ORIGINAL RESEARCH ARTICLE

A checklist on the status of targeted fish species in selected communities of Ondo coastal waters, Nigeria.

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Abstract

The increased human activities resulting from industrialization and urbanization around the Ondo section of the coastal waters of the Atlantic Ocean have significantly affected the environment. To this end, the water quality, fish abundance and target status of fish species were identified, notwithstanding the influence of human activities on the water quality and its effects on fish abundance. Four fishing communities were purposively selected based on geographical location and accessibility along the coast; Ayetoro and Idi-Ogba communities on the eastern side and Eruna-Ero and Igbokoda on the western side. A total of 120 structured questionnaires were randomly administered using snowball technique at 30 per site. Erunna-Ero community measured the highest mean temperature, dissolved oxygen, salinity and conductivity with 29.39 ± 0.30 ^{o}C, 4.48 ± 0.06 mg/L,10.68 ± 0.39 ppt and 40.70 ± 0.18 µS/cm respectively, while pH was highest in Idi-Ogba community (6.47 ± 0.00). A total of 61.67% were within 21-40 age brackets; 69.17% were males, and 75% of the males engaged in fishing activities. Agricultural activities were high (97%) with most wastes emptying into the river (85.83%). A total of 27,622 fish individuals were identified across the fishing communities with Igbokoda having the highest abundance (38.13%) and *Cynoglossus browni* (75.18%) was the highest fish species. In the past, three (3) economically important fish species were of major target but a reduction to two (2) species was observed at the time of study which indicated a reduction in target fish species in Igbokoda community. An increase from three (3) to four (4) target species were observed in Ayetoro, Erunna-Ero, and Idi-ogba communities which indicated an increase in target fish species. The study showed the activities around the coastal water dictated the abundance of fish species and therefore essential to monitor the water quality parameters for the sustainability of fish species in the coastal water.

Keywords: *anthropogenic activities, coastal waters, fish abundance, sustainability water quality*

Introduction

Water is an indispensable resource on earth and all living organisms depending on it for their sustenance. Nigeria has 46,300km^2 maritime area and 125,470.82 km^2 inland waters which accommodate small-scale artisanal fishers estimated at over 6 million contributing 85% to domestic fish consumption in Nigeria (Fish for All Summit, 2005). Fish is a cheap source of protein (FAO, 1999) and its diversity has decreased over the years as a result of various factors such as overfishing, unregulated mesh sizes, climatic actions, and pollution (Ipinmoroti, 2013). In recent time, industrialization and rapid urbanization has affected fish species in Ondo coastal waters. It has the longest coastline in Nigeria (78 km) and accommodates diverse finfish and

shellfish species which contribute greatly to food and protein supply. The coastal environment like all others is exposed to various pressures from agricultural activities, construction, and oil exploration which results to pollution of the surrounding water bodies. Emmanuel (2012) reported that pollution can influence the abundance and choice of target fish species in a fishing community. There have been several reports on the anthropogenic activities and water quality in Ondo coastal area (Ipinmoroti *et al.,* 2018a; Adebowale *et al.,* 2008; Atobatele *et al.,* 2005) and the reports did not link the effect of the anthropogenic activities on the aquatic resources over time. As human population increases, the pressure by human activities on the natural resources also increases. Based on this, it is expected that the increase in population around the coastal area would impact on the type and number of fish species that form the target fishing groups in the study area. This study therefore investigates the present anthropogenic activities and their influence t on the fish species presently targeted in the coastal water as an important tool for necessary management procedures towards sustainability.

Materials and Methods

Study area

Ondo coastal waters lie within Latitude 5^{o} $5^{0'}$ N – 6^{o} 09' N and Longitude 4^{o} 45' E – 5^{o} 05 'E in Ilaje Local Government Area which is located in the Southern part of Ondo state (Figure 1). This area has the longest coastline in Nigeria with about 78 km and the inhabitants majorly engaged in fishing activities (Ipinmoroti *et al*, 2018a). The area consists of over 80 fishing communities with diverse fishing activities which contributes significantly to fish production in the state (Adebowale *et al*, 2008). The coastline has falls within the prospective oil producing areas referred to as the Niger-Delta regions and diverse wastes from land discharges into the ocean through this estuary (Olu-Owolabi *et al.,* 2013). Several trading and fishing activities are done around the coastline and these are the principal activities; and, transportation of goods and services was via motorboat which indirectly pollute the waterway. The fishing communities were purposively grouped into two based on geographical location (East and West). Two fishing communities were purposively selected from each of the locations for sampling based on accessibility and logistic characteristics. The communities selected are Igbokoda and Erunna-Ero on the western side and Ayetoro and Idi-Ogba on the eastern side. From each selected community, structured questionnaire were administered and personal interviews were conducted. Fish and water samples were collected monthly for a period of six months (January – June 2016).

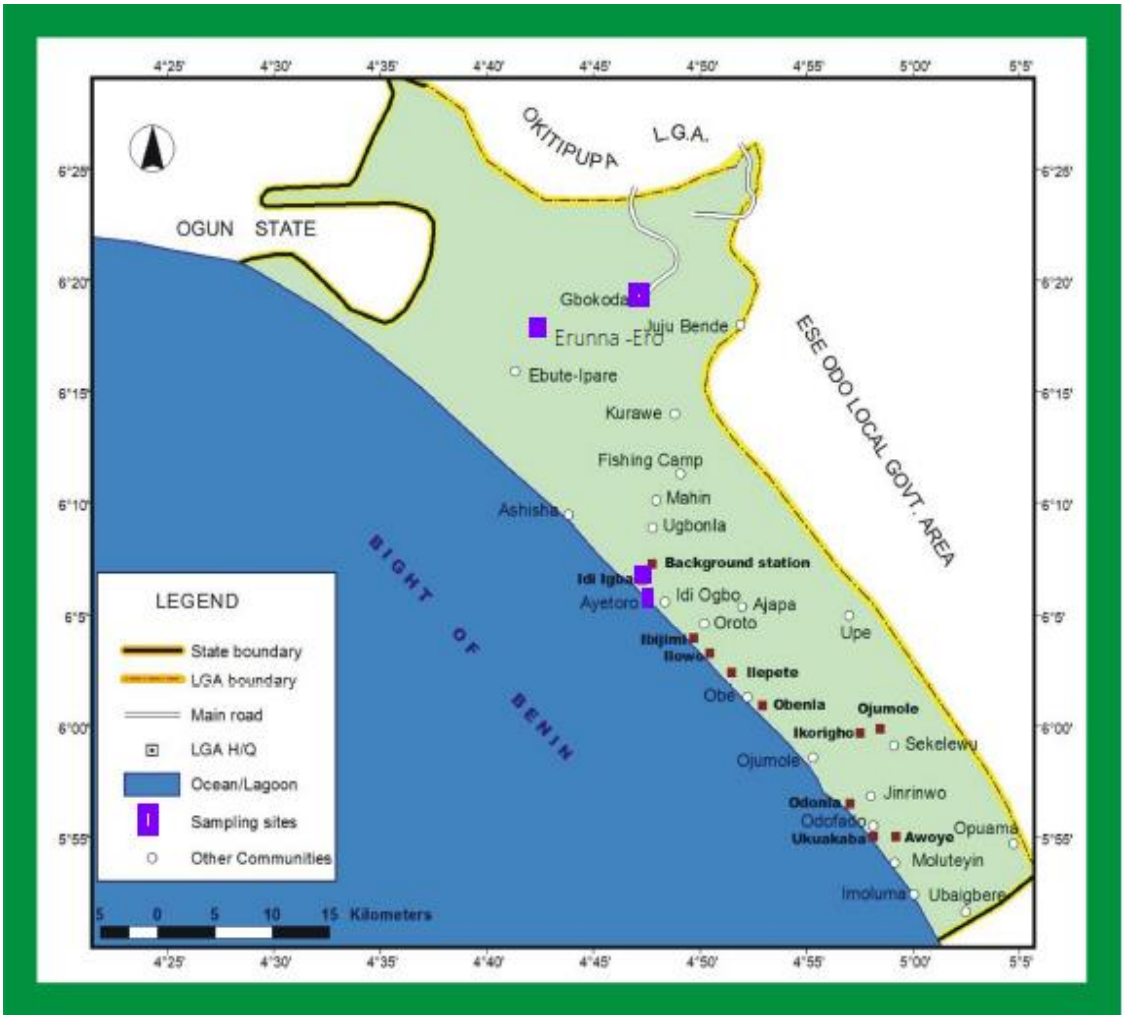

Figure 1: Map of the study area.

Source: Adapted from Olu-Owolabi *et al.*, (2013)

Water Quality analysis

Surface water samples collected fortnightly between the hours of 7.00am and 9.00am from the four sampling communities for a period of six months (January – June 2016). The samples were measured *in situ* for temperature, Dissolved Oxygen (DO), pH, conductivity and salinity.

Temperature and conductivity

These measurements were taken *in situ* using an hand-held Hanna Meter (Model HI98129) manufactured by Hanna Instruments, USA. It was determined by inserting the probe into the water body below the 1m depth and values for each parameter (temperature or conductivity) were taken by switching the mode on the meter. The measurement of each parameter was taken after at least five minutes of probe insertion and readings were taken after the meter values was steady and recorded in degrees Celsius (^{o}C) and parts per thousand (ppt) for temperature and conductivity respectively.

pH, salinity and DO

They were measured using a hand-held Hanna multi-parameter kit (Model HI9828) manufactured by Hanna Instruments, USA. The measurement of each parameter was taken by inserting the probe of meter into the water below the 1m depth and values for each parameter were taken by switching the mode on the meter to the appropriate parameter. The measurement of each parameter was taken

after at least five minutes of probe insertion and readings were taken after the meter values was steady and recorded in µS/cm and mg/L for conductivity and DO respectively.

Questionnaire administration

A total of 120 structured questionnaire at 30 per community were purposively administered using snowballing technique. The questionnaire was structured with both open questions which allowed respondents to express their opinions and close-ended questions. The questionnaire enquired from the fishermen about their demographic characteristics, anthropogenic activities and waste disposal systems, fishing practices, fish diversity, and targeted fish species. Personal interviews were conducted with the fishermen and some questions were interpreted into the local dialect with the assistance of a native interpreter for better understanding. This process was used to derive further information about their fishing activities and fish diversity.

Fish identification

Fish was sampled for six months (January –June, 2016) from the fishermen's landings and their abundance was recorded. Species were identified by their local and scientific names using the combined monographs by Olaosebikan and Raji (2013) and Froese and Pauly (2019).

Targeted Fish Species

From the questionnaire administered, the following information were derived about the status of fish targeted and were based on the following tags:

- TVO (Target Very Often) - describes fish species that are mostly purposively caught every fishing time. These fish species usually almost dominate the entire catch by the fisherman
- OT (Often Targeted) - describe fish species that are often purposively caught at every fishing period. These fish species usually form part of the entire catch.
- RT (Rarely Targeted) – describes fish species that are rarely purposively caught during the fishing time. These fish species may form very little part of the entire fish catch
- NT (Not Targeted) – describes fish species that are not intentionally caught during the fishing time.

Statistical analysis

The mean data on water quality from the sampling communities were separated using the Analysis of Variance (ANOVA) statistical tool and Descriptive statistics such as frequencies and percentages using Statistical Package for Social Sciences (SPSS) 23.0 while Microsoft Excel 2017 was used for graphical illustrations.

Results

Water quality parameters

The mean monthly water quality parameters measured from the sampling communities are presented in Tables 1 - 4. In Igbokoda community (Table 1), the mean temperature measured was 29.26 ± 0.32 ^{o}C with the highest in March (29.80 ± 0.01 °C) and least in May (28.95 ± 0.16 °C). The highest mean pH was measured in June (6.50 ± 0.01) and the least in January and March (6.10 ± 0.11) with an overall mean of 6.25 ± 0.13. DO was highest in May (3.50 ± 0.00 mg/L) and least in January and April with 3.10 ± 0.02mg/L respectively and an overall mean of 3.21 ± 0.04 mg/L. Salinity was highest in April (0.98 ± 0.01 ppt) and least in February (0.42 ± 0.00 ppt) and an overall mean of 0.68 ± 0.08 ppt was measured across the months. Conductivity was highest in April (13.21

± 0.11 µS/cm) and least in February (10.11 ± 0.02 µS/cm) and an overall mean of 11.77 ± 0.11 µS/cm was measured.

Table 1: The mean monthly values measured from Igbokoda fishing community

Months/ Parameters	Temperature (°C)	pH	DO (mg/L)	Salinity (ppt)	Conductivity (µS/cm)
January	29.10 ± 0.11 [a]	6.10 ± 0.11[a]	3.10 ± 0.02[a]	0.71 ± 0.02[a]	12.80 ± 0.05[a]
February	29.30 ± 0.18 [a]	6.30 ± 0.00[a]	3.30 ± 0.18[a]	0.42 ± 0.00[a]	10.11 ± 0.02[a]
March	29.80 ± 0.01 [a]	6.10 ± 0.11[a]	3.20 ± 0.00[a]	0.54 ± 0.02[a]	11.11 ± 0.22[a]
April	29.21± 0.12 [a]	6.30 ± 0.18[a]	3.10 ± 0.02[a]	0.98 ± 0.01[a]	13.21 ± 0.11[a]
May	28.95± 0.16 [a]	6.20 ± 0.12[a]	3.50 ± 0.00[a]	0.63 ± 0.00[a]	12.23 ± 0.01[a]
June	29.21 ± 0.00 [a]	6.50 ± 0.01[a]	3.10 ± 0.13[a]	0.81 ± 0.02[a]	11.18 ± 0.02[a]
Mean	29.26 ± 0.32	6.25 ± 0.13	3.21 ± 0.04	0.68 ± 0.08	11.77 ± 0.11

Values with the same superscript within the same column are not significantly different (P>0.05)

In Erunna-Ero community (Table 2), the mean temperature measured was 29.39 ± 0.30 °C with the highest in February (30.10 ± 0.11 °C) and the least in June (28.11 ± 0.00 °C). The highest mean pH was measured in April (6.42 ± 0.31) and the least in February (6.11 ± 0.01) with an overall mean of 6.29 ± 0.76. DO was highest in January (4.60 ± 0.03 mg/L) least in February and April with 4.40 ± 0.02 mg/L and 4.40 ± 0.01 mg/L respectively and an overall mean of 4.48 ± 0.06 mg/L. Salinity was highest in May (11.90 ± 0.11 ppt) and least in February (9.10 ± 0.02 ppt) and an overall mean of 10.68 ± 0.39 ppt was measured across the months. Conductivity was highest in May (41.20 ± 0.00 µS/cm) and least in April (40.50 ± 0.01 µS/cm) and an overall mean of 40.70 ± 0.11 µS/cm was measured.

Table 2: The mean monthly values measured from Erunna-Ero fishing community

Months/ Parameters	Temperature (°C)	pH	DO (mg/L)	Salinity (ppt)	Conductivity (µS/cm)
January	29.01 ± 0.02[a]	6.21 ± 0.00[a]	4.60 ± 0.03[a]	11.10 ± 0.11[b]	41.10 ± 0.00[a]
February	30.10 ± 0.11[a]	6.11 ± 0.01[a]	4.40 ± 0.02[a]	9.10 ± 0.02[a]	40.10 ± 0.02[a]
March	29.91 ± 0.01[a]	6.31 ± 0.03	4.50 ± 0.00[a]	9.90 ± 0.01[a]	41.10 ± 0.04[a]
April	29.21 ± 0.04[a]	6.42 ± 0.31[a]	4.40 ± 0.01[a]	10.60 ± 0.00[b]	40.50 ± 0.01[a]
May	30.02 ± 0.02[a]	6.40 ± 0.01[a]	4.50 ± 0.20[a]	11.90 ± 0.02[b]	41.20 ± 0.00[a]
June	28.11 ± 0.00[a]	6.30 ± 0.03[a]	4.50 ± 0.00[a]	11.50 ± 0.03[b]	40.20 ± 0.00[a]
Mean	29.39 ± 0.30 [a]	6.29 ± 0.76 [a]	4.48 ± 0.06	10.68 ± 0.39	40.70 ± 0.18

Values with the same superscript within the same column are not significantly different (P>0.05)

In Ayetoro community (Table 3), the overall mean temperature measured was 29.20 ± 0.31 °C with the highest in February (29.30 ± 0.00 °C) and the least in April (29.00 ± 0.20 °C). The highest mean pH was measured in April (6.40 ± 0.10) and the least in (6.10 ± 0.00) with an overall mean of 6.25 ± 0.23. DO was highest in March (4.30 ± 0.00 mg/L) and least in June (3.95 ± 0.20mg/L) and an overall mean of 4.11 ± 0.06 mg/L. Salinity was highest in May (10.90 ± 0.11 ppt) and least in March (10.00 ± 0.21 ppt) and an overall mean of 10.35 ± 0.38 ppt was measured across the months. Mean values of salinity in January, March and April were significantly different (P<0.05) from other months during the study period. Conductivity was highest in March (41.40 ± 0.05 µS/cm) and least in January, February and June with 40.20 ± 0.06 µS/cm, 40.20 ± 0.02 µS/cm 40.20 ± 0106 µS/cm respectively. An overall mean of 40.52 ± 0.11 µS/cm was measured across the months.

Table 3: The mean monthly values measured from Ayetoro fishing community

Months	Temperature (ºC)	pH	DO (mg/L)	Salinity (ppt)	Conductivity (µS/cm)
January	29.20 ± 0.01[a]	6.20 ± 0.02[a]	4.10 ± 0.04[a]	10.20 ± 0.21[a]	40.20 ± 0.06[a]
February	29.40 ± 0.00[a]	6.30 ± 0.03[a]	4.10 ± 0.00[a]	10.30 ± 0.31[b]	40.20 ± 0.02[a]
March	29.10 ± 0.40[a]	6.10 ± 0.00[a]	4.30 ± 0.10[a]	10.00 ± 0.21[a]	41.40 ± 0.00[a]
April	29.00 ± 0.20[a]	6.40 ± 0.10[a]	4.00 ± 0.03[a]	10.10 ± 0.01[a]	40.10 ± 0.04[a]
May	29.30 ± 0.40[a]	6.30 ± 0.05[a]	4.20 ± 0.02[a]	10.90 ± 0.11[b]	41.00 ± 0.21[a]
June	29.20 ± 0.00[a]	6.20 ± 0.06[a]	3.95± 0.20[a]	10.60 ± 0.28[b]	40.20 ± 0.10[a]
Mean	29.20 ± 0.31	6.25 ± 0.23	4.11 ± 0.06	10.35 ± 0.38	40.52 ± 0.51

Values with the same superscript within the same column are not significantly different (P>0.05)

In Idi-Ogba community (Table 4), the overall mean temperature measured was 29.11 ± 0.33 ºC with the highest in March (29.60 ± 0.01 °C) and the least in April (28.90 ± 0.06 °C). The highest mean pH was measured in March (6.80 ± 0.04) and the least in January and April with 6.20 ± 0.02 respectively with an overall mean of 6.47 ± 0.00. DO was highest in January and June with 4.60 ± 0.01 mg/L) and least in April (4.00 ± 0.01 mg/L) and an overall mean of 4.30 ± 0.04 mg/L. Salinity was highest in January, April and June with 10.40 ± 0.21 ppt, 10.40 ± 0.32 ppt and 10.40 ± 0.02 ppt respectively. The mean values in February and March were significantly different (P<0.05) from other months. Conductivity was highest in May (41.11 ± 0.00 µS/cm) and least in January (40.00 ± 0.11 µS/cm) with overall mean value of 40.57 ± 0.26 µS/cm.

Table 4: The mean monthly values measured from Idi-Ogba fishing community

	Temperature (ºC)	pH	DO (mg/L)	Salinity (ppt)	Conductivity (µS/cm)
January	29.10 ± 0.02[a]	6.20 ± 0.02[a]	4.60 ± 0.01[a]	10.40 ± 0.21[b]	40.00 ± 0.11[a]
February	29.10 ± 0.21[a]	6.60 ± 0.03[a]	4.20 ± 0.02[a]	10.30 ± 0.01[a]	41.10 ± 0.12 [a]
March	29.60 ± 0.01[a]	6.80 ± 0.04[a]	4.30 ± 0.00[a]	10.00 ± 0.11[a]	40.98 ± 0.11[a]
April	28.90 ± 0.06[a]	6.20 ± 0.01[a]	4.00 ± 0.01[a]	10.40 ± 0.32[b]	40.12 ± 0.01[a]
May	28.95 ± 0.04[a]	6.60 ± 0.02[a]	4.20 ± 0.03[a]	10.10 ± 0.01[b]	41.11 ± 0.00[a]
June	29.00 ± 0.00[a]	6.40 ± 0.10[a]	4.60 ± 0.01[a]	10.40 ± 0.02[b]	40.10 ± 0.02[a]
Mean	29.11 ± 0.33	6.47 ± 0.00	4.3 ± 0.01	10.26 ± 0.36	40.57 ± 0.26

Values with the same superscript within the same column are not significantly different (P>0.05)

Demographic and Anthropogenic Characteristics of Fishers

The demographic characteristics and activities of the fishermen in the fishing communities are presented on Table 5. In terms of age, 61.67% of the total respondents were within between 21-40 years while the 17.23% were less than 20 years of age. The population was male-dominated (69.17%) while females were 30.83%. Most of the males (79%) were engaged in fishing activities while most females (89%) were involved in processing activities. As total of 81.67% of males were engaged in mechanic activities, 97% of males were engaged in agricultural activities as secondary sources of income. Only 31% use the designated waste area for their refuse, 69% dumped their wastes indiscriminately.

Table 5: Demographic and activities of respondents in the fishing communities.

Parameter	Range	Mean
Age	< 20 years	17.23%
	21 – 40 years	61.67%
	41 – 60 years	21.10%
Sex	Male	69.17%
	Female	30.83%
Fishing activities	Males	79%
	Females	21%
Processing activities	Males	11%
	Females	89%
Mechanic activities	Males	81.67%
	Females	18.33%
Agricultural activities	Males	97%
	Females	3%
Crop production	Males	85.3%
	Females	14.7%
Waste Disposal	Indiscriminately	69%
	Refuse dumps	31%

Fish species

The mean fortnight relative abundance of fish species identified in the four fishing communities are presented in Table 6. A total of 10,532 individuals belonging to 33 species were identified with *Cynoglossus browni* the most abundant (78.34%) and the least was *Drepane africana* (0.03%) in Igbokoda community. At Ayetoro community, a total of 4783 individuals belonging to 33 species were identified with *Cynoglossus browni* the most abundant (67.28%) and *Polycentropsis abbreviate* 0.02% as the least. At Idi-Ogba community, 5629 individuals belonging to 32 species were identified, *Cynoglossus browni* the most abundant (73.21%) and the least was *Synodontis melanopteron* (0.02%). While at Erunna -Ero community, a total of 6678 individuals belonging to 30 species were identified, *Cynoglossus browni* was the most abundant (77.60%) and *Ophisternon afrum* was the least (0.01%). *Cynoglossus browni*, a carnivorous species generally accounted for 75% of the numerical abundance of the total fish species sampled. Across the months, at Igbokoda and Ayetoro the highest occurrences were in the month of April (12.64% and 13% respectively) and the least were in October (5.99%, 4.56% respectively). While at Idi-Agba and Eunna-Ero the highest were in the month of March (11.72% and 13.33%) and the least were similarly October (4.85% and 4.37%).

Table 6: Relative abundance of fish species identified in the fishing communities

	Species/months	Igbokoda	Ayetoro	Idi-Ogba	Erunna Ero	Total	Total (%)
1	*Arius gigas*	29	19	21	20	89	0.32
2	*Barbus stigmatopygus*	3	1	2	2	8	0.03
3	*Caranax hippos*	239	198	212	232	881	3.19
4	*Carcharihnus leucas*	2	3	5	2	12	0.04
5	*Clarias gariepinus*	129	101	99	123	452	1.64
6	*Coptodon gunieensis*	36	30	57	16	139	0.50
7	*Cynoglossus browni*	8249	3218	4121	5182	20770	75.19
8	*Drepane Africana*	3	10	7	8	28	0.10
9	*Ethmalosa frimbriata*	158	175	191	150	674	2.44
10	*Gnathonemus petersii*	7	2	5	4	18	0.07
11	*Gymnarchus niloticus*	99	68	61	76	304	1.10
12	*Hydrocynus forskahli*	6	1	5	0	12	0.04
13	*Ilisha Africana*	321	91	141	203	756	2.74
14	*Malapterurus electricus*	8	3	0	2	13	0.05
15	*Monodactylus sebea*	17	9	11	0	37	0.13
16	*Mormyrus rume rume*	79	71	43	52	245	0.89
17	*Ophisternon afrum*	8	2	4	1	15	0.05
18	*Ophisurus serpens*	13	21	18	12	64	0.23
19	*Oreochromis niloticus*	29	21	46	19	115	0.42
20	*Papynocranus afer*	8	12	4	0	24	0.09
21	*Parachanna obscura*	9	6	5	4	24	0.09
22	*Parauchenoglanis fasciatus*	51	25	39	27	142	0.51
23	*Pentanemus quinquarius*	123	83	92	105	403	1.46
24	*Polycentropsis abbreviate*	5	1	3	4	13	0.05
25	*Polydactylus quadrifilis*	28	51	28	60	167	0.60
26	*Pseudotolithus elongates*	657	410	287	270	1624	5.88
27	*Sarotherodon galileaus*	51	35	21	41	148	0.54
28	*Schilbe uranoscopus*	4	36	2	0	42	0.15
29	*Selene dorsalis*	78	6	28	25	137	0.50
30	*Synodontis melanopteron*	9	53	1	6	69	0.25
31	*Tilapia marie*	35	11	59	22	127	0.46
32	*Xenimystus nigri*	32	10	9	5	56	0.20
33	*Zanobatus atlanticus*	7	4783	2	5	14	0.05
	Total	10,532	4783	5629	6678	27622	
	Total (%)	38.13	17.32	20.38	24.18		

Fish species targeted in the past and present in Igbokoda community

The targeted fish species based on the responses in the Igbokoda fishing community in the past and present is presented in Tables 7 and 8. A total of nine (9) fish species: *Coptodon spp, Clarias gariepinus, Heterotis niloticus, Gymnarchus niloticus, Parachanna obscura, Gnathonemus petersii, Malapterurus electricus, Xenomystus nigri, and Hydrocynus forskahlii* were targeted at different levels in this community. *C. gariepinus, H. niloticus, and G. niloticus* had the highest percentage of fishers that Targeted them Very Often (TVO) in the past (100%) while *C. gariepinus*

and H. niloticus had the highest TVO fish species at the time of the study (100%) (Figure 2). *G. petersii* and *M. elecricus* had the highest target percentage of fish species Often Targeted (OT) in the past (56.67%) and present (93.33%) respectively (Figure 3). *X. nigri* and *G. petersii* were Rarely Targeted (RT - 33.33%) in the past and present (RT-53.33%) respectively (Figure 4). All the species enjoy one level of target or the other (Figure 4 and 5).

Table 7: Relative abundance of fish species targeted in the past by Igbokoda fishermen.

Fish species	TVO		OT		RT		NT	
	Number	%	Number	%	Number	%	Number	%
Coptodon spp.	19	63.33	8	26.67	3	10	nil	-nil
Clarias spp.	30	100	nil	nil	Nil	nil	nil	nil
H. niloticus	30	100	nil	nil	Nil	nil	nil	nil
G. niloticus	30	100	nil	nil	Nil	nil	nil	nil
P. obscura	23	76.67	5	16.67	2	6.67	nil	nil
G. petersii	10	33.33	17	56.67	3	10	nil	nil
M. electricus	11	36.67	13	43.33	6	20	nil	nil
X. nigri	7	23.33	13	43.33	10	33.33	nil	nil
H. forskahlii	10	33.33	14	46.67	6	20	nil	nil

Key: TVO- target very often; OT- often targeted; RT- rarely targeted; NT- not targeted; %- Relative abundance; Number- across the roles total adds up to 30 respondents.

Table 8: Relative abundance of fish species presently targeted by Igbokoda fishermen.

Fish species	TVO		OT		RT		NT	
	Number	%	Number	%	Number	%	Number	%
Coptodon spp	26	86.67	2	6.67	Nil	nil	2	6.67
Clarias spp.	30	100	Nil	nil	Nil	nil	nil	Nil
H. niloticus	30	100	Nil	nil	Nil	nil	nil	Nil
G. niloticus	29	96.67	1	3.33	Nil	nil	nil	Nil
P. obscura	2	6.67	23	76.67	5	16.67	nil	Nil
G. petersii	1	3.33	13	43.33	16	53.33	nil	Nil
M. electricus	1	3.33	28	93.33	1	3.33	nil	Nil
X. nigri	3	10	13	43.33	14	46.67	nil	Nil
H. forskahlii	4	13.33	24	80	2	6.67	nil	Nil

Key: TVO- target very often; TO- often targeted; RT- rarely targeted; NT- not targeted; %- Relative abundance; Number- across the roles total adds up to 30 respondents.

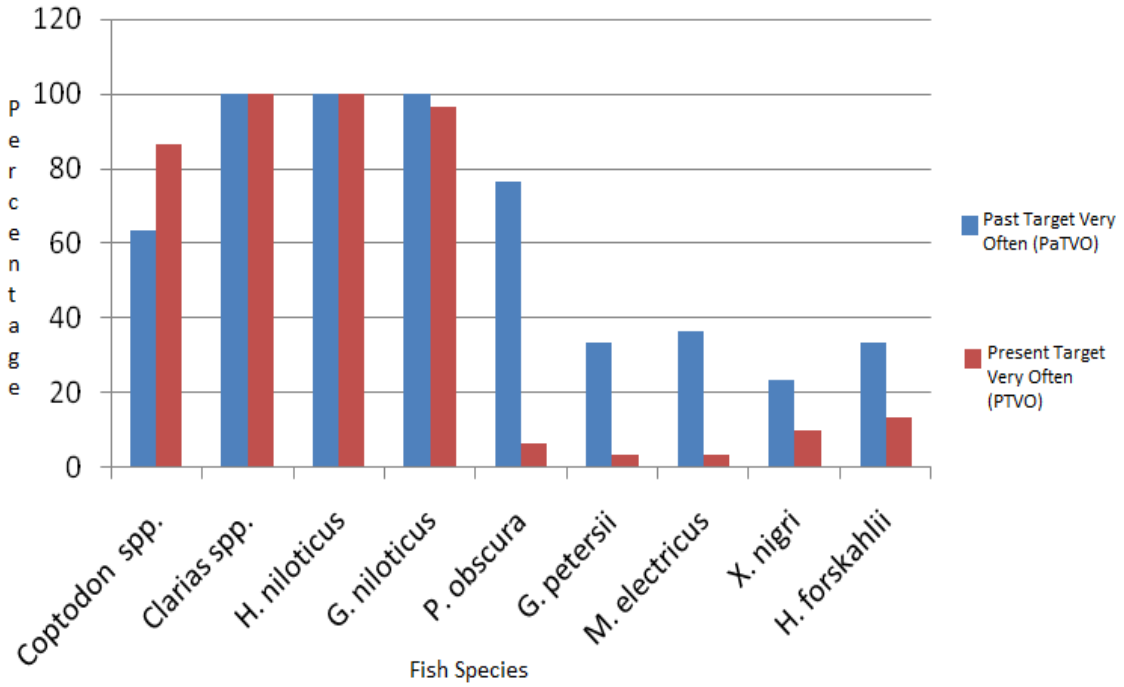

Figure 2: Fish species TVO in the past and present by Igbokoda fishermen

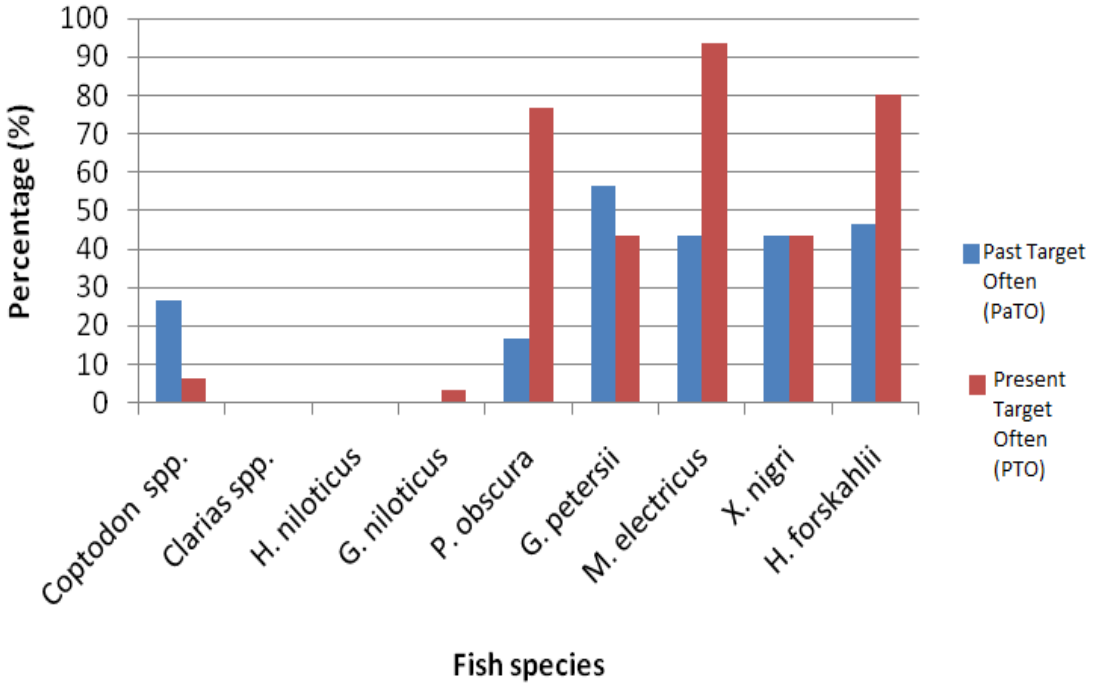

Figure 3: Fish species OT in the past and present by Igbokoda fishermen

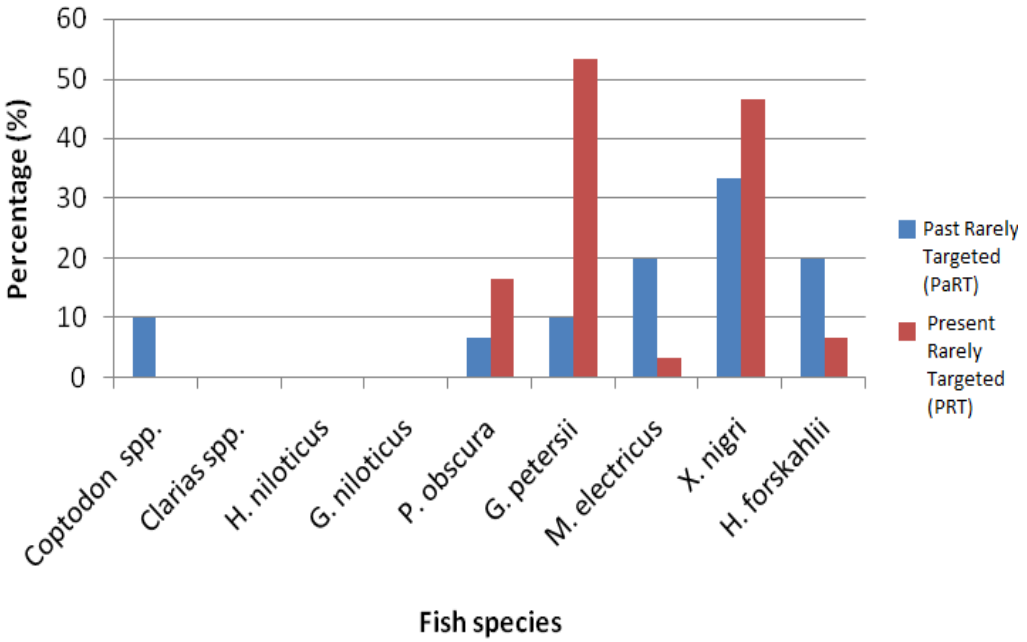

Figure 4: Fish species RT in the past and present by Igbokoda fishermen

Fish species targeted in the past and present in Ayetoro, Erunna-Ero and Idi-Ogba communities

The relative abundance of fish species targeted in the past and present in Ayetoro, Erunna-Ero, and Idi-Ogba fishing communities are presented in Tables 9 and 10. A total of nine (9) fish species, *Liza falcipinnis, Ethmalosa fimbriata, Pseudotolithus elongatus, Dalophis cephalopeltis, Illisa africana, Eleotris senegalensis, Sole sole, Carcharodon* carcharias, and *Carlarius* heudelotii. *I. africana, S. sole,* and *C. heudeloti* had the highest percentage of fish species TVO in the past (100%) while *E. fimbriata, P. elongates, I. africana and S. sole* were the highest occurring fish species TVO in the present (100%) (Figure 5). *L. falcipinnis* had the highest percentage of fish species OT in the past (62.22%) while *D. cephalopeltis* was OT in the present (58.89%) (Figure 6). There was no response for fish species RT and NT in the past and present in these communities.

Table 9: Relative abundance of fish species targeted in the past by Ayetoro, Eruna-Ero, and Idiogba fishermen.

Fish species	TVO		OT		RT		NT	
	Number	%	Number	%	Number	%	Number	%
L. falcipinnis	34	37.78	56	62.22	nil	nil	nil	Nil
E. fimbriata	88	97.78	2	2.22	nil	nil	nil	Nil
P. elongates	88	97.78	2	2.22	nil	nil	nil	Nil
D. cephalopeltis	40	44.44	50	55.56	nil	nil	nil	Nil
E. selengalensis	39	43.33	51	56.67	nil	nil	nil	Nil
I. Africana	90	100	Nil	nil	nil	nil	nil	Nil
S. sole	90	100	Nil	nil	nil	nil	nil	Nil
C. heudeloti	90	100	Nil	nil	nil	nil	nil	Nil
C. carcharias	42	46.67	48	53.33	nil	nil	nil	Nil

Key: TVO- target very often; OT- often targeted; RT- rarely targeted; NT- not targeted; %- Relative abundance; Number- across the roles total adds up to 90 respondents.

Table 10: Relative abundance of fish species presently targeted by Ayetoro, Eruna-Ero, and Idiogba fishermen

Fish species	TVO		OT		RT		NT	
	Number	%	Number	%	Number	%	Number	%
L. falcipinnis	42	46.67	48	53.33	Nil	Nil	nil	nil
E. fimbriata	90	100	Nil	nil	Nil	Nil	nil	nil
P. elongates	90	100	Nil	nil	Nil	Nil	nil	nil
D. cephalopeltis	37	41.11	53	58.89	Nil	Nil	nil	nil
E. selengalensis	41	45.56	49	54.44	Nil	Nil	nil	nil
I. Africana	90	100	Nil	nil	Nil	Nil	nil	nil
S. sole	90	100	Nil	nil	Nil	Nil	nil	nil
C. heudeloti	82	91.11	8	8.89	Nil	Nil	nil	nil
C. carcharias	45	50	45	50	Nil	Nil	nil	nil

Key: TVO- target very often; TO- often targeted, RT- rarely targeted; NT- not targeted; %- Relative abundance; Number- across the roles total adds up to 90 respondents.

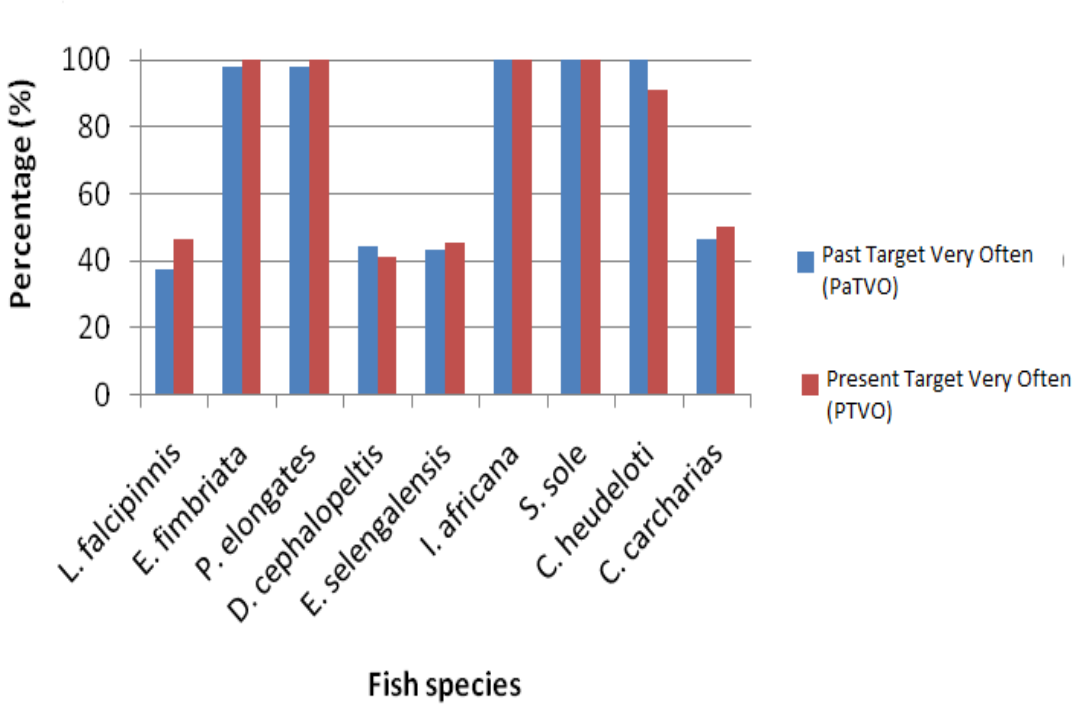

Figure 5: Fish species TVO in the past and present by Ayetoro, Erunna-Ero, and Idi-Ogba fishermen

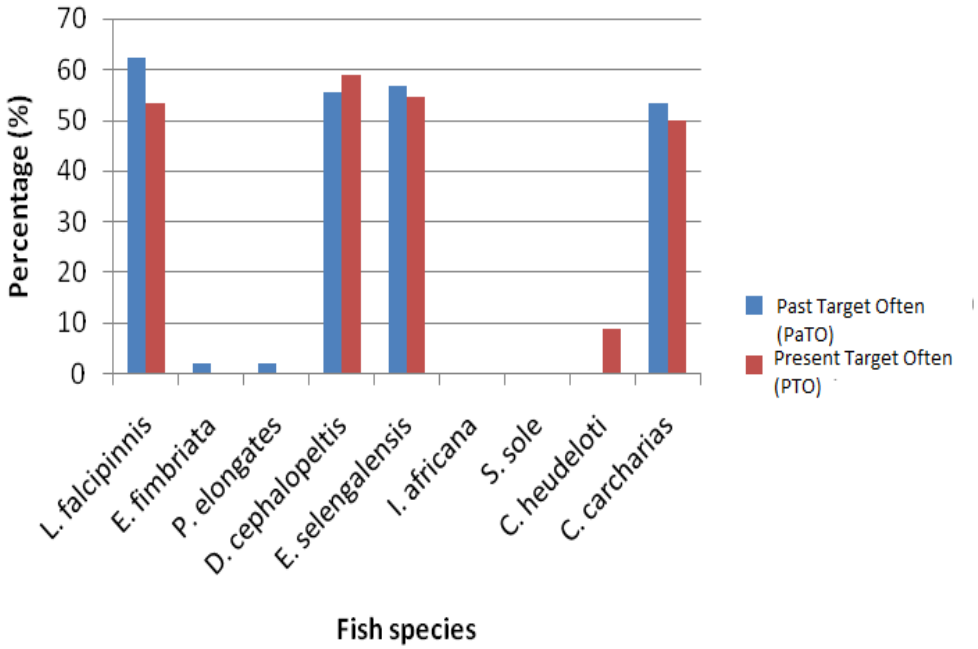

Figure 6: Fish species OT in the past and present by Ayetoro, Erunna-Ero, and Idi-Ogba fishermen

Discussion

Water Quality Parameters

The mean temperature (29.15 ± 0.29 °C) measured from the fishing communities were within the recommended range of 25 - 32°C as stated by Viveen *et al.,* (1985). Most of the mean pH values and the overall mean value measured across the communities were below the recommended range of 6.5 to 8.5 which implied that the water was acidic in nature and may be a function of the agricultural and industrial activities peculiar to these communities. Igbokoda and Ayetoro communities had the least concentration of pH and can be attributed to the mining and explorative activities which releases chemicals to the environment (Bolarinwa *et al.*, 2015). Fish processing activities and craft mending jetties were also observed to be on the rampant in these areas (Olu-Owolabi *et al.*, 2013). The mean concentration of DO was observed to be above the recommended level of 4 mg/L as reported by Boyd (2010) except for the mean values in Igbokoda community which was below the recommended level. The nature of wastes discharged which resulted to the acidic nature of water inhibited the dissolved oxygen concentration which resulted to a reduction below the recommended level in Igbokoda community. Dissolved oxygen is very crucial in aquatic systems and when concentration is beyond an organism's threshold, their abundance and biodiversity is affected (Makori *et al.*, 2017). Therefore, the increased nature of wastes in Igbokoda community as a result of the rapid industrialization and urbanization (Adebowale *et al.*, 2008) poses a serious threat to aquatic resources (Emmanuel, 2012). The water in Igbokoda community during the study period was observed to be fresh water as measured in the salinity level of 0.68 ± 0.08 ppt. Boyd (2010) stated a mean salinity level of < 1 as fresh water, between 1 – 34 ppt as brackish and above 34 as marine waters. Based on this description, it can be said that the waters in Igbokoda were fresh water and the other three communities were brackish water regions during the period of study. These salinity levels dictated the conductivity of these waters and this ability was low in Igbokoda (11.77 ± 0.11 µS/cm) when compared with Ayetoro (40.52 ± 0.51 µS/cm), Erunna-Ero (40.70 ± 0.18 µS/cm) and Idi-Ogba (40.57 ± 0.26 µS/cm) communities. These salinity and conductivity levels can also be dictated by tidal flows from the marine and freshwater environments (Adebowale *et al.*, 2008). Generally, the variations in water quality parameters were observed among the fishing communities which could be a result of factors such as climatic factors,

tidal activities, anthropogenic activities and the secondary use of water (Ipinmoroti *et al.,* 2018b, Olaoye *et al.,* 2013, Ipinmoroti, 2013).

Demographic characteristics of respondents

It was observed from these results that the four fishing communities were male-dominated and the most populous age range was 21 – 40 (61.67%). This result was corroborated by findings of Ipinmoroti *et al.,* (2018a), Nwabeze *et al.,* (2013), and Olaoye *et al.,* (2012) who reported the dominance of an active population force of young men in active fishing activities on the coastal waters of Ondo state while the females were into fish processing. It was observed that activities such as agriculture (97%), crop production (85.3%), mechanic activities (81.67%) which were male dominated disposed their wastes indiscriminately (69%) and end up directly or indirectly into the water, having a significant negative impact on the water quality (Emmanuel, 2012). Urbanization and industrialization also contributed to refuse and wastes generated in these communities, some of which are dumped uphill which eventually run off into the aquatic system when torrential rain occurs (Olaoye and Adedeji, 2005). Generally, a larger percentage of inhabitants (69%) dump the wastes from their various anthropogenic activities in locations where they find their way into the water system either directly or indirectly.

Fish species

The fishing communities were observed to have diverse fish species and targeted fish species by fishermen in the Igbokoda community were entirely different from those targeted by fishermen in Ayetoro, Erunna-Ero and Idi-Ogba fishing communities. The possible reasons may be the salinity level in which Igbokoda waters are more of fresh water and the other three communities' marine waters with salinity levels over 35ppt. The fish species abundance was highest in Igbokoda community (10,530 individuals) and this was expected because the area was larger than other commuities'. At the time of study, only two (2) fish species namely *C. gariepinus* and *H. niloticus* were presently TVO when compared with the three (3) fish species namely *C. gariepinus*, *H. niloticus* and *G. niloticus* which were TVO in the past at Igbokoda fishing community with a slight reduction in the target of *G. niloticus* when compared with the past. This may be linked with the reduction in the level of abundance of these target fish species which has also reduced drastically (Table 7). Igbokoda community is a large fishing community that is faced with rapid urbanization and the advance of oil exploration in the area has impacted the community (Akegbejo, 2005). These indicators could be the cause of a drastic reduction in the very frequent target of other fish species in the present when compared with the target in the past (Adebowale *et al.,* 2008).

The reverse was the case at Erunna-Ero, Idi-Ogba, and Ayetoro fishing communities which are smaller in population size when compared to the Igbokoda community. The targeted species increased from three (3) in the past namely *I. africana, S. sole*, and *C. heudeloti* to four (4) in the present namely *E. fimbriata, P. elongates, I. africana, and S. sole.* The possible reason for this increase in target species could be as a result of migration by fish species to new locations (Erunna-Ero, Idi-Ogba, and Ayetoro fishing communities) due to the negative effects of the anthropogenic activities at the Igbokoda community which is becoming urbanized. As a means of survival, fish species will normally migrate for various reasons, one of which is the search of better water conditions for their survival when the current state of water is not conducive. This migration was observed to result into increased fishing activities at Erunna-Ero, Idi-Ogba, and Ayetoro fishing communities and this was evident by the increase number in target species in these communities. *S. sole* was the only fish species targeted in the past and present and a possible reason for this increase in target could be based on the high market value, the availability of fish species, and consumer preferences in these three communities (Ipinmoroti *et al.,* 2018a).

Conclusion

The water quality parameters measured from the coastal waters present values which were within the recommended ranges for the sustenance of aquatic life although the anthropogenic activities affected the water quality at some periods most especially in Igbokoda community. The coastal area was male-dominated and majorly involved in fishing activities while the females engaged majorly in fish processing. It also revealed that the coastal water is rich in fish diversity and the past and present state of targeted fish species in Igbokoda, Ayetoro, Erunna-Ero, and Idi-Ogba fishing communities fluctuated over time and differently. These differences could be traced to anthropogenic factors most especially the oil exploration activities and transportation activities as such resulting in fish migration to a more conducive environment. The coastal water system can be classified as a good, stable, and healthy system; although there is need for decisive management to sustain the quality of the coastal water. Orientation is also needed on proper disposal of wastes and clean-up activities for the coastal inhabitants.

Conflict of Interest

The authors declare no conflict of interest exists

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