Journal of Ecology and the Natural Environment Vol. 4(5), pp. 135-140, 12 March, 2012
Available online at http://www.academicjournals.org/JENE
DOI: 10.5897/JENE11.139
ISSN 2006 - 9847©2012 Academic Journals

Full Length Research Paper

Gill net selectivity in the White Nile fisheries, Khartoum State, Sudan

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Accepted 14 February, 2012

Gill-net selectivity is a size and type of fish that caught depending upon specific mesh size of a used gill-net. In this study, four different mesh sizes (4, 6, 8 and 15 cm) were used in al-Kalakla Fishery (KF) and Jabel Awlia Dam Fishery (JADF) in the White Nile for studying their selectivity. The results of a catch per unit effort (CPUE) study showed that meshes 4 and 6 cm had higher productivity in fishing in KF than that in JADF; whereas, meshes 8 and 15 cm caught more fishes in JADF than in KF for the entire year. In KF, autumn season was the best for fishing with meshes 6 and 8 cm. In JADF, summer and autumn were the best for fishing by meshes 4 and 6 cm. The gill-nets of the study were highly selective for fish species according to their body size. Five fishes of small sizes (body depth at around 4 cm) as Tilapias (*Oreochromis niloticus:* Linnaeus, 1758; *Tilapia zilli*: Gervais, 1848; *Sarotherodon galilaeus*: Linnaeus, 1758), Kas (*Hydrocynus forskali:* Cuvier, 1819; *Hydrocynus vittatus*: Castelnau, 1861; *Hydrocynus brevis:* Günther, 1864), Nile Perch (*Lates niloticus:* Linnaeus, 1758), Dabis (*Labeo vulgaris*: Heckel, 1847) and Bayad (*Bagrus bayad:* Forsskål, 1775) were caught intensively by mesh of 4 cm during all seasons in both KF and JADF; whereas, meshes of 8 and 15 cm caught occasionally bigger fishes ranged between 8 to15 cm as Nile Perch and Bayad. The selectivity of these nets reflected over-fishing caused in the White Nile.

Key words: Fisheries, freshwater fish, River Nile, fishing gear, fishing nets.

INTRODUCTION

Gill-net selectivity affect fish stocks through (a) decrease in yield due to intensive fishing, (b) direction of catching effort toward specific species and (c) over-fishing due to long-term practice (Potter and Pawson, 1991). Nowadays, there is a considerable interest in improving the selectivity of fishing gear to reduce the capture and discarding of unwanted sizes and species of both freshwater and marine fishes (Steward, 2001).

Twine thickness was correlated with mesh size to establish a comparison (Ali, 1975; Ali and Abu-Gideiri, 1984). The physical properties of synthetic nets may change gradually with use. The abrasion of the nets removes the transparency from the material so; the accumulation of knots and roughened surface of the yarn makes the netting more visible in water. Monofilament nets are more effective than multifilament nets, because they are less visible (Potter and Pawson, 1991).

In the Sudan, with its large bodies of water, there are no regulations governing fishing gear (Ali and Abu-Gideiri, 1984). As a result of the intensive fishing with a wide range of mesh sizes, especially the smaller ones which are used irregularly have led to over-fishing of the White Nile fishery (Kawai, 1994; Mohammed, 2004). The commonest types of fishing nets used in Khartoum State fisheries are fixed nets, drift nets, trammel nets and beach nets. Most of them are made of monofilament; while, few are made of multi-filament (Mohammed, 2004; 2008).

This study was done to determine which mesh size of gill-net causes the greatest depletion of fish stocks and to study the effect of water level and its transparency on gill-net efficiency.

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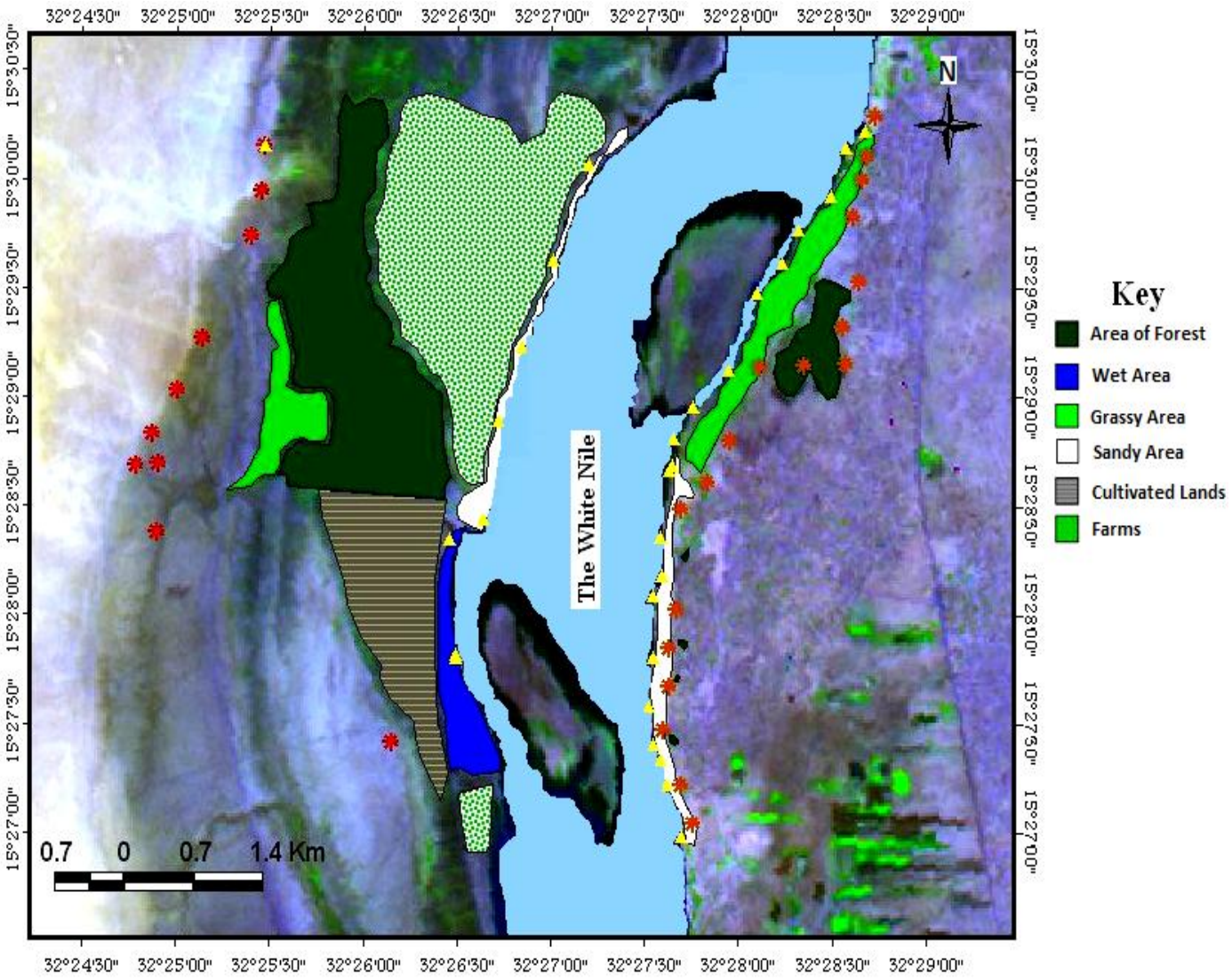

Figure 1. A satellite map of Al-Kalakla Fishery (KF) in the White Nile, Khartoum State (cited by Mohammed 2006).

MATERIALS AND METHODS

This study was conducted in JADF (dam reservoir and five km downstream from the dam's barrier) and KF in the White Nile (Figures 1 and 2, respectively) described by Mohammed (2006: 34 to 35, Figure 6a and b). Four different mesh sizes of multi-filament gill-nets were used. Their mesh sizes were 4, 6, 8, and 15 cm made of appropriate twines of numbers 2/210, 3/210, 6/210, and 12/210 respectively. Each net measured 50 m in length and 1.5 m and half in depth.

The gill-nets were set for three days every mid-month for the entire year of the study (October, 2005/2006). They were checked to record the catches twice a day at sunrise and sunset as described by Mohammed (2006).

The caught fishes were identified according to Sandon (1950). They were measured using a dissecting board and weighed using a Salter Balance (25 kg × 100 g) for large specimens and a One-Pan Balance for small specimens. A Secchi Disk was used to determine transparency of water and a Bulb thermometer of 50 × 1°C for water temperature. Catch per unit effort (CPUE) was computed using a following formula:

$$\text{CPUE} = \frac{\text{Gross weight of catch of fish (g)}}{\text{Surface area of the net (m}^2\text{) long of time of fishing (h)}}$$

RESULTS

Catch per unit effort (CPUE)

Results of CPUE showed that mesh 4 cm netted with twine 6/210 was the most effective particularly during the night in both JADF and KF. JADF was the best fishery to use mesh 15 cm netted with twine 12/210. Generally, KF appeared to be a more productive fishery than JADF (Table 1).

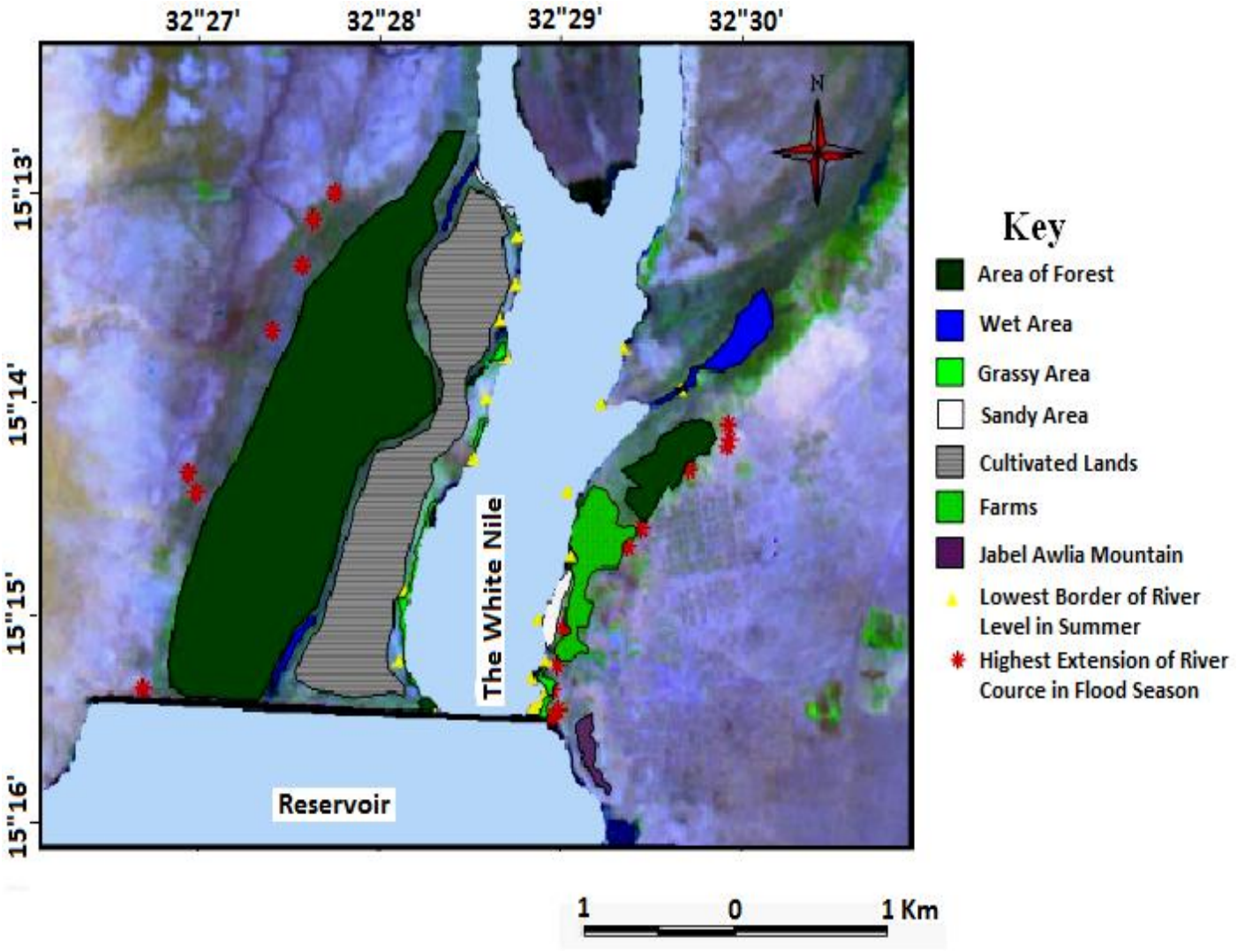

Figure 2. A satellite map of Jabel Awlia Dam Fisheries (JADF) in the White Nile, Khartoum State (cited by Mohammed 2006).

CPUE per day and night

In JADF, mesh 4 cm was most productive in fishing at night for the entire year, but daytime productivity in December, February, and June was also high. Mesh 8 cm showed high productivity at night for the entire year, but mesh 6 and 15 cm were ineffective. In KF, mesh 4 cm showed high productivity when used nightly for the entire year, but mesh 8 and mesh 15 cm were ineffective in fishing both night and day (Table 2).

Selectivity of each mesh/water characteristics

Mesh 4 cm showed the highest selectivity towards five small Nile fishes (body depth at around 4 cm) in JADF and KF during all seasons of year, followed by mesh 6 cm. Those fishes were Tilapias (*O. niloticus*, *T. zilli*, and *S. galilaeus*), Kas (*H. forskalii, H. vittatus & H. brevis*), Nile Perch (*L. niloticus*), Dabis (L. *vulgaris*), and Bayad (*B. bayad*). Mesh 15cm showed selectivity toward bigger fishes (body depth at around 15 cm) and also reflected over-fishing of the White Nile (Table 3).

KF recorded lower temperatures during the entire year than the JADF. On the other hand, JADF showed highest transparency during the entire year (Table 4).

DISCUSSION AND RECOMMENDATION

The results of CPUE showed that KF was more productive than JADF, probably, due to three reasons: one, KF is a breeding region for herbivorous fishes such as Tilapias, so that, all members of chain food are available, Two, there are fewer fishermen in KF and three, the JADF is rocky and consequently prohibits

Table 1. Catch per unit effort (CPUE) of multi-filament gill-nets used in Jabel Awlia Dam Fishery (JADF) and Al-Kalakla Fishery (KF) in the White Nile, Khartoum State (2005/2006).

CPUE	Mesh size							
	Mesh 4		Mesh 6		Mesh 8		Mesh 15	
	Day	Night	Day	Night	Day	Night	Day	Night
KF	4.19	5.61	0.05	1.44	0.52	0.80	0.0	0.48
JADF	0.92	2.24	0.09	1.06	0.61	1.36	0.0	1.28

Table 2. Seasonal fluctuations of catch per unit effort (CPUE) of the different mesh sizes in Jabel Awlia Dam Fishery (JADF) and Al-Kalakla Fishery (KF) in the White Nile, Khartoum State (2005/2006).

Month mesh	Fishery	October, 2005	December, 2005	February, 2006	April, 2006	June, 2006	August, 2006
Mesh 4	KF	D† 5.87	1.14	0.15	0.66	0.42	0.08
		N* 6.06	2.40	0.08	2.04	0.51	0.06
	JADF	D† 0.27	0.30	0.49	0.16	0.38	0.23
		N* 1.28	0.38	0.38	1.15	0.59	0.69
Mesh 6	KF	D† 0.0	0.0	0.0	0.0	0.09	0.0
		N* 2.88	0.0	0.0	0.0	0.0	0.0
	JADF	D† 0.0	0.76	0.11	0.0	0.0	0.0
		N* 1.63	0.0	0.0	0.48	0.0	0.0
Mesh 8	KF	D† 0.76	0.0	0.0	0.0	0.28	0.0
		N* 0.32	0.0	0.0	0.0	0.64	0.32
	DSF	D† 0.0	0.0	0.45	0.38	0.19	0.19
		N* 0.80	0.80	0.16	0.32	0.32	0.32
Mesh 15	KF	D† 0.0	0.0	0.0	0.0	0.0	0.0
		N* 0.96	0.0	0.0	0.0	0.0	0.0
	DSF	D† 0.0	0.0	0.0	0.0	0.0	0.0
		N* 2.56	0.0	0.0	0.0	0.0	0.0

† = day, *=night.

Table 3. Seasonal selectivity of the different mesh sizes in Jabel Awlia Dam Fishery (JADF) and Al-Kalakla Fishery (KF) in the White Nile, Khartoum State (2005/2006).

Species	Mesh size											
	Mesh 4cm			Mesh 6cm			Mesh 8cm			Mesh 15		
	Aut†. (%)	Win* (%)	Sum¥. (%)	Aut. (%)	Win. (%)	Sum. (%)	Aut. (%)	Win. (%)	Sum. (%)	Aut. (%)	Win. (%)	Sum. (%)
Tilapias	0.32	4.81	0.32	-	-	-	-	-	-	-	-	-
Hydrocynus sp.	35.58	3.21	1.60	0.32	0.32	-	-	0.32	-	-	-	-
Lates niloticus	2.56	2.88	1.60	0.96	-	-	064	-	-	-	-	-
Labeo vulgaris	2.88	6.73	4.81	-	-	-	0.32	-	-	-	-	-
Bagrus Bayad	2.56	1.28	0.32	-	-	-	1.28	-	-	-	-	-
Others	8.01	1.92	9.94	0.9	-	-	0.32	-	-	0.32	-	-

†= Autumn, *=Night, ¥= Summer.

Table 4. Mean temperature (ºC) and transparency (m) readings in Jabel Awlia Dam Fishery (JADF) and Al-Kalakla Fishery (KF) in the White Nile, Khartoum State (2005/2006).

Fishery		Season											
		Max. value (night)			Min. value (night)			Max. value (day)			Min. Value (day)		
		Aut†.	Win*.	Sum¥.	Aut.	Win.	Sum.	Aut.	Win.	Sum.	Aut.	Win.	Sum.
ºC	KF	26	20	24	25	17	23	26	19	24	25	16	22
	JADF	28	23	24	25	18	23	26	23	26	25	17	24
m.	KF	32	42	31	32	39	30	33	41	32	30	39	30
	JADF	28	46	45	24	35	30	23	43	44	47	36	38

†= Autumn *= Winter ¥= Summer

fishing by seine nets or even drifting nets. This observation confirms the findings of Mohammed (2006).

Mesh 4cm and mesh 6 cm showed higher CPUE than other meshes used in KF, particularly during autumnand winter. This may be for many reasons: flooded water is considered one of the most effective factors, because rates of migrated fishes from both the upper parts of the White Nile and Blue Nile enrich KF. This fishery is rich with breeding ground areas, so fishing by finer meshes was more productive.

At the end of flood season, the high level of the river begins to decline and fishes accumulate from the flooded banks to the main river. This observation also confirms the findings of Mohammed (2006).

Mesh 4 cm appeared effective in JADF due to the diverse environment which is suitable for many kinds of fishes through the year. Fishermen used both fixed gill-nets and drift gill-nets. Winter and summer seasons had low levels of water and high transparency, so that, fishing by mesh 8 cm was the best because it could easily be determined which place contained the largest number of fish. This agrees with the findings of Ali and Abu-Gideiri (1984) and Mohammed (2006). The CPUE of mesh 4 cm in both fisheries indicated that this mesh size select towards small fish sizes; whereas mesh 15 cm selects toward big fishes. The small sizes of most fishes and fewer numbers of large fishes indicate an over-fishing phenomenon. This agrees with results of Kawai (1994) and Mohammed (2006).

As discussed above, the results of this study suggests a prohibition of mesh sizes 4 and 6 cm

in both fisheries during all the year except in flooded water due to the migration of fishes from Blue Nile and upper parts of the White Nile.

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