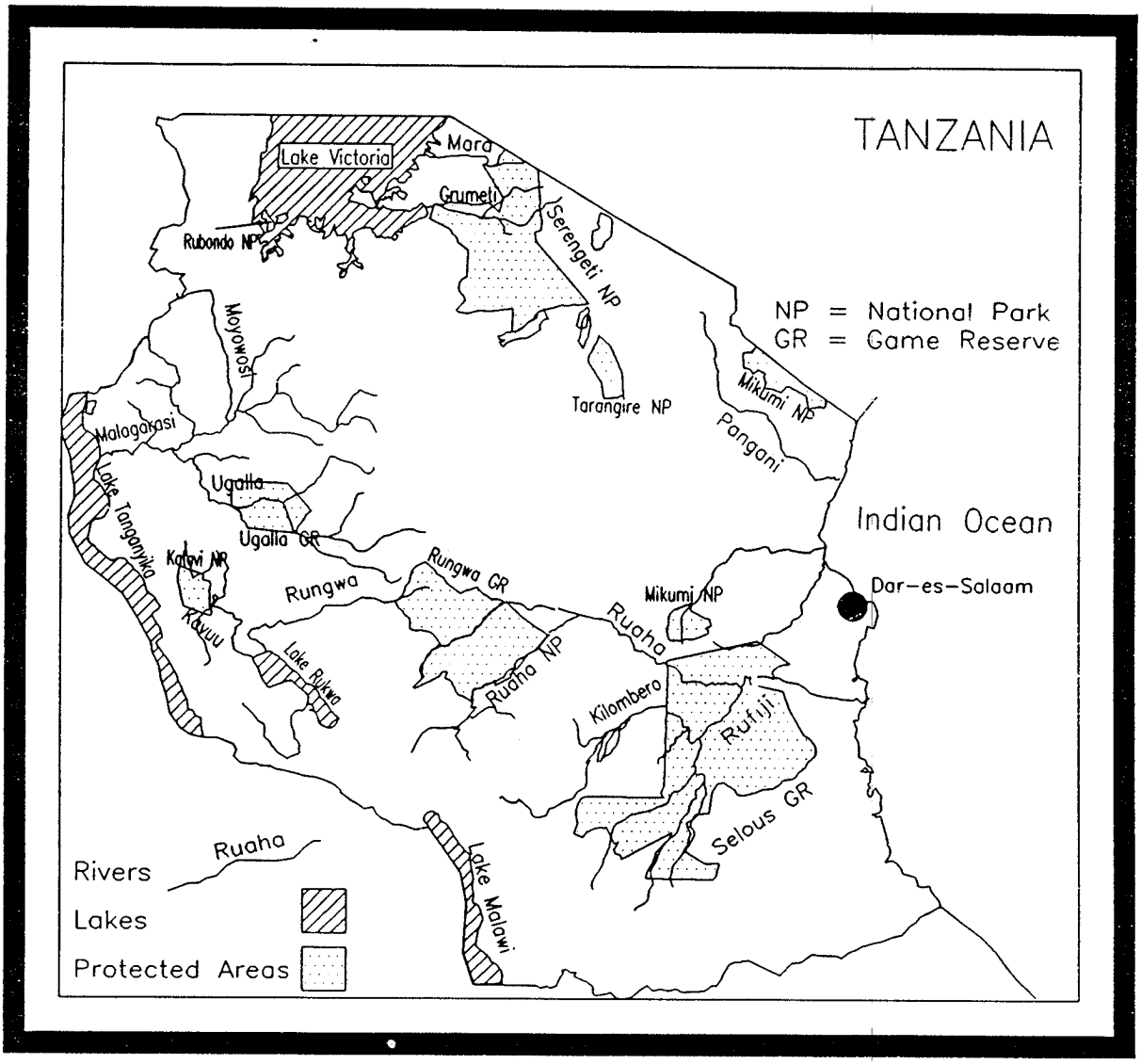


Plate 10: Mtera dam - Unsuitable for aerial survey



TANZANIAN CROCODILE SURVEY
OCTOBER-NOVEMBER, 1996

APPENDIX I - SURVEY DETAILS



CROCODILE ESTIMATES FROM SAMPLE COUNTS				
KILOMBERO RIVER - Afternoon, 27th October, 1996				
Number of Samples = 16				
Length of Strata = 92.5 km				
Average Density = 5.6 crocs/km - Range 2.0 to 17.6 crocs/km				
COMMENTS: Start at Boma ya Ulanga to Shughuli Falls. Start 4:50 end 5:15. Plane 1.				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	7	40	5.71	32.604
2	5	44	8.80	77.44
3	8.5	23	2.71	7.344
4	3.5	14	4.00	16.000
5	3	37	12.33	152.029
6	4	18	4.50	20.029
7	7.5	35	4.67	21.809
8	5	24	4.80	23.040
9	4	8	2.00	4.000
10	5	15	3.00	9.000
11	6	28	4.67	21.809
12	10.5	58	5.52	30.470
13	6	14	2.33	5.429
14	7	41	5.86	32.262
15	5.5	97	17.64	311.169
16	5	18	3.60	12.960
SUM	92.5	518	92.14	777.615
Sampling Variance Sd^2	=		16.47	
Variance of Estimate	=		8805.94	
Square Root of Variance	=		93.84	
Co-efficient of Variation	=		18	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS

ULANGA RIVER - Afternoon, 27th October, 1996

Number of Samples = 14

Length of Strata = 108.5 km

Average Density = 1.98 crocs/km - Range 0.00 to 4.21 crocs/km

COMMENTS: Shughuli Falls to Stieglers Gorge. Start 17:20; End 17:45. Plane 1.

Section	Length (km)	Crocodiles	Density (d)	d^2
1	8	18	2.25	5.063
2	5.5	13	2.36	5.570
3	5	3	0.60	0.360
4	5	16	3.20	10.240
5	6	11	1.83	3.349
6	7	20	2.86	8.180
7	8	12	1.50	2.250
8	9.5	25	2.63	6.917
9	10	14	1.40	1.960
10	14	59	4.21	17.724
11	8	8	1.00	1.000
12	9	0	0.00	0.000
13	6	6	1.00	1.000
14	7.5	10	1.33	1.769
SUM	108.5	215	26.17	65.382

Sampling Variance Sd^2	=	1.27	
Variance of Estimate	=	1064.86	
Square Root of Variance	=	32.63	
Co-efficient of Variation	=	15	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
RUAHA RIVER - Afternoon, 27th October, 1996				
Number of Samples = 16				
Length of Strata = 114 km				
Average Density = 1.43 crocs/km - Range 0.26 to 8.8 crocs/km				
COMMENTS: Kilombero Sugar Estate to Stieglers Gorge. Plane 2.				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	3.5	1	0.29	0.084
2	11.5	3	0.26	0.068
3	8.0	41	5.13	26.317
4	5.5	30	5.46	29.812
5	3.5	4	1.14	1.299
6	9.0	24	2.67	7.129
7	12.5	14	1.12	1.254
8	9.0	17	1.89	3.572
9	6.0	10	1.67	2.789
10	7.0	16	2.29	5.244
11	14.0	21	1.50	2.250
12	1.5	13	8.67	75.169
13	5.0	44	8.80	77.440
14	6.0	35	5.83	33.989
15	4.0	12	3.00	9.000
16	8.0	20	2.50	6.250
SUM	114	163	52.22	281.666
Sampling Variance Sd^2 =			7.42	
Variance of Estimate =			6023.27	
Square Root of Variance =			77.61	
Co-efficient of Variation =			48	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
LOWER RUFIJI RIVER - Afternoon, 27th October, 1996				
Number of Samples = 10				
Length of Strata = 45.5 km				
Average Density = 19.98 crocs/km - Range 1.29 to 45 crocs/km				
COMMENTS: Stieglers Gorge to Mloka. Plane 2.				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	· 5	225	45.00	2025.000
2	3.5	83	23.70	561.690
3	3	120	40.00	1600.000
4	4	174	43.50	1892.250
5	6	76	12.67	160.529
6	2	65	32.50	1056.250
7	2.5	55	22.00	484.000
8	6	76	12.67	160.529
9	5	24	4.80	23.040
10	8.5	11	1.29	1.664
SUM	45.5	909	238.13	7964.952
Sampling Variance Sd^2 =			254.93	
Variance of Estimate =			52776.71	
Square Root of Variance =			229.73	
Co-efficient of Variation =			25	%
Ulanga[1]	25	89	3.56	

[1] = Section from Ruaha junction to exit from Stieglers gorge

CROCODILE ESTIMATES FROM SAMPLE COUNTS

RUAHA RIVER - Morning, 28th October, 1996

Number of Samples = 10

Length of Strata = 116 km

Average Density = 1.67 crocs/km - Range 0 to 3.18 crocs/km

COMMENTS: Ruaha River Bridge to Stieglers Gorge. Plane 2.

Section	Length (km)	Crocodiles	Density (d)	d^2
1	9	0	0.00	0.000
2	10.5	22	2.09	4.368
3	11.5	36	3.13	9.797
4	5	14	2.80	7.840
5	5.5	6	1.09	1.188
6	11.5	12	1.04	1.082
7	9	13	1.44	2.074
8	24	44	1.83	3.349
9	18	36	2.00	4.000
10	12	11	0.92	0.846
SUM	116	194	16.34	34.544

Sampling Variance Sd^2	=	0.87	
Variance of Estimate	=	1172.83	
Square Root of Variance	=	34.25	
Co-efficient of Variation	=	18	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
LOWER RUFIJI RIVER - Morning, 28th October, 1996				
Number of Samples = 10				
Length of Strata = 51 km				
Average Density = 18.25 crocs/km - Range 0 to 101.33 crocs/km				
COMMENTS: Stieglers Gorge to Mloka. Plane 2. Start 09:50				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	3.5	54	15.43	238.080
2	1.5	152	101.33	10267.768
3	4	148	37.00	1369.000
4	5	251	50.20	2520.040
5	5.5	77	14.00	196.000
6	4.5	76	16.89	285.272
7	5	71	14.20	201.640
8	6	51	8.50	72.250
9	14	7	0.50	0.250
10	2	0	0.00	0.000
SUM	51	931	258.05	15150.300
Sampling Variance Sd^2 =			943.48	
Variance of Estimate =			245399.14	
Square Root of Variance =			495.38	
Co-efficient of Variation =			53	%
Ulanga[1]	20	44	2.2	

[1] = Section from Ruaha junction to exit from Stieglers gorge

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
ULANGA RIVER - Morning, 28th October, 1996				
Number of Samples = 14				
Length of Strata = 109.5 km				
Average Density = 3.33 crocs/km - Range 0.33 to 6.33 crocs/km				
COMMENTS: Stieglers Gorge to Shughuli Falls. Start 9:25; End 9:55. Plane 1.				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	9	32	3.55	12.603
2	5	7	1.40	1.960
3	9	3	0.33	0.109
4	9.5	15	1.58	2.496
5	10.5	50	4.76	22.658
6	9.5	19	2.00	4.000
7	11	41	3.73	13.913
8	7	19	2.71	7.344
9	9	57	6.33	40.069
10	6	38	6.33	40.069
11	9	15	1.67	2.789
12	5	17	3.40	11.560
13	7	40	5.71	32.604
14	3	12	4.00	16.000
SUM	109.5	365	47.50	208.174
Sampling Variance Sd^2 =			3.62	
Variance of Estimate =			3097.26	
Square Root of Variance =			55.65	
Co-efficient of Variation =			15	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
KILOMBERO RIVER - Morning, 28th October, 1996				
Number of Samples = 17				
Length of Strata = 128 km				
Average Density = 3.01 crocs/km - Range 0.00 to 9.75 crocs/km				
COMMENTS: Shughuli Falls to Boma ya Ulanga. Start 10:0; End 10:30. Plane 1.				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	5	40	8.00	64.000
2	6	40	6.67	44.488
3	5	15	3.00	9.000
4	4.5	20	4.44	19.714
5	6	22	3.67	13.469
6	9.5	38	4.00	16.000
7	8	34	4.25	18.063
8	6.5	16	2.46	6.052
9	7	7	1.00	1.000
10	13	37	2.85	8.123
11	6.5	23	3.54	12.532
12	8	78	9.75	95.063
13	6	13	2.17	4.709
14	5	0	0.00	0.000
15	12	1	0.08	0.006
16	7.5	0	0.00	0.000
17	12.5	1	0.08	0.006
SUM	128	385	58.97	312.225
Sampling Variance Sd^2 =			6.73	
Variance of Estimate =			6485.44	
Square Root of Variance =			80.53	
Co-efficient of Variation =			21	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
LOWER RUFIJI RIVER - Afternoon, 28th October, 1996				
Number of Samples = 20				
Length of Strata = 65 km				
Average Density = 12.7 crocs/km - Range 1.6 to 55.6 crocs/km				
COMMENTS: Stieglers Gorge to Mloka (Short section experiment). Plane 1. Start 16:22				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	10.0	16	1.60	2.56
2	1.2	37	30.83	950.488
3	1.4	75	53.57	2869.745
4	1.1	17	15.45	238.703
5	2.5	139	55.60	3091.360
6	2.3	51	22.17	491.509
7	2.3	36	15.65	244.923
8	1.9	93	48.95	2396.103
9	2.3	68	29.57	874.385
10	2.5	32	12.80	163.840
11	2.4	16	6.67	44.489
12	1.9	34	17.89	320.052
13	2.3	50	21.74	472.627
14	3.0	39	13.00	169.000
15	3.3	38	11.52	132.710
16	3.2	10	3.13	9.797
17	4.2	22	5.24	27.458
18	2.5	19	7.60	57.760
19	4.7	14	2.98	8.880
20	10.0	21	2.10	4.410
SUM	65	827	378.06	12570.799
Sampling Variance Sd^2	=		285.49	
Variance of Estimate	=		60309.99	
Square Root of Variance	=		245.58	
Co-efficient of Variation	=		30	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS

LOWER RUFIJI RIVER - Morning, 30th October, 1996

Number of Samples = 12

Length of Strata = 67 km

Average Density = 7.6 crocs/km - Range 0.25 to 19.67 crocs/km

COMMENTS: Mloka to Stieglers Gorge via Mbuyu channel. Start at 08:50. Most crocs seen in the water.

Section	Length (km)	Crocodiles	Density (d)	d^2
1	12	3	0.25	0.063
2	9.5	10	1.05	1.103
3	4.5	8	1.78	3.168
4	2.5	42	16.80	282.240
5	2	17	8.50	72.250
6	9.5	34	3.58	12.816
7	4.5	65	14.44	208.514
8	3.5	52	14.86	220.082
9	6	118	19.67	386.909
10	6	82	13.67	186.869
11	3	52	17.33	300.329
12	4	24	6.00	36.000
SUM		507	100.60	1710.343
Sampling Variance Sd^2	=		78.82	
Variance of Estimate	=		29483.88	
Square Root of Variance	=		171.71	
Co-efficient of Variation	=		31	%
The following two were for Stieglers Gorge (13) and the sand banks prior to the gorge (14)				
13	10.5	8	0.76	0.578
14	8	42	5.25	27.563

CROCODILE ESTIMATES FROM SAMPLE COUNTS

LOWER RUFIJI RIVER - Morning, 29th October, 1996

Number of Samples = 9

Length of Strata = 43 km

Average Density = 15.8 crocs/km - Range 7.2 to 44.5 crocs/km

COMMENTS: Stieglers Gorge to Mloka. Start at 09:00. Night count correction.

Section	Length (km)	Crocodiles	Density (d)	d^2
1	2	15	7.50	56.25
2	2	89	44.50	1980.25
3	2.5	31	12.40	153.76
4	10.5	183	17.43	303.805
5	5	60	12.00	144.000
6	3	72	24.00	576.000
7	4	53	13.25	175.563
8	9	141	15.67	245.543
9	5	36	7.20	51.84
SUM	43	680	153.95	3687.017

Sampling Variance Sd^2	=	131.70	
Variance of Estimate	=	27057.46	
Square Root of Variance	=	164.49	
Co-efficient of Variation	=	24	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
RUAHA RIVER - Morning, 29th October, 1996				
Number of Samples = 15				
Length of Strata = 110 km				
Average Density = 1.32 crocs/km - Range 0.00 to 2.40 crocs/km				
COMMENTS: Stieglers Gorge to Railway bridge. Start 09:19; End 09:50. Plane 1.				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	8.5	6	0.71	0.504
2	8	10	1.25	1.563
3	5	12	2.40	5.760
4	6	12	2.00	4.000
5	4	0	0.00	0.000
6	14	20	1.43	2.045
7	7	14	2.00	4.000
8	8.5	16	1.88	3.353
9	4	2	0.50	0.250
10	8	6	0.75	0.563
11	8.5	12	1.41	1.988
12	10	20	2.00	4.000
13	9.5	9	0.95	0.903
14	5	4	0.80	0.640
15	4	2	0.50	0.250
SUM	110	145	18.58	30.00
Sampling Variance Sd^2 =			0.50	
Variance of Estimate =			402.5	
Square Root of Variance =			20.06	
Co-efficient of Variation =			14	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
RUBONDO ISLAND - 30th October, 1996				
Number of Samples = 15				
Length of Strata = 124 km				
Average Density = 2.5 crocs/km - Range 0 to 8.27 crocs/km				
COMMENTS: Late afternoon. Clear sky. Start 16:00				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	11.5	7	0.61	0.372
2	7.5	39	5.20	27.040
3	6	12	2.00	4.000
4	13	0	0.00	0.000
5	7.5	14	1.87	3.490
6	4	7	1.75	3.060
7	6.5	38	5.84	34.110
8	8	21	2.63	6.920
9	4	3	0.75	0.563
10	7	54	7.71	59.444
11	7.5	62	8.27	68.393
12	6	14	2.33	5.429
13	15	9	0.60	0.360
14	5	13	2.60	6.760
15	15.5	17	1.09	1.188
SUM	124	310	43.25	220.940
Sampling Variance Sd^2 =			6.87	
Variance of Estimate =			7046.30	
Square Root of Variance =			83.94	
Co-efficient of Variation =			27	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
GRUMETI RIVER - 1st November, 1996				
Number of Samples = 8				
Length of Strata = 137 km				
Average Density = 2.0 crocs/km - Range 0 to 25.14 crocs/km				
COMMENTS: Most crocodiles at Kirawira. Start 10:36				
Section	Length (km)[1]	Crocodiles	Density (d)	d^2
1	63	9	0.14	0.019
2	3.5	88	25.14	632.019
3	3.5	71	20.29	411.684
4	9	75	8.33	69.389
5	9	29	3.20	10.250
6	11	7	0.64	0.409
7	26	0	0.00	0.000
8	12	0	0.00	0.000
SUM	137	279	57.74	1123.76
Sampling Variance Sd^2 =			101.00	
Variance of Estimate =			236965.85	
Square Root of Variance =			486.79	
Co-efficient of Variation =			174	%

[1] = Measured from 1:250 000 maps and corrected by 1.75 from a measurement of a 1:50 000 map

CROCODILE ESTIMATES FROM SAMPLE COUNTS				
MARA RIVER - 1st November, 1996				
Number of Samples = 7				
Length of Strata = 110.5 km				
Average Density = 0.62 crocs/km - Range 0.08 to 1.89 crocs/km				
COMMENTS: Start 11:35				
Section	Length (km)	Crocodiles	Density (d)	d^2
1	35	9	0.26	0.068
2	12	1	0.08	0.006
3	10.5	10	0.95	0.903
4	12	3	0.25	0.063
5	9	1	0.11	0.012
6	18	34	1.89	3.572
7	14	11	0.79	0.624
SUM	110.5	69	4.33	5.248
Sampling Variance Sd^2 =			0.43	
Variance of Estimate =			747.03	
Square Root of Variance =			27.33	
Co-efficient of Variation =			40	%

CROCODILE ESTIMATES FROM SAMPLE COUNTS

RUAHA RIVER: RUAHA NATIONAL PARK - 31st October, 1996

Number of Samples = 12

Length of Strata = 117.5 km

Average Density = 2.66 crocs/km - Range = 0 to 21.54 crocs/km

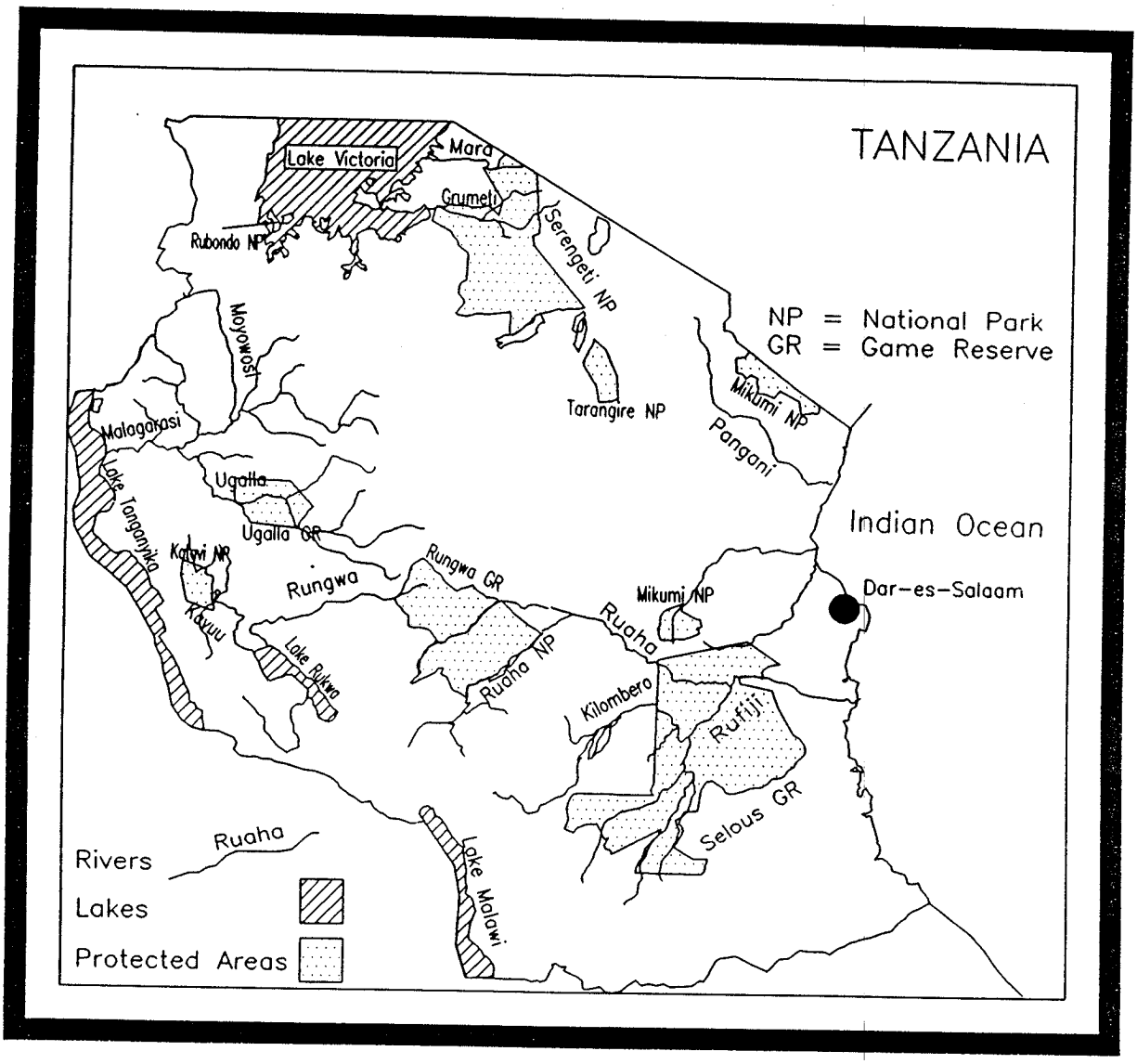
COMMENTS: Survey done in two parts on separate days. Upstream of Msembe (wpts 1-8) in afternoon. Rest the next morning.

Section	Length (km)	Crocodiles	Density (d)	d^2
1	10.5	2	0.19	0.036
2	8.5	4	0.47	0.221
3	6	9	1.50	2.250
4	10.5	6	0.57	0.323
5	10	4	0.40	0.160
6	11	8	0.73	0.530
7	13	4	0.31	0.090
8	6.5	140	21.54	463.971
9	3.5	35	10.00	100.00
10	18	40	2.22	4.928
11	9	61	6.78	45.968
12	11	0	0.00	0.00
SUM	117.5	313	44.71	618.477

Sampling Variance Sd^2	=	41.08	
Variance of Estimate	=	47264.96	
Square Root of Variance	=	217.41	
Co-efficient of Variation	=	69	%

TANZANIAN CROCODILE SURVEY
OCTOBER-NOVEMBER, 1996

APPENDIX II - COORDINATES OF SURVEY SECTIONS



Lower Rufiji - 27th OCTOBER. Plane 1			Lower Rufiji - 27th OCTOBER. Plane 2		
WAYPOINT	**LAT/LONG**	**UTM**	**WAYPOINT**	**LAT/LONG**	**UTM**
0	S 07 49.043 E 37 54.019	37M 787 358	0	S 07 55.389 E 37 46.200	37M 644 239
1	S 07 48.308 E 37 55.136	808 371	1	S 07 48.146 E 37 52.715	763 373
2	S 07 47.680 E 37 56.791	838 383	2	S 07 48.746 E 37 55.011	805 362
3	S 07 47.145 E 37 59.406	886 393	3	S 07 48.193 E 37 56.628	835 373
4	S 07 45.919 E 38 02.333	940 416	4	S 07 47.669 E 37 57.813	857 382
5	S 07 44.654 E 38 04.195	974 439	5	S 07 47.259 E 37 59.605	890 390
6	S 07 43.506 E 38 06.837	022 460	6	S 07 46.780 E 38 01.983	933 399
7	S 07 42.818 E 38 08.885	060 473	7	S 07 46.054 E 38 02.522	943 412
8	S 07 44.587 E 38 11.436	107 440	8	S 07 44.988 E 38 03.669	964 432
9	S 07 46.054 E 38 13.733	149 413	9	S 07 43.706 E 38 06.718	020 456
10	S 07 47.735 E 38 16.566	201 383	10	S 07 42.898 E 38 08.966	062 471
			11	S 07 45.369 E 38 12.205	121 425

Single survey - Small section experiment

Lower Rufiji - 28th OCTOBER. Plane 1			Lower Rufiji - 28th OCTOBER. Plane 1		
WAYPOINT	LAT/LONG	UTM	WAYPOINT	LAT/LONG	UTM
0	S 07 48.631 E 37 49.669	37M 707 365	11	S 07 45.516 E 38 02.579	37M 944 423
1	S 07 48.149 E 37 53.367	775 374	12	S 07 44.948 E 38 03.400	959 433
2	S 07 48.455 E 37 53.923	785 368	13	S 07 44.461 E 38 04.427	978 443
3	S 07 48.560 E 37 54.699	800 367	14	S 07 43.976 E 38 05.817	37L 004 451
4	S 07 48.122 E 37 55.203	809 375	15	S 07 43.496 E 38 07.510	035 460
5	S 07 48.005 E 37 56.377	830 377	16	S 07 42.740 E 38 08.962	061 474
6	S 07 47.456 E 37 57.250	846 387	17	S 07 43.658 E 38 10.601	092 458
7	S 07 47.335 E 37 58.337	867 389	18	S 07 44.572 E 38 11.491	108 441
8	S 07 47.146 E 37 59.339	885 393	19	S 07 45.534 E 38 13.543	146 423
9	S 07 46.738 E 38 00.432	905 400	20	S 07 48.045 E 38 16.664	203 377
10	S 07 46.492 E 38 01.593	926 405			

Lower Rufiji - 28th OCTOBER. Plane 2			Lower Rufiji - 29th OCTOBER. Plane 1		
WAYPOINT	**LAT/LONG**	**UTM**	**WAYPOINT**	**LAT/LONG**	**UTM**
0	S 07 56.083 E 37 47.668	37M 671 227	0	S 07 47.901 E 37 52.592	37M 761 379
1	S 07 48.184 E 37 51.168	735 373	1	S 07 48.381 E 37 53.665	780 370
2	S 07 48.358 E 37 53.009	768 369	2	S 07 48.728 E 37 54.619	798 363
3	S 07 48.938 E 37 54.495	796 359	3	S 07 48.039 E 37 55.391	812 376
4	S 07 48.492 E 37 55.224	809 367	4	S 07 46.744 E 38 00.473	906 400
5	S 07 48.163 E 37 56.749	837 373	5	S 07 46.248 E 38 02.431	942 409
6	S 07 47.550 E 37 58.901	877 385	6	S 07 44.827 E 38 03.857	968 436
7	S 07 47.013 E 38 01.473	924 395	7	S 07 47.967 E 38 05.793	003 452
8	S 07 45.375 E 38 03.103	954 425	8	S 07 43.001 E 38 10.002	081 470
9	S 07 44.217 E 38 05.357	995 446	9	S 07 45.037 E 38 11.768	113 432
10	S 07 43.635 E 38 08.243	048 457	10	S 07 48.281 E 37 55.228	809 372
11	S 07 45.804 E 38 13.681	148 417			
12	S 07 46.752 E 38 13.933	153 400			

Ulanga - 27th OCTOBER			Ulanga - 28th OCTOBER		
WAYPOINT	**LAT/LONG**	**UTM**	**WAYPOINT**	**LAT/LONG**	**UTM**
0	S 08 30.870 E 37 20.742	37M 179 585	0	S 07 49.865 E 37 49.830	37M 710 342
1	S 08 28.561 E 37 23.263	225 627	1	S 07 53.448 E 37 48.740	690 276
2	S 08 26.730 E 37 25.345	263 661	2	S 07 55.646 E 37 47.905	675 236
3	S 08 24.442 E 37 25.925	273 704	3	S 07 59.582 E 37 47.089	660 163
4	S 08 22.410 E 37 27.333	299 741	4	S 08 01.981 E 37 42.976	585 119
5	S 08 20.863 E 37 29.755	343 770	5	S 08 05.965 E 37 40.767	544 045
6	S 08 18.030 E 37 31.516	375 822	6	S 08 10.026 E 37 38.305	500 970
7	S 08 14.328 E 37 33.809	417 891	7	S 08 13.705 E 37 34.232	427 902
8	S 08 11.358 E 37 37.696	488 945	8	S 08 16.531 E 37 32.291	390 850
9	S 08 07.173 E 37 40.084	532 023	9	S 08 20.547 E 37 30.324	354 776
10	S 08 01.681 E 37 43.776	600 124	10	S 08 21.974 E 37 27.881	309 749
11	S 07 59.533 E 37 46.998	659 164	11	S 08 26.155 E 37 25.738	270 672
12	S 07 55.819 E 37 47.760	672 232	12	S 08 27.474 E 37 23.974	238 648
13	S 07 53.057 E 37 49.178	698 283	13	S 08 30.092 E 37 21.431	191 599
14	S 07 50.358 E 37 50.036	714 333	14	S 08 31.026 E 37 20.616	176 582

Ulanga - 27th OCTOBER		
WAYPOINT	**LAT/LONG**	**UTM**
0	S 07 47.880 E 37 51.953	37M 749 378
1	S 07 51.460 E 37 50.581	724 312
2	S 07 53.163 E 37 49.653	707 281
3	S 07 56.655 E 37 48.465	685 216
4	S 07 58.379 E 37 47.683	671 184
5	S 08 00.302 E 37 46.088	642 149
6	S 08 01.278 E 37 44.997	622 131
7	S 08 02.908 E 37 42.668	579 101
8	S 08 04.125 E 37 41.441	557 078
9	S 08 06.384 E 37 40.716	544 037
10	S 08 08.268 E 37 40.026	531 002
11	S 08 09.977 E 37 38.346	500 970
12	S 08 12.371 E 37 36.945	475 926
13	S 08 13.947 E 37 34.297	426 897
14	S 08 16.189 E 37 32.518	394 855
15	S 08 19.989 E 37 30.648	360 785
16	S 08 21.996 E 37 28.592	322 748
17	S 08 24.633 E 37 26.166	278 699
18	S 08 27.214 E 37 24.973	256 652
19	S 08 29.677 E 37 22.377	209 606

Kilombero - 27th OCTOBER			Kilombero - 28th OCTOBER		
WAYPOINT	**LAT/LONG**	**UTM**	**WAYPOINT**	**LAT/LONG**	**UTM**
0	S 08 09.946 E 36 55.717	37M 717 968	0	S 08 34.662 E 37 14.856	37M 071 515
1	S 08 08.737 E 36 53.241	627 990	1	S 08 33.757 E 37 12.383	025 531
2	S 08 09.722 E 36 54.956	703 972	2	S 08 31.043 E 37 11.290	005 581
3	S 08 12.960 E 36 56.229	727 913	3	S 08 28.436 E 37 11.511	009 629
4	S 08 13.491 E 36 57.587	752 903	4	S 08 26.509 E 37 11.421	007 664
5	S 08 15.046 E 36 58.215	764 874	5	S 08 23.914 E 37 10.975	999 712
6	S 08 15.525 E 37 00.156	799 866	6	S 08 25.458 E 37 07.693	939 683
7	S 08 16.416 E 37 02.756	847 850	7	S 08 21.647 E 37 06.735	921 754
8	S 08 16.901 E 37 05.368	895 841	8	S 08 18.131 E 37 06.806	922 818
9	S 08 18.161 E 37 06.832	922 818	9	S 08 16.752 E 37 03.864	868 844
10	S 08 20.705 E 37 06.863	923 771	10	S 08 15.232 E 36 58.785	770 871
11	S 08 23.931 E 37 06.830	923 711	11	S 08 13.333 E 36 56.462	731 906
12	S 08 23.757 E 37 10.153	984 715	12	S 08 10.007 E 36 55.142	707 967
13	S 08 25.404 E 37 11.707	012 685	13	S 08 09.116 E 36 52.838	664 983
14	S 08 28.897 E 37 11.594	011 621	14	S 08 09.803 E 36 50.799	627 970
15	S 08 31.946 E 37 11.675	012 564	15	S 08 10.495 E 36 46.527	548 957
16	S 08 33.843 E 37 13.151	040 529	16	S 08 10.469 E 36 44.118	504 957
17	S 08 34.648 E 37 15.610	085 515	17	S 08 11.578 E 36 41.946	464 937

Ruaha - 27th OCTOBER			Ruaha - 28th OCTOBER		
WAYPOINT	**LAT/LONG**	**UTM**	**WAYPOINT**	**LAT/LONG**	**UTM**
0	S 07 45.239 E 37 05.985	37M 904 424	0	S 07 44.608 E 37 05.196	37M 889 435
1	S 07 47.368 E 37 06.788	919 385	1	S 07 47.321 E 37 06.835	920 385
2	S 07 51.558 E 37 06.450	913 307	2	S 07 52.474 E 37 07.084	925 291
3	S 07 51.908 E 37 09.523	969 301	3	S 07 51.721 E 37 12.583	026 305
4	S 07 51.698 E 37 12.395	022 305	4	S 07 51.493 E 37 16.324	094 309
5	S 07 51.563 E 37 14.021	052 308	5	S 07 52.580 E 37 18.616	137 289
6	S 07 52.572 E 37 18.282	130 290	6	S 07 52.523 E 37 22.972	217 291
7	S 07 52.912 E 37 23.415	225 284	7	S 07 51.197 E 37 26.363	279 316
8	S 07 51.192 E 37 26.395	279 316	8	S 08 52.593 E 37 36.065	457 290
9	S 07 52.107 E 37 29.047	328 299	9	S 07 52.788 E 37 44.108	605 287
10	S 07 52.437 E 37 31.591	375 293	10	S 07 56.083 E 37 47.668	671 227
11	S 07 52.825 E 37 37.435	483 286			
12	S 07 53.454 E 37 37.853	490 275			
13	S 07 53.844 E 37 39.604	522 268			
14	S 07 53.101 E 37 42.812	581 281			
15	S 07 52.517 E 37 44.290	608 292			
16	S 07 55.389 E 37 46.200	644 239			

Ruaha - 29th OCTOBER			Rubondo Island - 29th OCTOBER		
WAYPOINT	**LAT/LONG**	**UTM**	**WAYPOINT**	**LAT/LONG**	**UTM**
0	S 07 55.658 E 37 47.833	37M 690 235	0	S 02 18.467 E 31 55.285	800 448
1	S 07 54.228 E 37 45.625	633 262	1	S 02 22.549 E 31 54.272	782 373
2	S 07 52.998 E 37 42.771	581 284	2	S 02 24.631 E 31 55.168	798 335
3	S 07 53.810 E 37 40.303	535 269	3	S 02 26.293 E 31 54.161	780 304
4	S 07 53.405 E 37 37.717	488 276	4	S 02 25.184 E 31 50.433	710 324
5	S 07 52.270 E 37 36.114	458 297	5	S 02 21.750 E 31 50.400	710 388
6	S 07 51.176 E 37 30.457	354 317	6	S 02 20.495 E 31 49.018	684 411
7	S 07 51.061 E 37 27.569	301 319	7	S 02 18.988 E 31 49.414	691 439
8	S 07 52.910 E 37 24.598	247 285	8	S 02 19.003 E 31 46.718	641 438
9	S 07 52.563 E 37 22.853	214 291	9	S 02 17.858 E 31 47.170	650 459
10	S 07 52.241 E 37 19.461	152 297	10	S 02 15.040 E 31 48.891	682 511
11	S 07 51.453 E 37 16.159	091 311	11	S 02 14.309 E 31 46.556	638 525
12	S 07 51.545 E 37 10.946	996 309	12	S 02 12.209 E 31 47.627	658 563
13	S 07 51.917 E 37 06.310	910 302	13	S 02 13.789 E 31 51.215	725 534
14	S 07 49.370 E 37 06.013	905 348	14	S 02 16.028 E 31 50.702	715 493
15	S 07 46.675 E 37 06.614	915 398			

Grumeti - 1st November			Mara - 1st November		
WAYPOINT	**LAT/LONG**	**UTM**	**WAYPOINT**	**LAT/LONG**	**UTM**
0	S 02 05.869 E 33 52.207	967 680	0	S 01 29.329 E 34 16.018	409 353
1	S 02 09.775 E 34 07.647	253 608	1	S 01 29.981 E 34 23.437	547 341
2	S 02 09.969 E 34 08.447	268 605	2	S 01 29.703 E 34 26.028	595 346
3	S 02 09.817 E 34 09.416	286 608	3	S 01 29.718 E 34 27.681	625 346
4	S 02 09.856 E 34 11.773	330 607	4	S 01 29.911 E 34 30.489	677 343
5	S 02 10.792 E 34 14.254	376 590	5	S 01 30.420 E 34 32.481	714 333
6	S 02 11.216 E 34 17.217	431 582	6	S 01 34.255 E 34 32.554	716 263
7	S 02 13.420 E 34 23.976	556 541	7	S 01 36.031 E 34 34.899	759 230
8	S 02 14.844 E 34 26.900	610 515			

Ruaha National Park - 31st October		
WAYPOINT	**LAT/LONG**	**UTM**
0	S 08 02.980 E 34 30.519	669 099
1	S 07 58.912 E 34 30.519	662 174
2	S 07 55.616 E 34 33.275	713 235
3	S 07 53.674 E 34 35.385	752 271
4	S 07 51.072 E 34 40.498	846 318
5	S 07 49.226 E 34 45.179	932 352
6	S 07 47.673 E 34 50.177	024 380
7	S 07 43.392 E 34 52.333	064 459
8	S 07 41.690 E 34 54.483	104 490