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Gear analysis of freshwater *Macrobrachium species* catch at Igbedi Creek for regulation recommendation in Bayelsa State, Nigeria

BINAEBI EDUBAMO DAVIDSON [1,*] and DEEKAE SUANU N [2]

[1] *Department of Fisheries, Niger Delta University, Wilberforce Island, PMB 071 Bayelsa State NG, 560103, Amassoma, Wilberforce Island, Bayelsa State, Nigeria.*
[2] *Department of Fisheries and Aquatic Environment, Rivers State University, Nkpolu-Oroworukwo, P. M. B. 5080, Port Harcourt, Rivers State, Nigeria.*

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Abstract

Gears are tools for fishing without which the fisher cannot gain access to the fisheries resource in Nigeria. The gears at riparian communities of Ogoubiri, Toru-Ebeni, Amassoma and Otuan along Igbedi Creek, Bayelsa, Nigeria were analyzed to evaluate the effect on the shrimp catch at the Creek, for regulation recommendation, by measuring the gears utilized and the length of the shrimps caught from each gear. This research revealed that there were three species of Palaemonidae: *Macrobrachium vollenhovenii*, *M. macrobrachion* and *M. felicinum* which were harvested with Hand-push nets, Non-return valve traps and Non-return net traps. The traps were generally small in size and few. A total of 156 gears, with catch ranging from 0 to 1309. The mean length and width for each gear range from 36.75±4.16cm and 25.64±2.88 cm to 38.73±3.73 cm and 26.99±2.67 cm for G1, 131.58±6.73 cm and 19.17±2.15 cm to 127.54±4.06 cm and 18.39±1.55 cm for G2, 107.58±1.70 cm and 20.27±0.58 cm to 108.01±1.65 cm and 20.35±0.03 cm for G3 and 91.44±0.00 cm and 60.96±0.00 cm to 91.64±0.52 cm and 61.21±0.98 cm for G4. The entrance hole ranging from 2.49±0.38 cm to 61.40±0.78 cm in all four locations and species catch ranging from 2.2 cm to 9.8 cm for *M. macrobrachion*, 2.0 cm to 12.8 cm for *M. vollenhovenii* and 2,5 cm to 8.4 cm for *M. felicinum* at the stations. The gears allow the escape of shrimps less than 1.9 cm. This implies that growth overfishing can be averted but recruitment overfishing is inevitable if the fishers continue in the free access conditions and increase catch capacity therefore, this study recommend gear size and seasonal catch regulation.

Keywords: Gear; Regulation; Shrimp; Capture; Growth Overfishing; Recruitment

1 Introduction

Gears are tools for fishing without which the fisher cannot gain access to the fish [1]. Fisheries resources and the aquatic environment are affected by fishing gears in different ways. Based on several surveys in various inland water bodies of Nigeria, gear types in use include; Traps, Hook and line/longline, spears, cast-nets, fence, Drift/gill nets and others [1, 2, 3, 4, 5, 6, 7, 8,]. These gears have low rate of by-catch and do not alter substrates [5, 9]. Gear regulation seeks to actualize optimum age and size of fish and shrimp selectivity, i.e. to avoid the catch of too small or too big species [10]. Gear selectivity is the gear's capacity based on design to catch a section of a population. Gear selectivity is the key tool in gear regulations and policy formulation.

Fish catch regulation in Nigerian inland waters is captured in the Nigerian Inland Fisheries Act of 1992. This Act seek to regulate fisheries resource exploitation by several means which includes; 76mm mesh and 500m total length of nets.

* Corresponding author: BINAEBI EDUBAMO DAVIDSON
Department of Fisheries, Niger Delta University, Wilberforce Island, PMB 071 Bayelsa State NG, 560103, Amassoma, Wilberforce Island, Bayelsa State, Nigeria.

The law also permits 3mm cod-end in terms of gear control regulations. This law is not adequately enforced and State riparian dwellers still see aquatic resources as common properties in Nigeria. The law did not capture regulations of other gear described by [1, 3, 5,] utilized in Nigeria apart from mesh size and length of nets.

Macrobrachium species are tropical species and tropical prawns are characterized by faster growth and shorter life-span [11]. The management of the fisheries of species consider size of capture in the design of the gear that would produce sustainable yield and avert growth overfishing (capture of sizes below average) or minimize capture of spawning stock, averting recruitment overfishing. The inland fisheries regulation of Nigeria notably the Nigerian Inland Fisheries Act of 1992, made provision for mesh size regulation of nets but does not consider the gear types and capture of crawling species such as inland *Macrobrachium species.* Freshwater Shrimps are captured mainly by set-traps and hand-push nets [12, 13] in the Niger Delta and Igbedi Creek is no exception.

Shrimps are regularly exploited at Igbedi Creek in Bayelsa state with no formal regulation of the catch. Bayelsa State like some States of the federation lack a fisheries law for fish catch regulation [14, 15] which include shrimps. Therefore, there is lack of surveillance of aquatic resource exploitation [14]. The implication therefore means there might be probable unintended consequence of recruitment and growth overfishing. The effect of gear on the catch of the shrimps at the creek is essential for management and regulation [16], as the Igbedi Creek is a large drainage system in the State, an important water body due to the increasing level of fishing.

2 Material and methods

2.1 The Study Area

The study was carried out at Igbedi Creek which is a tributary in Bayelsa State. Bayelsa State is the southernmost part of Nigeria and it has drainage systems of the River Niger cutting across it as veins. Bayelsa State lies at latitude 4° 39’ 50” North and longitude 6° 2’ 13.15” East. The Igbedi Creek was selected because the species are caught by fishers in the region. The stations which were purposively selected are Ogoubiri, Toruibeni, Amassoma and Otuan and were sampled for the *Macrobrachium species*.

Ogoubiri (Station 1) is located within latitude 4° 59' 43"N and longitude 6° 06' 56"E. Toruibeni (Station 2) is located within latitude 4° 58’ 31"N and longitude 6° 4’ 25"E along Igbedi Creek at the Nun river. Amassoma (Station 3) is located within latitude 4° 58’ 15” N and longitude 6° 06’ 32.94” E along Igbedi Creek. It lies within the flood plains of the western flanks of the Wilberforce Island in Southern Ijaw Local Government Area of Bayelsa State. Otuan (Station 4) is located at latitude 4^0 52’ 27” N and longitude 6^0 07’ 18” E downstream from Amassoma in Southern Ijaw, Local Government Area of Bayelsa State

2.2 The Gear used and Catch Composition

The gear utilized and the catch composition of each was investigated by identifying the gear and measuring them with a measuring tape. The length, the width and the entrance hole or opening were measured at each location of Ogoubiri, Toru-Ebeni, Amassoma and Otuan.

2.3 Collection of Shrimp Samples and identification of species

Fresh live specimens of *Macrobrachium species* were obtained from fishers for twelve calendar months biweekly at the chosen sampling stations at Igbedi Creek. Specimens were kept and preserved in 10% formalin to preserve them to the Laboratory.

The species of prawns were identified using key identification tool [17, 18, 19]. Morphological features of the difference between the rostrum length and the antennal scale, difference in the segmented foot and colour of each species. Samples were measured and monthly length data were taken. Samples were measured by sizes (standard length-from tip of rostrum to tip of telson) to the nearest 0.1 mm.

3 Results

3.1 The gear used and catch composition

The *Macrobrachium species* which were obtained from fishers for twelve calendar months biweekly at the chosen sampling stations of Ogoubiri, Toru-Ebeni, Amassoma and Otuan at Igbedi Creek were examined. The species were

caught with four major gear, the hand-push net, and two types of non-return valve trap and the non-return net traps. The range of length sizes of each species per month were measured.

3.2 Non-return valve traps

There were two types of traps utilized an oval shaped trap (Figure 1) and an elongated trap (Figure 3). These traps were set during the wet season from the second week of July to November, 2020 (Table 1 to 4). The traps were set using stakes to hold them firm in shallow waters along the shores of the Creek (Figure 5) and (Figure 6). The traps were set for 24hrs before been retrieved.

3.3 Hand-push nets

This net was utilized during the day throughout the dry season from December into the wet seasons of April to August, 2020 (Table 1 to 4). The catch was generally low as fishers actively engaged in the catch of prawn during the wet season when prawns were abundant (Figure 2 and (Figure 7). The nets were used to haul shallow waters covered with grasses.

3.4 Non-return net trap

This trap was also utilized during the wet season but it is mostly allowed to float and held by a rope tied to a stake along the shores. They are less efficient compared to the Non-return valve traps as there catch of prawns were fewer (Figure 4) (Table 1 to 4). The traps were set for 24hrs before been retrieved.

3.5 Species identification

Three *Macrobrachium species* were identified from the Creek which *were Macrobrachium vollenhovenii, Macrobrachium macrobrachion and Macrobrachium felicinum.*

Figure 1 Non-return valve trap locally called *Okou*

Figure 2 Hand-push net locally called *Aboriye*

Figure 3 Non-return valve trap locally called *Ige*

Figure 4 None return net trap locally called *Deriboflo*

Figure 5 Plastic containers attached to stakes used to set the Non-return valve trap for easy identification during high tide

Figure 6 Setting a Non-return valve trap

Figure 7 Utilization of hand-push nets

Table 1 The Gear used and Catch Composition at Ogoubiri

Month	Gear types	Gear numbers	ML	MW	MEH	Catch	Percentage (%)	*Mm*	*Mv*	*Mf*
								Length range (cm)	Length range (cm)	Length range (cm)
JULY	G1	14	36.75±4.16	25.64±2.88	2.6±0.46	151	41.37	2.8 -9.1	2.4 -12.1	0.00
	G2	7	131.58±6.73	19.17±2.15	2.41±0.41	120	32.88			
	G3	4	108.01±1.65	20.35±0.03	4.55±0.52	20	5.48			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	74	20.27			
	Total					365	100.00			
August	G1	14	36.75±4.16	25.64±2.88	2.6±0.46	351	49.79	2.8 - 9.9	2.2- 12.5	0.00
	G2	7	131.58±6.73	19.17±2.15	2.41±0.41	281	39.86			
	G3	4	108.01±1.65	20.35±0.03	4.55±0.52	11	1.56			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	62	8.79			
	Total					705	100			
September	G1	14	36.75±4.16	25.64±2.88	2.6±0.46	403	50.57	3.0 - 9.1	2.0 -12.1	0.00
	G2	7	131.58±6.73	19.17±2.15	2.41±0.41	352	44.17			
	G3	4	108.01±1.65	20.35±0.03	4.55±0.52	42	5.27			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	0.00	0.00			
	Total					797	100			
October	G1	14	36.75±4.16	25.64±2.88	2.6±0.46	521	63.46	2.4 - 9.8	2.1 - 12. 4	0.00
	G2	7	131.58±6.73	19.17±2.15	2.41±0.41	231	28.14			
	G3	4	108.01±1.65	20.35±0.03	4.55±0.52	69	8.4			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	0.00	0.00			
	Total					821	99.99			
November	G1	14	36.75±4.16	25.64±2.88	2.6±0.46	549	59.61	2.2 - 8.7	2 - 12.1	2.5 – 8.3
	G2	7	131.58±6.73	19.17±2.15	2.41±0.41	332	36.05			
	G3	4	108.01±1.65	20.35±0.03	4.55±0.52	40	4.34			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	0.00	0.00			
	Total					921	100.00			
December	G1	0	0.00	0.00	0.00	0	0.00	2.8 - 8.5	2 - 10.5	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	62	100.00			
	Total					62	100.00			
January	G1	0	0.00	0.00	0.00	0.00	0.00	3.7 - 7.2	2 - 5.9	
	G2	0	0.00	0.00	0.00	0.00	0.00			
	G3	0	0.00	0.00	0.00	0.00	0.00			

	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	19	100.00			
	Total					19	100.00			
February	G1	0	0.00	0.00	0.00	0.00	0.00		3.3 - 8.5	
	G2	0	0.00	0.00	0.00	0.00	0.00			
	G3	0	0.00	0.00	0.00	0.00	0.00			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	18	100.00			
	Total					18	100.00			
March	G1	0	0.00	0.00	0.00	0.00	0.00	2.4 - 9.9	2.3 - 10.1	
	G2	0	0.00	0.00	0.00	0.00	0.00			
	G3	0	0.00	0.00	0.00	0.00	0.00			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	38	100.00			
	Total					38	100.00			
April	G1	0	0.00	0.00	0.00	0.00	0.00	2.6 - 7.3	2 - 11.2	
	G2	0	0.00	0.00	0.00	0.00	0.00			
	G3	0	0.00	0.00	0.00	0.00	0.00			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	73	100.00			
	Total					73	100.00			
May	G1	0	0.00	0.00	0.00	0.00	0.00	2.4 - 9.8	3.4 - 10.7	
	G2	0	0.00	0.00	0.00	0.00	0.00			
	G3	0	0.00	0.00	0.00	0.00	0.00			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	133	100.00			
	Total					133	100.00			
June	G1	0	0.00	0.00	0.00	0.00	0.00	2.5 - 9.7	2 - 10.1	
	G2	0	0.00	0.00	0.00	0.00	0.00			
	G3	0	0.00	0.00	0.00	0.00	0.00			
	G4	6	91.44±0.00	60.96±0.00	60.96±0.00	165	100.00			
	Total					165	100.00			

G1; Non-return valve trap locally called *Ige,* G2; Non-return valve trap locally called *Okou,* G3; None return net trap locally called *Deriboflo,* G4; Hand-push net locally called *Aboriye,* ML; Mean length, MW; Mean width, MEH; Mean entrance hole, *Mm; Macrobrachium macrobrachion, Mv; Macrobrachium vollenhovenii, Mf; Macrobrachium felicinum*

Table 2 The Gear used and Catch Composition at Amassoma

Month	Gear types	Gear numbers	ML	MW	MEH	Catch	Percentage (%)	Mm	Mv	Mf
								Length range (cm)	Length range (cm)	Length range (cm)
JULY	G1	18	38.63±3.56	26.90±2.56	2.54±0.44	415	50.86	2.4 - 9.1	2.4 - 12.3	0.00
	G2	10	130.47±6.65	19.30±2.26	2.52±0.42	204	25.00			
	G3	6	107.69±1.93	20.35±0.56	4.62±0.49	50	6.13			
	G4	9	91.56±0.35	61.40±0.78	61.40±0.78	147	18.02			

	Total					816	100.00			
August	G1	18	38.63±3.56	26.90±2.56	2.54±0.44	559	60.56	2.5 - 9.7	2.5 - 12.3	0.00
	G2	10	130.47±6.65	19.30±2.26	2.52±0.42	297	32.18			
	G3	6	107.69±1.93	20.35±0.56	4.62±0.49	67	7.26			
	G4					0	0.00			
	Total					923	100.00			
September	G1	18	38.63±3.56	26.90±2.56	2.54±0.44	566	52.17	2.3 - 9	2.8 - 12.3	0.00
	G2	10	130.47±6.65	19.30±2.26	2.52±0.42	412	37.97			
	G3	6	107.69±1.93	20.35±0.56	4.62±0.49	107	9.86			
	G4					0	0.00			
	Total					1085	100.00			
October	G1	18	38.63±3.56	26.90±2.56	2.54±0.44	756	57.75	2.4 -9.6	2.4 - 12. 4	0.00
	G2	10	130.47±6.65	19.30±2.26	2.52±0.42	487	37.20			
	G3	6	107.69±1.93	20.35±0.56	4.62±0.49	66	5.04			
	G4	0	0	0	0	0	0.00			
	Total					1309	100.00			
November	G1	18	38.63±3.56	26.90±2.56	2.54±0.44	467	59.87	2.7 - 9.3	2.4 - 12.3	2.8 - 8
	G2	10	130.47±6.65	19.30±2.26	2.52±0.42	288	36.92			
	G3	6	107.69±1.93	20.35±0.56	4.62±0.49	25	3.21			
	G4	0	0	0	0	0	0.00			
	Total					780	100.00			
December	G1	18	38.63±3.56	26.90±2.56	2.54±0.44	95	62.91	2.4 - 8.6	2.9 - 12.3	0.00
	G2	10	130.47±6.65	19.30±2.26	2.52±0.42	56	37.09			
	G3	0	0	0	0	0	0.00			
	G4	0	0	0	0	0	0.00			
	Total					151	100.00			
January	G1	0	0	0	0	0	0.00	2.4 - 9.7	3.1 - 9.9	0.00
	G2	0	0	0	0	0	0.00			
	G3	0	0	0	0	0	0.00			
	G4	9	91.56±0.35	61.40±0.78	61.40±0.78	72	100.00			
	Total					72	100.00			
February	G1	0	0.00	0.00	0.00	0	0.00	7.1 – 9.9	2.2 - 9.9	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	0	91.56±0.35	61.40±0.78	61.40±0.78	91	100.00			
	Total					91	100.00			
March	G1	0	0.00	0.00	0.00	0	0.00	0.00	5.3 -12.1	0.00
	G2	0	0.00	0.00	0.00	0	0.00			

	G3	0	0.00	0.00	0.00	0	0.00			
	G4	9	91.56±0.35	61.40±0.78	61.40±0.78	26	100.00			
	Total					26	100.00			
April	G1	0	0.00	0.00	0.00	0	0.00	2.4 - 9.5	2.7 - 10	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	9	91.56±0.35	61.40±0.78	61.40±0.78	88	100.00			
	Total					88	100.00			
May	G1	0	0.00	0.00	0.00	0	0.00	2.4 - 9.3	2.7 - 10.8	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	9	91.56±0.35	61.40±0.78	61.40±0.78	130	100.00			
	Total					130	100.00			
June	G1	0	0.00	0.00	0.00	0	0.00	2.4 - 9.8	2.2 - 12.3	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	9	91.56±0.35	61.40±0.78	61.40±0.78	387	100.00			
	Total					387	100.00			

G1; Non-return valve trap locally called *Ige*, G2; Non-return valve trap locally called *Okou,* G3; None return net trap locally called *Deriboflo*, G4; Hand-push net locally called Aboriye, ML; Mean length, MW; Mean width, MEH; Mean entrance hole, *Mm; Macrobrachium macrobrachion, Mv; Macrobrachium vollenhovenii, Mf; Macrobrachium felicinum*

Table 3 The Gear used and Catch Composition at Toru-Ebeni

Month	**Gear types**	**Gear numbers**	**ML**	**MW**	**MEH**	**Catch**	**Percentage (%)**	***Mm***	***Mv***	***Mf***
								Length range (cm)	Length range (cm)	Length range (cm)
JULY	G1	15	38.73±3.73	26.99±2.67	2.49±0.38	321	43.91	2.4 - 9	2.3 - 12.3	0.00
	G2	9	127.54±4.06	18.39±1.55	2.41±0.41	232	31.74			
	G3	8	107.58±1.70	20.27±0.58	4.68±0.43	50	6.84			
	G4	7	91.64±0.52	61.21±0.98	61.21±0.98	128	17.51			
	Total					731	100.00			
August	G1	15	38.73±3.73	26.99±2.67	2.49±0.38	373	45.43	2.5 - 8.7	2.1 - 11.8	0.00
	G2	9	127.54±4.06	18.39±1.55	2.41±0.41	269	32.76			
	G3	8	107.58±1.70	20.27±0.58	4.68±0.43	82	9.99			
	G4	7	91.64±0.52	61.21±0.98	61.21±0.98	97	11.82			
	Total					821	100.00			
September	G1	15	38.73±3.73	26.99±2.67	2.49±0.38	528	48.40	2.8 - 9	2.4 - 12.8	0.00
	G2	9	127.54±4.06	18.39±1.55	2.41±0.41	378	34.65			
	G3	8	107.58±1.70	20.27±0.58	4.68±0.43	185	16.96			

	G4	0	0	0	0	0	0.00			
	Total					1091	100.00			
October	G1	15	38.73±3.73	26.99±2.67	2.49±0.38	517	45.51	2.7 - 8.6	2.4 - 11.5	0.00
	G2	9	127.54±4.06	18.39±1.55	2.41±0.41	432	38.03			
	G3	8	107.58±1.70	20.27±0.58	4.68±0.43	187	16.46			
	G4	0	0	0	0	0	0.00			
	Total					1136	100.00			
November	G1	15	38.73±3.73	26.99±2.67	2.49±0.38	418	46.14	2.6 - 9	2.4 - 12.5	2.5 - 8.4
	G2	9	127.54±4.06	18.39±1.55	2.41±0.41	356	39.29			
	G3	8	107.58±1.70	20.27±0.58	4.68±0.43	132	14.57			
	G4	0	0	0	0	0	0.00			
	Total					906	100.00			
December	G1	0	0	0	0	0	0.00	3.2 - 8.9	2.5 - 9.1	0.00
	G2	0	0	0	0	0	0.00			
	G3	0	0	0	0	0	0.00			
	G4	7	91.64±0.52	61.21±0.98	61.21±0.98	59	100.00			
	Total					59	100.00			
January	G1	0	0	0	0	0	0.00	0.00	6.8 - 11.8	0.00
	G2	0	0	0	0	0	0.00			
	G3	0	0	0	0	0	0.00			
	G4	7	91.64±0.52	61.21±0.98	61.21±0.98	29	100.00			
	Total					29	100.00			
February	G1	0	0.00	0.00	0.00	0	0.00	2.8 - 7.1	4.3 - 11.4	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	7	91.64±0.52	61.21±0.98	61.21±0.98	41	100.00			
	Total					41	100.00			
March	G1	0	0.00	0.00	0.00	0	0.00	2.4 - 8.7	3.6 - 12.3	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	7	91.64±0.52	61.21±0.98	61.21±0.98	49	100.00			
	Total					49	100.00			
April	G1	0	0.00	0.00	0.00	0	0.00	2.8 - 8.2	2 - 11.8	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	7	91.64±0.52	61.21±0.98	61.21±0.98	63	100.00			
	Total					63	100.00			
May	G1	0	0.00	0.00	0.00	0	0.00	2.5 - 9.5	2 - 9.9	0.00

	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	7	91.64±0.52	61.21±0.98	61.21±0.98	162	100.00			
	Total					162	100.00			
June	G1	0	0.00	0.00	0.00	0	0.00	2.4 - 8.4	2.1 - 10.3	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	7	91.64±0.52	61.21±0.98	61.21±0.98	390	100.00			
	Total					390	100.00			

G1; Non-return valve trap locally called *Ige,* G2; Non-return valve trap locally called *Okou,* G3; None return net trap locally called *Deriboflo,* G4; Hand-push net locally called *Aboriye,* ML; Mean length, MW; Mean width, MEH; Mean entrance hole, *Mm*; *Macrobrachium macrobrachion, Mv; Macrobrachium vollenhovenii, Mf; Macrobrachium felicinum*

Table 4 The Gear used and Catch Composition at Otuan

Month	Gear types	Gear numbers	ML	MW	MEH	Catch	Percentage (%)	*Mm*	*Mv*	*Mf*
								Length range (cm)	Length range (cm)	Length range (cm)
JULY	G1	16	38.41±3.82	26.73±2.78	2.53±0.34	329	45.69	2.4 - 10.7	2 - 12.5	0.00
	G2	12	128.79±3.40	19.20±1.48	2.54±0.41	244	33.88			
	G3	6	107.86±1.83	20.01±0.78	4.82±0.36	44	6.10			
	G4	9	91.57±0.67	61.01±0.94	61.01±0.94	103	14.31			
	Total					720	100.00			
August	G1	16	38.41±3.82	26.73±2.78	2.53±0.34	347	44.26	2.6 -9.1	2 - 12.1	0.00
	G2	12	128.79±3.40	19.20±1.48	2.54±0.41	256	32.65			
	G3	6	107.86±1.83	20.01±0.78	4.82±0.36	83	10.59			
	G4	9	91.57±0.67	61.01±0.94	61.01±0.94	98	12.50			
	Total					784	100.00			
September	G1	16	38.41±3.82	26.73±2.78	2.53±0.34	443	58.52	2.4 - 9.9	2.3 - 11.7	0.00
	G2	12	128.79±3.40	19.20±1.48	2.54±0.41	213	28.14			
	G3	6	107.86±1.83	20.01±0.78	4.82±0.36	101	13.34			
	G4	0	0	0	0	0	0.00			
	Total					757	100.00			
October	G1	16	38.41±3.82	26.73±2.78	2.53±0.34	402	55.83	2.7 - 9.5	2.1 - 12.1	0.00
	G2	12	128.79±3.40	19.20±1.48	2.54±0.41	271	37.64			
	G3	6	107.86±1.83	20.01±0.78	4.82±0.36	47	6.53			
	G4	0	0	0	0	0	0.00			
	Total					720	100.00			
November	G1	16	38.41±3.82	26.73±2.78	2.53±0.34	475	60.43	2.4 - 9.3	2.4 - 11.5	2.7 - 7.1
	G2	12	128.79±3.40	19.20±1.48	2.54±0.41	189	24.05			
	G3	6	107.86±1.83	20.01±0.78	4.82±0.36	122	15.52			

	G4	0	0	0	0	0	0.00			
	Total					786	100.00			
December	G1	16	38.41±3.82	26.73±2.78	2.53±0.34	76	100.00	2.5 - 8.6	2.9 - 9.2	0.00
	G2	0	0	0	0	0	0.00			
	G3	0	0	0	0	0	0.00			
	G4	0	0	0	0	0	0.00			
	Total					76	100.00			
January	G1	0	0	0	0	0	0.00	2.4 - 9	4.5 - 10.1	0.00
	G2	0	0	0	0	0	0.00			
	G3	0	0	0	0	0	0.00			
	G4	9	91.57±0.67	61.01±0.94	61.01±0.94	48	100.00			
	Total					48	100.00			
February	G1	0	0.00	0.00	0.00	0	0.00	2.4 - 9.9	3.1 - 12.5	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	9	91.57±0.67	61.01±0.94	61.01±0.94	55	100.00			
	Total					55	100.00			
March	G1	0	0.00	0.00	0.00	0	0.00	2.4 - 10.7	3.1 - 9.2	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	9	91.57±0.67	61.01±0.94	61.01±0.94	102	100.00			
	Total					102	100.00			
April	G1	0	0.00	0.00	0.00	0	0.00	0.00	2.4 - 12.7	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	9	91.57±0.67	61.01±0.94	61.01±0.94	43	100.00			
	Total					43	100.00			
May	G1	0	0.00	0.00	0.00	0	0.00	2.4 - 9.8	3 - 9.6	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	9	91.57±0.67	61.01±0.94	61.01±0.94	101	100.00			
	Total					101	100.00			
June	G1	0	0.00	0.00	0.00	0	0.00	2.5 - 9.5	3 - 11.8	0.00
	G2	0	0.00	0.00	0.00	0	0.00			
	G3	0	0.00	0.00	0.00	0	0.00			
	G4	9	91.57±0.67	61.01±0.94	61.01±0.94	348	100.00			
	Total					348	100.00			

G1; Non-return valve trap locally called *Ige,* G2; Non-return valve trap locally called *Okou,* G3; None return net trap locally called *Deriboflo,* G4; Hand-push net locally called *Aboriye,* ML; Mean length, MW; Mean width, MEH; Mean entrance hole, *Mm; Macrobrachium macrobrachion, Mv; Macrobrachium vollenhovenii, Mf; Macrobrachium felicinum*

4 Discussion

4.1 The gear used and catch composition

The species were caught with four major gears, (G1) Non-return valve trap locally called *Ige,* (G2) Non-return valve trap locally called *Okou*, (G3) None return net trap locally called *Deriboflo* and (G4) Hand-push net locally called *Aboriye* (Table 1 to 4). The result revealed that the gears utilized 'G1' were 14 gears with mean length of 36.75±4.16 cm, mean width of 25.64±2.88 cm and mean entrance hole of 2.6±0.46 cm. 'G2' were 7 gears with mean length of 131.58±6.73 cm, mean width of 19.17±2.15 cm and mean entrance hole of 2.41±0.41 cm. 'G3' were 4 gears with mean length 108.01±1.65 cm, mean width of 20.35±0.03 cm and mean entrance hole of 4.55±0.52 cm. 'G4' were 6 gears with mean length of 91.44±0.00 cm, mean width of 60.96±0.00 cm and mean entrance hole of 60.96±0.00 cm. Catch sizes range from 2.4 to 9.9 cm for *M. macrobrachion,* 2.0 to 12.5 cm for *M. vollenhovenii* and 2.5 to 8.3 cm for *M. felicinum* at Ogoubiri. The number of catches shows that, 151 to 549 for G1, 120 to 352 for G2, 11 to 63 for G3 and 62 to 74 specimens for G4 in the months of July to November. From 0 catch for G1, G2, G3 and 19 to 165 specimens for G4 in the months of December to June at Ogoubiri.

The result from Amassoma showed that the gears utilized 'G1' were 18 gears with mean length of 38.63±3.56 cm, mean width of 26.90±2.56 cm and mean entrance hole of 2.54±0.44 cm. 'G2' were 10 gears with mean length of 130.47±6.65 cm, mean width of 19.30±2.26 cm and mean entrance hole of 2.52±0.42 cm. 'G3' were 6 gears with mean length 107.69±1.93 cm, mean width of 20.35±0.56 cm and mean entrance hole of 4.62±0.49 cm. 'G4' were 9 gears with mean length of 91.56±0.35 cm, mean width of 61.40±0.78 cm and mean entrance hole of 61.40±0.78 cm. Catch sizes range from 2.3 to 9.9 cm for *M. macrobrachion*, 2.2 to 12.4 cm for *M. vollenhovenii* and 2.8 – 8 cm for *M. felicinum.* The number of catches shows that, 95 to 756 for G1, 56 to 487 for G2, 25 to 107 for G3 and 0 to 147 specimens for G4 in the months of July to November. From 0 to 95 for G1, 0 to 56 for G2, 0 to 0 for G3 and 26 to 387 specimens for G4 in the months of December to June.

The result from Toru-Ebeni revealed that the gears utilized 'G1' were 15 gears with mean length of 38.73±3.73 cm, mean width of 26.99±2.67 cm and mean entrance hole of 2.49±0.38 cm. 'G2' were 9 gears with mean length of 127.54±4.06 cm, mean width of 18.39±1.55 cm and mean entrance hole of 2.41±0.41 cm. 'G3' were 8 gears with mean length 107.58±1.70 cm, mean width of 20.27±0.58 cm and mean entrance hole of 4.68±0.43 cm. 'G4' were 7 gears with mean length of 91.64±0.52 cm, mean width of 61.21±0.98 cm and mean entrance hole of 61.21±0.98 cm. Catch sizes range from 2.4 to 9.5 cm for *M. macrobrachion,* 2.0 to 12.8 cm for *M. vollenhovenii* and 2.5 - 8.4 cm for *M. felicinum*. The number of catches shows that, 321 to 528 for G1, 232 to 432 for G2, 50 to 187 for G3 and 0 to 97 specimens for G4 in the months of July to November. From 0 catch for G1, G2, G3 and 29 to 390 specimens for G4 in the months of December to June.

The result from Otuan revealed that the gears utilized 'G1' were 16 gears with mean length of 38.41±3.82 cm, mean width of 26.73±2.78 cm and mean entrance hole of 2.53±0.34 cm. 'G2' were 12 gears with mean length of 128.79±3.40 cm, mean width of 19.20±1.48 cm and mean entrance hole of 2.54±0.41 cm. 'G3' were 6 gears with mean length 107.86±1.83 cm, mean width of 20.01±0.78 cm and mean entrance hole of 4.82±0.36 cm. 'G4' were 9 gears with mean length of 91.57±0.67 cm, mean width of 61.01±0.94 cm and mean entrance hole of 61.01±0.94 cm. Catch sizes range from 2.4 - 10.7 cm for *M. macrobrachion*, 2.4 - 12.7 cm for *M. vollenhovenii* and 2.7 - 7.1 cm for *M. felicinum.* The number of catches shows that, 329 to 475 for G1, 189 to 271 for G2, 44 to 101 for G3 and 0 to 103 specimens for G4 in the months of July to November. From 0 catch for G1, G2, G3 and 48 to 348 specimens for G4 in the months of December to June.

The traps were generally small in size and few. A total of 156 gears, with catch ranging from 0 to 1309. The mean length and width for each gear range from 36.75±4.16 cm and 25.64±2.88 cm to 38.73±3.73 cm and 26.99±2.67 cm for G1, 131.58±6.73 cm and 19.17±2.15 cm to 127.54±4.06 cm and 18.39±1.55 cm for G2, 107.58±1.70 cm and 20.27±0.58 cm to 108.01±1.65 cm and 20.35±0.03 cm for G3 and 91.44±0.00 cm and 60.96±0.00 cm to 91.64±0.52 cm and 61.21±0.98 cm for G4.

The mean entrance hole is the part of the trap by which the shrimp enters the trap. Unlike the nets that have mesh sizes with known regulations of 76mm as stipulated by the Inland Fisheries Act of 1992 in Nigeria which allow for smaller fishes to escape, the entrance hole of all traps utilized at Igbedi Creek which range from 2.41 cm to 61.60 cm can catch sizes from 2 cm juveniles (recruits) to adults without a known regulation. [20], described maximum sizes of *M. vollenhovenii, M. macrobrachion* and *M. felicinum* to be 18.9 cm, 13.8 cm and 8.8 cm and *M. felicinum* reaches maturity at 5 to 8 months. while [13], described three stages of development for *M. macrobrachion,* 1.0 to 3.9 cm as juveniles, 4.0 to 3.9 cm as young adults and 8.0 and above as adults at Ekole Creek. [21], reported size range of 6 *Macrobrachium* species *; M. vollenhovenii M. macrobrachion, M. sollaudii, M. dux, M. chevalieri* and *M. felicinum* to be 4.98 cm to 16.9 cm,

4.3 cm to 15.7 cm, 5.7 cm to 9.2 cm, 3.8 cm to 8.6 cm and 4.3 cm to 6.83 cm at South Region of the Cameroons. These size ranges can be caught successfully by the gear utilized at Igbedi creek.

The entrance hole of the gear by which the shrimp is captured captures 2 cm and above indicating that less than 2 cm in length of shrimps are allowed to escape. This means with species like *M. felicinum* that can reach maturity at 5 to 8months and the fishers setting of traps for a period of 5 months from July to November as was observed in this study, the new recruits especially those bellow 2 cm can be allowed to grow to maturity within a year. This implies that growth overfishing can be averted but recruitment overfishing is inevitable if the fishers continue in the free access conditions and increase their capacity to fish through catch capacity. The number of traps were not regulated nor the time and season of catch in Bayelsa State as the State have no Fisheries Law, therefore fisheries resources are common property resources in the State. Traps are efficient tools to catch shrimps and prawns, but are detrimental for management if the size and number are not regulated. The best management strategy according to the finding of this study therefore, should be regulation of the number of traps to be utilized and the season of catch as the species are in a cyclical state at Igbedi Creek, i.e. the catch varies but are predictable throughout the year. They are more abundant during the flood seasons of July to November when fisher set their traps. The fishers no longer set traps from the month of December to June as these periods the catches are little and of little commercial value therefore hand-push nets are useful in shallow waters covered with grasses for the capture of shrimps in this period for consumption.

5 Conclusion

Igbedi Creek is a water-way with active fishing. The four riparian communities of Ogoubiri, Toru-Ebeni, Amassoma and Otuan sampled in Bayelsa State showed that the gear utilized were efficient for the capture of shrimp species but detrimental if not regulated as recruitment overfishing may be experienced in the water-way if the fishers continue in the open access exploitation and increase their capacity to catch the species. This study therefore recommends that;

- The entrance hole should be designed in such a way that less new recruits and adults would be caught to avert over-fishing.
- With the right gear *Macrobrachium vollenhovenii* and *Macrobrachium macrobrachion* were caught all year round except for *Macrobrachium felicinum* which is captured in the single month of November with few catches therefore the closed season should be encouraged to increase awareness among fishers for shrimp species sustainability.
- Fishers captured *Macrobrachium species* with few gears and when they are abundant during the flood season and such practice should be sustained.

Compliance with ethical standards

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Disclosure of conflict of interest

There was no conflict of interest.

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