Indigenous knowledge and Baseline Data survey on Fish Breeding areas and seasons in Lake Victoria – Kenya

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Abstract

Available baseline data and indigenous knowledge on Lake Victoria fisheries were used to identify potential fish breeding areas and seasons for subsequent scientific verification, demarcation and closure. River mouths, sheltered bays and wetlands featured as the major fish breeding grounds for the majority of the fishes. Two peak rainy seasons of March to August and October to December were found to be the major fish breeding seasons for the different species of fishes of Lake Victoria. The evidence given by the fishers to support the identified breeding areas/seasons particularly from indigenous knowledge include the presence of many fish fry, fingerlings and eggs in the mouths of the fish (mouth-brooders). The size at which fish matures and fecundity was well documented by baseline data. The fisher community has a wealth of knowledge that is useful in the identification of fish breeding (closed) areas and seasons, but the knowledge is clouded by socio-economic considerations. This study has resulted in the gazettement of 98 fish breeding grounds and declaration of breeding seasons between 1st April and 31st. July of each year in the Kenya waters of Lake Victoria vide the Kenya Gazette Notice No. 7565 of 9th. November, 2001.

Keyword: Baseline data, indigenous knowledge, breeding areas, breeding seasons, and closed areas/seasons.

Introduction

The main objective of the closed areas/season activities were to identify, demarcate and gazette fish breeding areas and designate the breeding seasons. This sub-component falls under the closed areas /seasons and the strengthening of enforcement, being undertaken by Fisheries Department (Ministry of Agriculture and Rural Development), under the Lake Victoria Environmental Management Programme (LVEMP). The stakeholders meeting under the sub-component recognized the need to carry out the following activities in order to achieve the desired objectives:

i) Compilation of a bibliography on Lake Victoria
ii) Compilation and availing baseline data
iii) Acquire information on indigenous knowledge
iv) Carry out scientific verification of proposed designated closed areas and seasons.

Part i to iii have been completed. This report covers part ii and iii that involves the compilation of baseline data and indigenous knowledge survey on the fish species, their distribution, breeding areas, breeding seasons, fecundity, growth and related meteorological data.

Materials and method

The baseline data compiled in this report was obtained from published material and raw data from various libraries, individuals and organization in Kisumu, Nairobi and Eldoret. Copies of the documents were made and relevant information extracted on various species, its area or

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extent of distribution in the Kenya side of Lake Victoria basin. Fish breeding grounds, seasons, fecundity and country from which the information was obtained and details of the document, whether published or oral were noted. To address the issue of season comprehensively, some data were acquired on monthly average rainfall patterns from 1950 to 2000 and estimated river discharge for the major effluent rivers draining the Kenya side of Lake Victoria basin.

Indigenous knowledge on breeding/closed areas and seasons were obtained from a pre-designed and semi-structured questionnaire administered through the District Fisheries Officers in the Kenya part of the lake. The questionnaires were floated to the fishermen and stakeholders between 1998 and 2000. Part A of the questionnaire form dealt with demographic characteristic of the fishermen; Part B and part C of the form dealt with knowledge on fish breeding grounds and closed season respectively including opinion of the fishermen on designating the identified areas as closed areas/seasons to fishing activities.

Results

Baseline Data

a)Fish Distribution

A variety of fish species were distributed over the basin in the main lake and in rivers. *Bagrus docmac* was specifically caught between 4 and 79 m in bottom trawl surveys in the 1970s and in the 1980s. Limited data was available on the present distribution or its abundance in the lake. The indigenous knowledge results came out with the fact that the fish have moved from the main lake to the fringes of the main lake, bays, river mouths, river courses and satellite lakes.

Clarias gariepinus was also caught in the bottom trawls between 4 and 79 m in the 1970s. Surveys in the 1980s and 1990s indicate that the fish is also found in effluent rivers, especially in the Sondu-Miriu system. The *C. gariepinus* is presumed to escape the open lake dominated by predatory *L. niloticus*.

The *Haplochromis spp.* were reported between 4m and 79m depth in the 1970s. Similar work during the same period in Kenya showed that different groups were found at different depths ranging from 4m to 9m and from 30 to 50m (Mwalo, 1994). *Oreochromis esculentus* was found between 4-50m depth (Bergstrand & Cordone, 1971) while *Oreochromis niloticus* has a wider distribution in >20 m depth and *Oreochromis*

Table 1: The distribution of different species in Lake Victoria basin obtained from published data by country and by source of information.

Species	Code	Distribution	Country	Authority
Bagrus docmac	5	4-79 m		Bergstrand & Cordone, 1971
Bagrus docmac	5	Ubiquitous	Kenya	Lowe-McConnell, 1987
Clarias gariepinus	7	4-79 m		Bergstrand & Cordone, 1971

Clarias gariepinus	7	Sondu-Miriu	Kenya	Lung'ayia, 1994
Clarias gariepinus	7	Sondu-Miriu	Kenya	Ochumba & Manyala, 1992
Haplochromis spp.	10	10-19m 59% of 74 groups	Kenya	Mwalo, 1994
Haplochromis spp.	10	20-29m 68% of 74 groups	Kenya	Mwalo, 1994
Haplochromis spp.	10	30-49m 30% of 74 groups	Kenya	Mwalo, 1994
Haplochromis spp.	10	4-79 m		Bergstrand & Cordone, 1971
Haplochromis spp.	10	4-9m 80% of 74 groups	Kenya	Mwalo, 1994
Haplochromis spp.	10	50-59m 10% of 74 groups	Kenya	Mwalo, 1994
Lates niloticus	13	0.92% <30 m	Uganda	Okaronon, 1994
Oreochromis esculentus	16	4-50 m		Bergstrand & Cordone, 1971
Oreochromis niloticus	18	<20 m	Uganda	Okaronon, 1994
Oreochromis niloticus	18	Nyanza Gulf	Kenya	Lunga'yia, 1994b
Oreochromis niloticus	18	Nyanza Gulf		Lowe-McConnell, 1955
Oreochromis variabilis	19	Inshore/exposed/shoaling for 17-20 cm		Fryer, 1961
Oreochromis variabilis	19	Inshore/exposed/shoals for 8-17 cm		Fryer, 1961
Oreochromis variabilis	19	Rocky <0.5 m for 30-45 mm		Fryer, 1961
Oreochromis variabilis	19	Rocky <5 cm for 15-30 mm		Fryer, 1961
Oreochromis variabilis	19	Rocky/Vegetation <0.5 m for 4.5 - 6 cm		Fryer, 1961
Oreochromis variabilis	19	Variable/rocky/sandy fro 20-28 cm		Fryer, 1961
Protopterus aethiopicus	22	4-60 m		Bergstrand & Cordone, 1971
Rastrineobola argentea	23	Bottom (Day)/Surface (Night)	Uganda	Wandera, 1993
Schilbe intermedius	24	Nyando		Omondi & Ogari, 1994
Schilbe intermedius	24	Sondu-Miriu		Ochumba & Manyala, 1992
Schilbe intermedius	24	Nyanza Gulf	Kenya	Rinne & Wanjala, 1980
Synodontis victoriae	25	4-79 m		Bergstrand & Cordone, 1971
Synodontis victoriae	25	Sondu-Miriu	Kenya	Ochumba & Manyala, 1982
Synodontis afrofischeri		Sondu-Miriu	Kenya	Ochumba & Manyala, 1982
Xenoclarias	26	>50m	Kenya/Uganda	Rinne, 1980
Xenoclarias eupagon	27	>40 m depth	Kenya, Uganda, Tanzania	Rinne, 1980

variabilis seem to be restricted to the inshore areas over rocky, vegetated, sandy and exposed areas.

Schilbe intermedius, Synodontis victoriae and *Synodontis afrofischeri* have been reported in the Sondu-Miriu in the recent past but was common in the main lake in the 1980s (Ochumba & Manyala, 1982) while *Xenolcarias spp.* was mainly found below 40 m depth in both Kenya, Uganda and Tanzania parts of Lake Victoria (Rinne, 1980). The general distribution of the species is shown in Table 1.

b) Breeding areas/seasons

Barbus altianalis and *Clarias gariepinus* breeds 10 Km upstream the Sondu-Miriu river while *Labeo victorianus, Oreochromis variabilis, Synodontis victoriae, Synodontis afrofischeri* and *Oreochromis niloticus* breeds 8 km up the same river. *Schilbe intermedius* breeds some 9 km up the Sondu-Miriu and also breeds in River Nyando (Ochumba & Manyala, 1992; Omondi & Ogari 1994). The results tend to confirm the observed high prevalence of juveniles and berried fish at the river mouths/estuaries. *Gnathonemus longiberbis, Hippopotomyrus grahami, Marcusenius victoriae, Mormyrus kannume, Petrocephalus catostoma* and *Pollymyrus nigricans* breeds in the effluent rivers of Lake Victoria, 2 - 24 km upstream (Table 2).

Protopterus aethiopicus breed in Lake Victoria in marginal swamp, *Cyperus papyrus* swamp, semi-aquatic grass and specifically in Nyando and Sondu-Miriu floodplains (Pabari, 1998). *Oreochromis variabilis* breeds in the fringe forming 15 m from shoreline (Ochumba & Manyala, 1992) while *Oreochromis niloticus* breeds at depths of 3-9 m in sandy areas as well as in offshore areas (Ogari, 1994). *Oreochromis leucostictus* breeds in inshore areas through out the year (LoweMconnell, 1987) while several groups of *Haplochromis spp.* breed in the littoral and sub-littoral areas (Witte, 1981; Lowe Mconnell, 1987). *Lates niloticus* is thought to breed in the pelagic zone of Lake Victoria (Acere, 1987). *Bagrus docmac* and *Clarias gariepinus* are thought to breed in Lake Victoria but the exact breeding areas are not specified. It is possible that this happened before the upsurge of *L. niloticus*. The information extracted from the questionnaire, indicate that the two species move to shallow waters and rivers to breed (Table 2)**.**

c) Size at maturity

The size at which more than 50% of sample population shows maturity is shown in Table 3 for both females and males. It should be noted that some fish species for example *Protopterus aethiopicus* mature at an earlier size than previously experienced. For example, *Protopterus aethiopi*cus was earlier recorded to mature at about 98cm (Okedi, 1971). Current records on the same fish indicate that they now mature at 35 cm (Pabari, 1998).

d) Fecundity

Fecundity of the fish species found within the Lake Victoria basin is shown in Table 4. *L. niloticus* has been recorded to produce as much as six million eggs (Ogutu-Ohwayo).

Table 2: The breeding season and areas in Lake Victoria Basin

Species	Code	Breeding Season	Breeding area	Country	Authority

Bagrus docmac	5	Protracted/Peaks in Jan/August	Lake Victoria		Lowe-McConn
Barbus altianalis	6	Mar-Apr/Aug-Sep/Oct-Nov	10 Km Sondu-Miriu	Kenya	Ochumba & M
Clarias gariepinus	7	April-June/Sept-Oct		Kenya	Lung' ayia, 19
Clarias gariepinus	7	Feb-Aug	10 Km Sondu-Miriu	Kenya	Ochumba & M
Clarias gariepinus	7	Protracted/Peaks in Jan/August	Lake Victoria		Lowe-McConn
Clarias gariepinus	7	Sep-Oct	Sondu-Miriu	Kenya	Lung' ayia, 19
Gnathonemus longiberbis	8	April-May/Sept-Dec	Effluent rivers, 2 - 24 km		Lowe-McConn
Haplochromis spp.	10	End of rainy seasons	Littoral/Sub-littoral	Tanzania	Witte, 1981
Hippopotomyrus grahami	11	April-May/Sept-Dec	Effluent rivers, 2 - 24 km		Lowe-McConn
Labeo victorianus	12	Jan-Apr/Sep-Nov	8 Km Sondu-Miriu	Kenya	Ochumba & M
Lates niloticus	13		Pelagic zone		Acere, 1987
Marcusenius victoriae	14	April-May/Sept-Dec	Effluent rivers, 2 - 24 km		Lowe-McConn
Mormyrus kannume	15	Throughout the year	Effluent rivers, 2 - 24 km		Lowe-McConn
Oreochromis esculentus	16	April-May/Sept-Dec			Lowe-McConn
Oreochromis esculentus	16	Sep-May			Greenwood, 19
Oreochromis leucostictus	17	October			Ogari, 19??
Oreochromis leucostictus	17	Throughout the year	Inshore		Lowe-McConn
Oreochromis niloticus	18	Apr-Jun/Sep-Dec	9 Km Sondu-Miriu	Kenya	Ochumba & M
Oreochromis niloticus	18		3-9 m sandy areas		Ogari, 19??
Oreochromis niloticus	18		Nyanza Gulf	Kenya	Lung' ayia, 19
Oreochromis niloticus	18		Offshore		Lowe-McConn
Oreochromis variabilis	19	Jun-Aug	8 Km Sondu-Miriu	Kenya	Ochumba & M
Oreochromis variabilis	19		15 m from shoreline		Fryer, 1961
Petrocephalus catostoma	20	April-May/Sept-Dec	Effluent rivers, 2 - 24 km		Lowe-McConn
Pollymyrus nigricans	21	April-May/Sept-Dec	Effluent rivers, 2 - 24 km		Lowe-McConn
Protopterus aethiopicus	22	Apr-May/Sep-Nov	Marginal swamp		Greenwood, 19
Protopterus aethiopicus	22	July-Aug/Feb	Nyando floodplains	Kenya	Pabari, 1998
Protopterus aethiopicus	22		Marginal swamps	Uganda	Greenwood, 19
Protopterus aethiopicus	22		Marginal swamps	Uganda	Copley, 1941
Protopterus aethiopicus	22		Papyrus swamp		Greenwood, 19
Protopterus aethiopicus	22		Papyrus swamps	Uganda	Greenwood, 19
Protopterus aethiopicus	22		Semi-aquatic grass	Uganda	Greenwood, 19
Rastrineobola argentea	23	Feb-Mar		Tanzania	Wadera & Wan
Rastrineobola argentea	23	Oct-Nov		Uganda	Wandera & Wa
Schilbe intermedius	24	Protracted/Peaks in Jan/August			Lowe-McConn
Schilbe intermedius	24	Rainy season	Sondu-Miriu	Kenya	Ojwang & Mul
Schilbe intermedius	24	Sep-Apr	9 Km Sondu-Miriu	Kenya	Ochumba & M
Schilbe intermedius	24		Nyando	Kenya	Omondi & Oga
Synodontis victoriae	25	Apr-Jun/Oct-Dec	8 Km Sondu-Miriu	Kenya	Ochumba & M
Synodontis afrofischeri	25	Jan-Apr/Jul-Sep	8 Km Sondu-Miriu	Kenya	Ochumba & M
Synodontis victoriae	25	Protracted/Peaks in Jan/August			Lowe-McConn
Tilapia zillii	25	Throughout the year			Lowe-McConn
Xenoclarias	26	Jan-Mar		Kenya/Uganda	Rinne, 1980
Xenoclarias eupagon	27	Jan-Mar/Dec		Kenya, Uganda,Tanzania	Rinne, 1980

1988). Another report indicates that it produces as much as eleven million eggs (Lowe Mc-Connell, 1987). The cichlid family of fishes are likely to surfer most because most of them produce few eggs, that is, in terms of hundreds and even tens as in the case of *Haplochromis spp.* (Lowe Mc-Connell, 1985, 1987, Mwalo, 1994). This is not healthy for their survival.

Protopterus aethiopicus was reported to produce eggs in terms of 8000 (Okedi, 1971). The same fish has been recorded recently to produce fish in terms of hundreds (Pabari, 1998). Generally, it is apparent that the fish fertility may be reducing.

Table 3: Size at maturity of different male and female fish species by different authors separated by country

Species	Code	Maturity (Females)	Maturity (Males)	Country	Authority
Barbus altianalis	6	7.0 cm SL	7.0 cm SL	Kenya	Ochumba & Manyala, 1992
Clarias gariepinus	7	21 cm TL	21 cm TL	Kenya	Lung' ayia, 1994a
Clarias gariepinus	7	21.1 cm SL	14.1 cm SL	Kenya	Ochumba & Manyala, 1992
Clarias gariepinus	7	41- 45 cm	41 - 45 cm	Kenya	Owiti & Dadzie, 1989
Haplochromis spp.	10	93 mm	85 mm	Kenya	Mwalo, 1994
Haplochromis spp.	10	93 mm	89 mm	Kenya	Mainga, 1994
Labeo victorianus	12	15.1 cm SL	11.1 cm SL	Kenya	Ochumba & Manyala, 1992
Lates niloticus	13	60 - 95 cm	50 - 65 cm	Uganda	Ogutu-Ohwayo, 1988
Lates niloticus	13	67 cm	53 cm		Acere, 1987
Lates niloticus	13	80 - 85 cm	50 - 55 cm	Kenya	Hughes, 1992
Oreochromis esculentus	16	25-26 cm TL	25-26 cm TL		Greenwood, 1967
Oreochromis niloticus	18	13 cm	13 cm		Ogari, 19??
Oreochromis niloticus	18	15.8 cm TL	15.5 cm TL		Ogari, 19??
Oreochromis niloticus	18	29.7 cm TL	24.5 cm TL	Kenya	Dache, 1994
Oreochromis niloticus	18	7.1 cm SL		Kenya	Ochumba & Manyala, 1992
Oreochromis variabilis	19	7.1 cm SL		Kenya	Ochumba & Manyala, 1992
Protopterus aethiopicus	22	35 cm	35 cm	Kenya	Pabari, 1998
Protopterus aethiopicus	22	96 cm TL	96 cm TL		Okedi, 1971
Rastrineobola argentea	23	36 mm SL	34 mm SL	Kenya	Manyala, 1995b
Rastrineobola argentea	23	44 mm SL	44 mm SL	Uganda	Wandera, 1988
Schilbe intermedius	24	12.1 cm SL	12.1 cm SL	Kenya	Ochumba & Manyala, 1992
Schilbe intermedius	24	17.8 cm	13.6 cm	Kenya	Ojwang & Muli, 1993
Synodontis afrofischeri	25	10.1 cm SL	10.1 cm SL	Kenya	Ochumba & Manyala, 1992
Synodontis victoriae	25	8.1 cm SL	10.1 cm SL	Kenya	Ochumba & Manyala, 1992
Xenoclarias eupagon	27	14-16 cm		Kenya, Uganda, Tanzania	Rinne, 1980

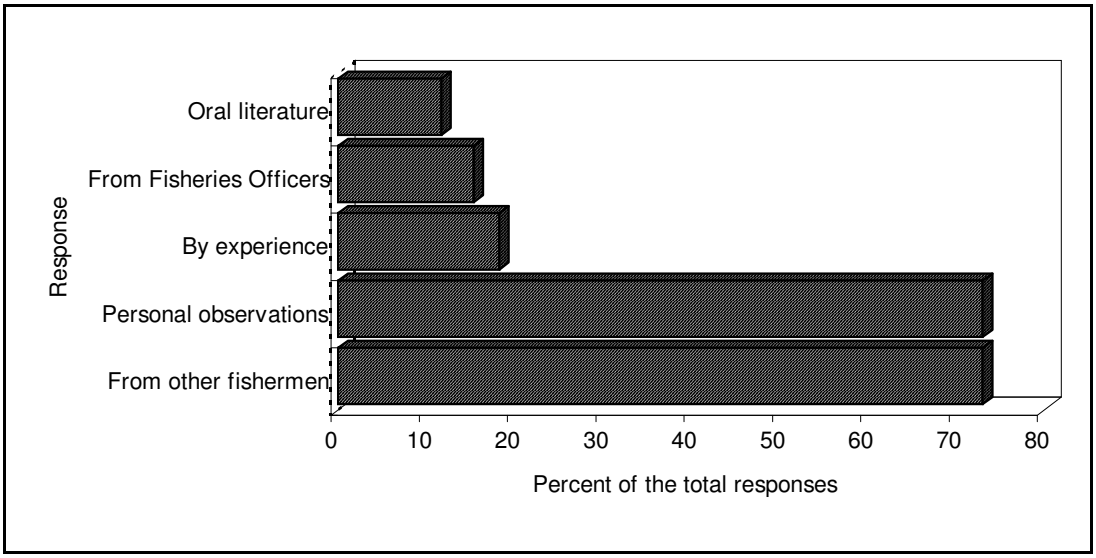
Indigenous knowledge survey

a) Fish breeding areas/seasons

A number of fish species were identified by the respondents to be breeding in the areas. Among the species mentioned were *Oreochromis niloticus* (L.) or generally tilapia featured in 85% of the respondents while *Clarias gariepinus* featured in 50% of the respondents respectively. The lungfish (*Protopterus aethiopicus* and *Lates niloticus* featured in about 38% and 47% of the answers given by the respondents. The rest of the species featured in less than 25% of the answers obtained from the respondents.

b) Sources of information for breeding areas/seasons

More than 70% of the respondents obtained information about the breeding grounds from fellow fishermen. All other sources of information featured less than 20% in all the respondents in (Fig. 1). The evidences given for designating the mentioned areas as breeding grounds were based on the presence of many larvae/juveniles in the catches in more than 50% of the respondents (Fig. 2). Other evidences given include the skewed sex ratio with more females than males (>40%), fish with larvae in their mouths, especially some cichlids (38%) while other reasons were given by less than 35% of the respondents.



Fig, 1: Relative importance of the sources of information for breeding seasons.

c) Designation of breeding (closed) areas

The results of designating the breeding grounds as closed areas indicate that more than 50% of the respondents think that these areas should not be designated as closed areas while only 25% think that they should be closed for fishing (Fig. 3). Majority of the respondents (83%) also thinks that these areas should be closed for fishing throughout the year and less than 5% think they should not be closed throughout the year (Fig. 4). Also, after identifying the breeding areas, 56 out of 137 respondents still opposed closing these areas as breeding

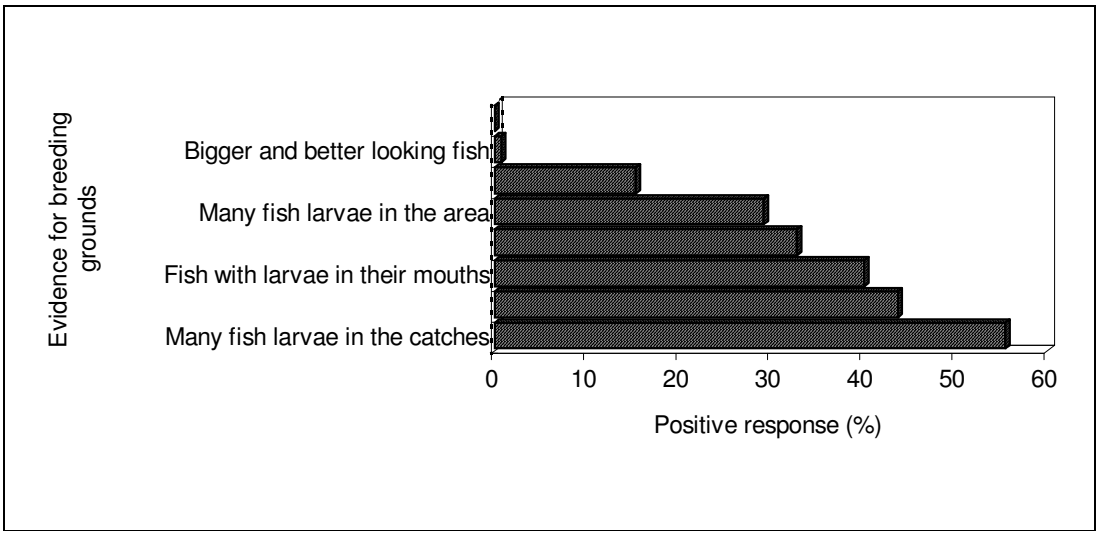


Fig 2: Relative % frequency of evidences given by the respondents in favour of breeding grounds.

grounds (Table 5). An analysis of the reasons given for opposing closure of these areas as breeding grounds, indicate that the respondents gave more socio-economic considerations than socio-cultural or biological factors. This situation signifies a breakdown of traditional norms of sustainable fisheries resource utilization and conservation.

The 98 localities areas identified in Table 7 were gazetted as fish breeding areas, Gazette Notice No. 7565 of 9th November 2001 and the notice became effective on 1st July 2001.

Those who think that these areas should not be closed for fishing throughout the year, gave varying reasons which range from the knowledge of the breeding months to loss of livelihood for fishermen (Table 6). From the analysis, the following are some of the identified major fish breeding areas ; Obolobolo, Samba wetlands in Homa Bay, Kusa Bay, Osiri, Arongo/Kagwel, Tako, Hippo point, Kabudho, Minara Island, Ndere Island, Ogenya, Matara Bay, Kadimo, Karugu Bay, Bays, Swamps, Flood plains and all river mouths (Table 7).

d) Breeding (closed) seasons

The respondents identified the peak breeding periods to be April/May and July. Most respondents did not specify the peak (months) of the fish breeding periods and the breeding months were therefore based on the cumulative responses for each month for 8 levels of priority (Fig. 5). There were several species identified by the respondents to be breeding during the breeding period. Tilapia (*Oreochromis niloticus*) featured in more than 70% of the total responses followed by *Lates niloticus* and *Clarias gariepinus* (40% each) (Fig. 6). Relative importance of evidences given by respondents for breeding seasons ranged from fish gravid fish to preponderance of fish larvae in the area (Fig. 7)

Rainfall data

Monthly rainfall data averaged from 1950 to 2000 indicate that there are two peak rainfall seasons falling between March and May and another one between October and December (Fig. 8). Indigenous knowledge seems to support synchronized movement of fish to breed upstream for anadromous fish during peak rainy seasons.

Table 4: Fecundity of different species by country

Species	Code	Fecundity	Country	Authority
Brycinus dentex	1	24800 - 27800		Lowe-McConnell, 1987
Brycinus leuciscus	2	1000 - 4000		Lowe-McConnell, 1987
Brycinus macrophthalmas	3	10000		Lowe-McConnell, 1987
Brycinus nurse	4	17000		Lowe-McConnell, 1987
Clarias gariepinus	7	7966-229648	Kenya	Owiti & Dadzie, 1989
Gnathonemus longiberbis	9	502 - 14624		Lowe-McConnell, 1987
Haplochromis spp.	10	84	Kenya	Mainga, 1994
Haplochromis spp.	10	78	Kenya	Mwalo, 1994
Hippopotomyrus grahami	11	248 - 5229		Lowe-McConnell, 1987
Labeo victorianus	12	40133		Lowe-McConnell, 1987
Lates niloticus	13	1104700 - 11790000		Lowe-McConnell, 1987
Lates niloticus	13	6000000	Uganda	Ogutu-Ohwayo, 1988
Marcusenius victoriae	14	846 - 16748		Lowe-McConnell, 1987
Mormyrus kannume	15	1393 - 17369		Lowe-McConnell, 1987
Oreochromis esculentus	16	324 - 1672		Lowe-McConnell, 1987
Oreochromis leucostictus	17	56 - 498		Lowe-McConnell, 1987
Oreochromis leucostictus	17	99 - 950		Lowe-McConnell, 1985
Oreochromis niloticus	18	340 - 3706		Lowe-McConnell, 1985
Oreochromis niloticus	18	864 - 6316	Kenya	Lung' ayia, 1994b
Oreochromis variabilis	19	23 - 496		Lowe-McConnell, 1985
Petrocephalus catostoma	20	116 - 1015		Lowe-McConnell, 1987
Polymyrus nigricans	21	206 - 739		Lowe-McConnell, 1987
Protopterus aethiopicus	22	8960		Okedi, 1971
Protopterus aethiopicus	22	1700 - 2300		Lowe-McConnell, 1987
Protopterus aethiopicus	22	218 - 542	Kenya	Pabari, 1998
Rastrineobola argentea	23	1800 - 3500	Kenya	Manyala, 1995b
Tilapia zillii	25	1000 - 5711		Lowe-McConnell, 1985
Xenoclarias eupagon	27	744-1357	Kenya, Uganda, Tanzania	Rinne, 1980

River Discharge

The average monthly river discharge for major river basin show that the highest period of discharge shown by River Nzoia April to December but only in May/June and September for River Sondu-Miriu (Fig. 9). River Yala experiences peak discharge from May to October while River Kuja-Migori has experiences only one peak during April/May but the their maximum discharge is sometimes less than half for those of River Nzoia and

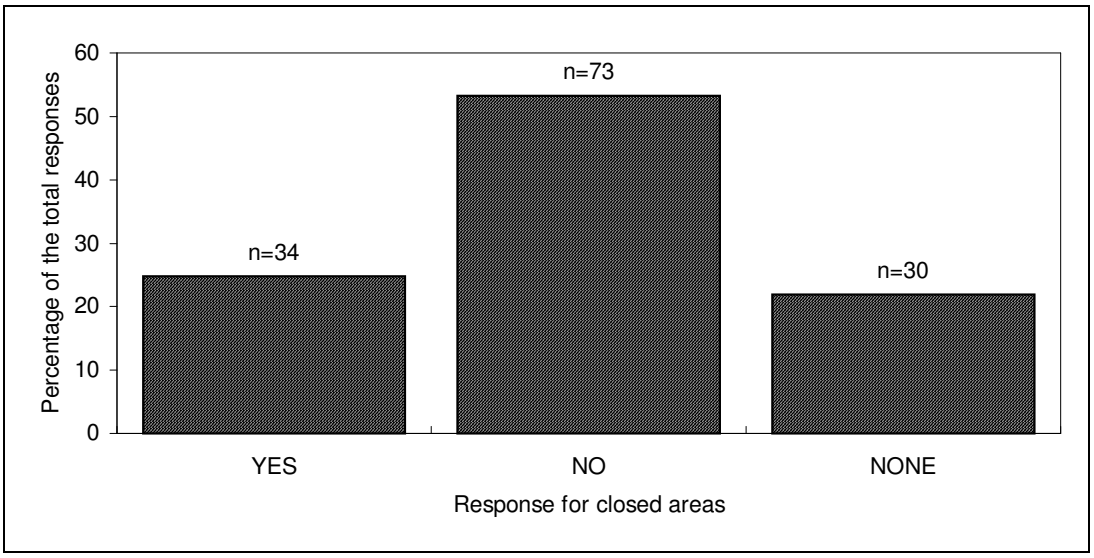


Fig. 3: Opinion by respondents about designating the identified breeding areas as closed areas

Sondu-Miriu (1000 m^3s^{-1}). River Nyando shows the least discharge volume but with peaks in April/May and August/September. More diversified fish species have been recorded in River Miriu than in River Nyando and this means that river discharge is also vital for diversity of fish species.

Table 5: Opinion given by the respondents for non-conformation to identified closed seasons.

REASONS	TOTAL	YES	NO	NONE
No reason given	62	32	6	24
Close during breeding months	50	1	47	2
Close during breeding seasons	2	1	1	
Fishermen loose their livelihood	13	11	2	
Fishermen get more fish	4	4		
No undersized fish caught at times	1	1		
Fishery should be open from August	1	1		
Enough fish since 1950s	1	1		
Throughout the year for breeding	1	1		
Only appropriate gear should be used	2	2		
TOTAL	137	55	56	26

Discussion

Data on the distribution of many species in Lake Victoria basin is scanty (Table 1). However, some of the information provided in published literature gives a starting point on which areas and seasons to target for closure. This information can only be used with

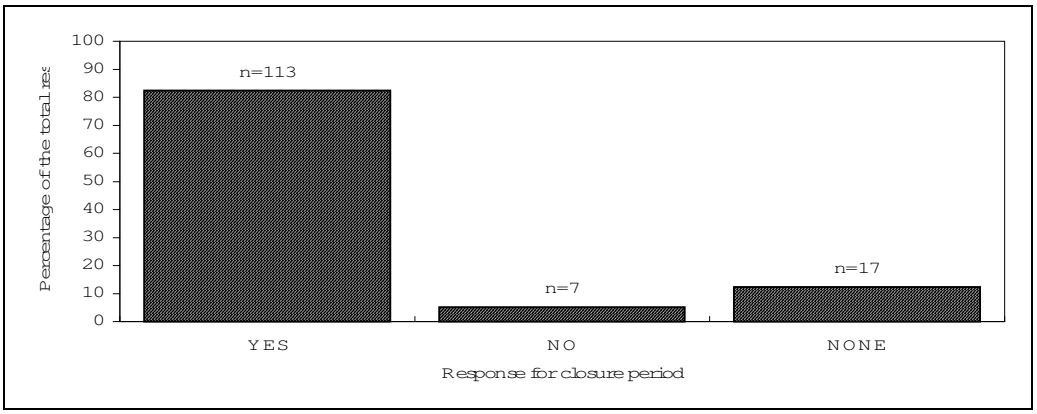


Fig 4: Opinion about having a closed season throughout the year as given by the respondents

the indigenous knowledge of the breeding areas since the geographical extent of the species is not necessarily an indication of the exact breeding areas. Very clear stratification of the breeding areas/seasons was observed for the haplochromiine cichlids and tilapiines, *Rastrineobola argentea* and *Lates niloticus*. Incidentally, these species form the major fisheries of Lake Victoria at the moment and are possible the primary candidates to be considered for protected areas. The next in line would be the riverine (potamadromous) species of which there is very scanty data apart from the Sondu-Miriu river.

Table 6: Information on opinion why there should not be a closed season for fishing as given by respondents.

REASON	TOTAL	YES	NO
No information given	1		1
Fencing of breeding grounds	104	102	2
Loss of fishermen' s livelihood	5		5
Prohibit undersized nets	10		1
Set nets away from the shoreline	15		1
Use large mesh sizes	2	2	
	137	104	10

On the published data for the breeding areas and seasons of different fish species in Lake Victoria basin, it is clear that available information is inadequate for some species, general for others and quite detailed for some species. This information therefore provides basic guideline on which closed areas can be delineated. One of the obvious target areas for closure includes the major river estuaries. It is clear from the information available from Sondu-Miriu that the riverine system provides a major breeding ground for many fish species

during some periods of the year. Many species breed from April to June and from September to October. There are also other species which show peak breeding periods during the other months of the year. These variations are a possible reflection of the impact of local variations in the river inflows from different drainage basins in the Lake Victoria catchment. The implication for observation in the Sondu-Miriu can be extended to the other major river basins but the peak periods of discharge are not similar for all the rivers. There seem to be remarkable local monthly variations (Table 2). The rainfall patterns however seem to suggest two peak rainfall periods within the year.

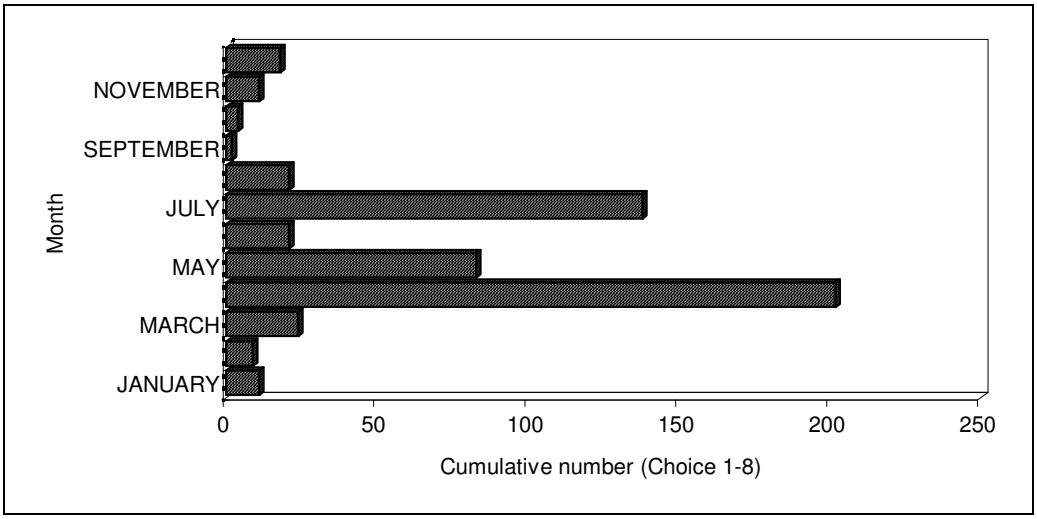


Fig. 5: Breeding seasons identified by the respondents.

The size at maturity for many of the species of fish found in the Lake system seems to have minimal variation among several authors. The mean sizes at maturity from different authors can therefore be used to set or revise the existing minimum mesh size for each of the targeted species of the fishery. There is need for additional data on gear selectivity for this purpose and this type of data may be obtained readily from the present catch assessment survey for Lake Victoria.

Our knowledge on fish fecundity can be useful in estimating expected recruitment for each species. Data on sex ratio and biomass estimate as well as larval mortality or survival can be used to estimate annual recruitment. Fortunately, data on biomass estimate and sex ratio can possibly be obtained from the ongoing Stock Assessment Programme funded by European Union through European Development Fund (EDF). Data on larval survival rates may not be available but estimates could be made based on

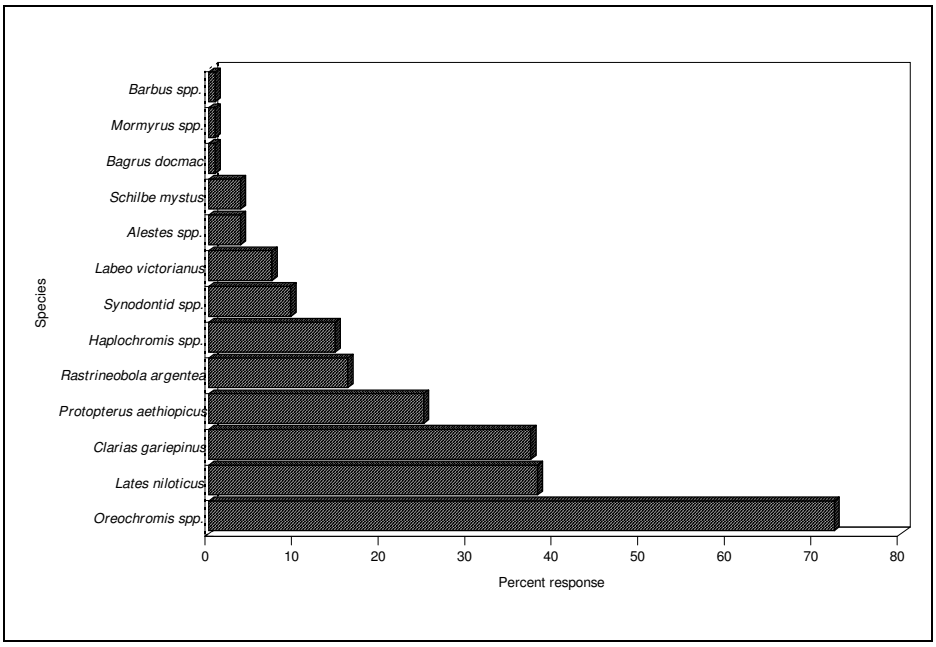


Fig. 6: Relative % frequency of fish species identified to be breeding during the peak breeding seasons.

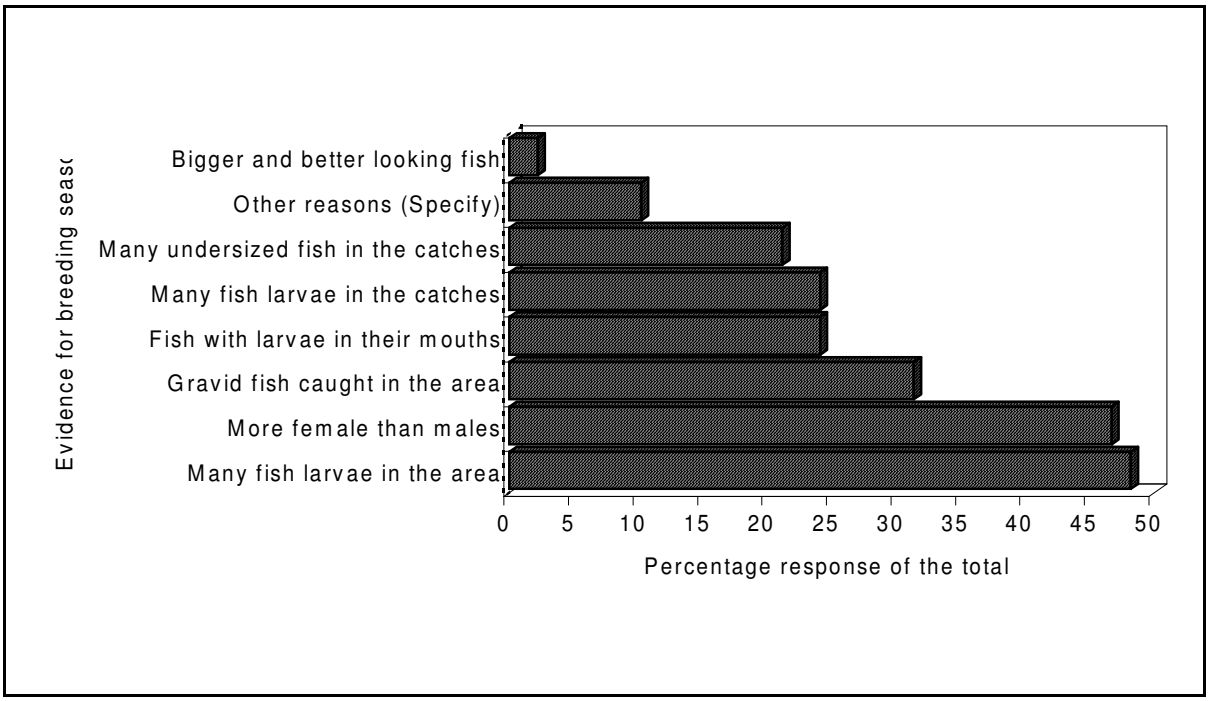


Fig. 7: Relative importance of evidences given by respondents for breeding seasons

analytical procedures. Indigenous Knowledge from the fisher community conforms to the latest findings, which indicates that the distribution of many endemic fish species has changed with the establishment of *Lates niloticus.*

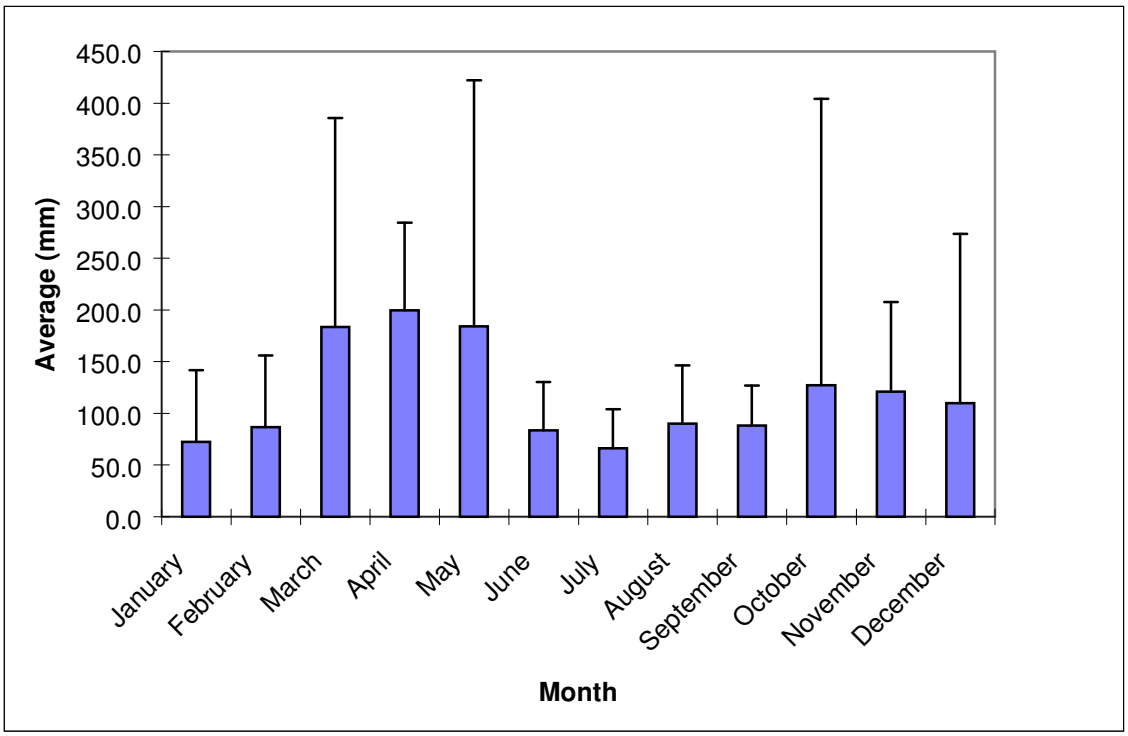


Fig. 8: Mean monthly rainfall averaged from 1950 to 2000 for Lake Victoria region

Recommendations

In view of the foregoing, it is necessary to carry out the following exercises:

1. Carry out ground-truthing exercise using GPS to demarcate the identified breeding areas based on indigenous knowledge and baseline data.
2. Carry out supplementary stock surveys for confirming the proposed areas for closure at the critical times of the year.
3. Obtain the following information from the stock assessment and experimental survey programme:
   a) Species distribution in the lake
   b) Sex ratio for each species
   c) Estimated biomass for each species and Breeding seasons and areas
   d) Determination of Maximum Sustainable Yield and Maximum Economic Yield of various fish species.
4. Hold a workshop to present the final list of the closed areas/seasons to the stakeholders for adoption, subsequent processing and implementation.
5. Work out with the stakeholders an action plan for implementing the closed areas/seasons based on co-management principles

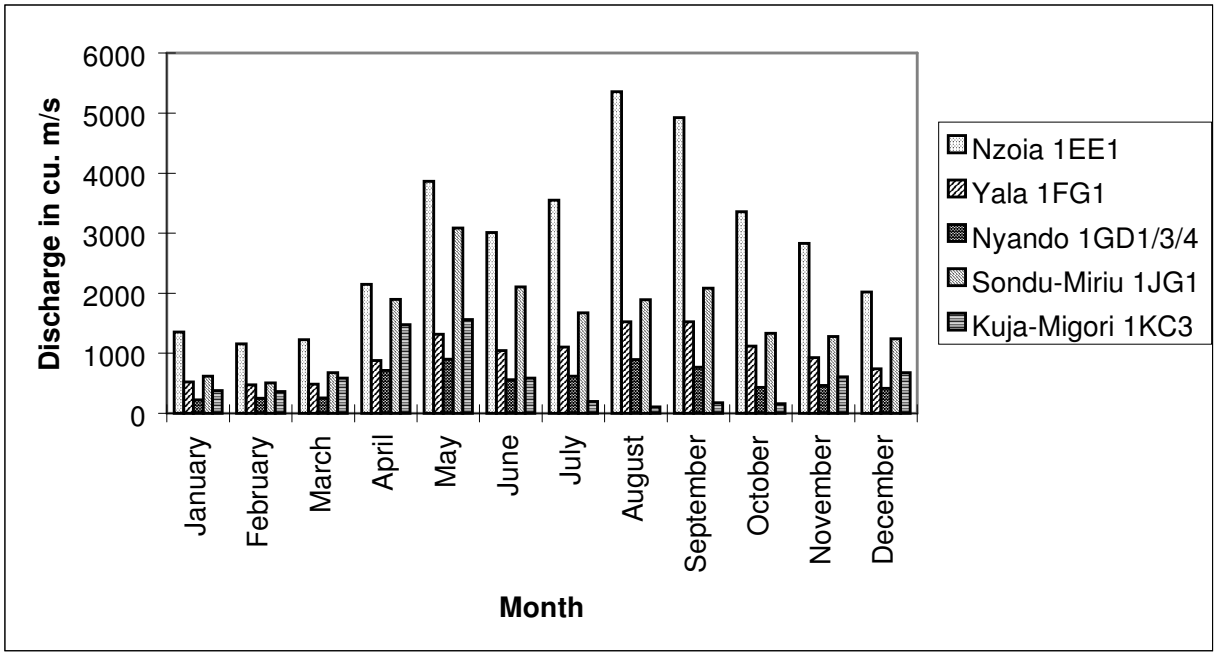


Fig. 9: Mean monthly discharge for the main effluent rivers in the Kenya portion of Lake Victoria.

Table 7: Breeding areas according to respondents interviewed.

District	Area	District	Area
Busia	Sio River mouth	Homa Bay	Obolobolo Bay
	Nzoia River mouth		Rangwena River mouth
	Munaka lagoon		Awach Tende River mouth
	Sango	Suba	Sikri Kamwai
	Ndekwa		Kisaka
	Sisenye		Alero
	Bulwani		Ondao
Bondo	Utonga bay		Gode Ariyo Bay
	Ugambe		Luanda Nyamasare bay
	Nyamwa Bay		Uyoga
	Osindo Bay		Mbita Causeway
	Bao		Kirindo
	Kadolrosa		Kakriga
	Misori area		Kolunga
	Aram zone		Chamaunga Island
	Odola (Kongonga)		Ulugi
	Pesa Odong.o (Uhendo)		Sena
	Ulala area		Nyakweri
	Ludhi		Wakula River mouth

Table 7 contd.

	Madada	Roo
	Rabolo (Ralayo)	Ragwe Bay
	Bur Kokise	Nyamusethi
	Wagusu	Rwanch
Kisumu	Nyando River mouth	Kayola stream mouth Nyamngenyi

	Otiwa-Kaloka Bay		Nyamgondho area
	Obange River mouth		Mungenyi
	Ogenya River mouth		Usulwa
	Oganda River mouth		Kiboe
	Kisat River mouth		Rasira
	Tako	Migori	Kuja River mouth
	Nyandiwa		Migori River mouth
	Abuogo		Ngwena
	Hippo Point		Modi
	Maboko		Aneko
Nyando	Kusa		Ratieny River mouth
	Gehena		Masarura
	Singida		makwach
	Gal stream mouth		Kikongo
	Bala stream mouth		Kower
	Koguta		Tito
	Sondu-Miriu River mouth		Koyondi
Rachuonyo	Sondu-Miriu River mouth		Maguti
	Awach Kibuon River mouth		Mwarache
	Sare Kongoro		Kamambra
	Riat bay		
	Uhuru (Olasi) Bay Rambira		
	In-between Awana and Mitimbili beaches		
	In-between Mariwa and Kobiero beaches		
	In-between Bala Kochoo and Mariwa beaches		
	In-between Lwasi and Remo beaches		
	In-between Bala Rawi and Doho beaches		
	In-between Kanyakiti and Tausi beaches		
	Awach Tende River mouth		

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