Species Diversity and Relative Abundance of Fisheries Resources Found in Beach Seine along the Central Coast of Ghana

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Abstract

The diversity and relative species abundance of fisheries resources were studied from Winneba to Cape Coast on the central coast of Ghana during December 2007 to May 2009. Samples of organisms were collected at random from beach seine landings during the study period. The fishes were counted and identified to the family and species levels. Ecological indices such as Shannon-Wiener diversity index, equitability and Sørenson's similarity index were used to analyse the data. Specimens from Winneba, Saltpond and Cape Coast comprise 56 species belonging to 30 families. Carangidae, Haemulidae, Clupeidae and Sciaenidae were some of the families, where key species occurred during the study. The relative abundance of key organisms in the beach seine landings include *Chloroscombrus chrysurus* (26.0%) in 2007, *Brachydeuterus auritus* (22.8%) in 2008, *Ilisha africana* (14.7%) in 2008, *Sardinella aurita* (13.1%) in 2009 and *Selene dorsalis* (11.2%) in 2007. The organisms that were in low relative abundance were *Acanthurus monroviae, Penaeus notialis, Galeoides decadactylus* and *Trichiurus lepturus*. Shannon-Wiener diversity index, estimated in the study, ranged from 2.54 to 2.83. Species equitability range was 0.67–0.77, and the Sørenson's similarity estimated ranged was 0.66–0.69. The estimations of fish species diversity and equitability were higher (H' = 2.83; J' = 0.77) during the 2009 study in the central coast of Ghana. The similarity indicators in the various paired periods during the study showed considerable similarity in the organisms that were exploited by the beach seine in the area. The study explains the linkage between the diversity and relative species abundance of the coastal fisheries resources and offshore marine resources in Ghana, and the need to regulate beach seine operations in order not to over exploit the juvenile stocks.

Introduction

The Ghanaian waters, which form part of the Gulf of Guinea, is endowed with abundant fishery resource (Mensah & Quaatey, 2002; Mehl *et al.*, 2004, 2005). The resources are exploited by the industrial and the artisanal fishers. In Ghana, the artisanal fisheries contribute about two-thirds of the total annual marine production (MFRD, 2002). The artisanal fishery is mostly practised in the nearshore areas in the form of inshore canoe and beach seine fisheries. The beach seining is the common traditional fishing method, which is used all year round (MoFA, 2003) and widely practiced on sandy beaches of Ghana. It contributes 12% to the total artisanal fishery landings (Bannerman *et al.*, 2001).

The fish species composition of beach seine had been assessed in other areas of Ghanaian coastal waters by Nunoo *et al.* (2007) and other unpublished reports by the Directorate of Fisheries, Accra, Ghana. The diversity of fish in Benya Lagoon and Kakum River Estuary (Blay, 1997), which are linked to the fisheries resources in the coastal waters of the Central Region, Ghana, had been assessed. The central coastal zone happens to

be the longest coastline (330 km) and has the highest concentration of brackish water systems; 65 as compared to that of western 17 and eastern 16 (Yankson & Obodai, 1999). These brackish water habitats are known to provide nursery and feeding grounds to vast number of marine fish species (Lasiak, 1984; Armah & Amlalo, 1998; Nash & Santos, 1998; GCLME, 2006). The study, therefore, seeks to update fish species diversity and abundance records in the coastal waters of the Central Region, which are very important to the Ghanaian fisheries, and to serve as a contribution to the baseline information on coastal fisheries resources.

Materials and methods

There are three coastal zones of Ghana, which are Eastern (128 km), Central (330 km) and Western (93 km) alongshore distance (Yankson & Obodai, 1999; EIA, 2009). The fish species diversity and relative abundance were studied in the central coast (Fig. 1) of Ghana from Winneba to Cape Coast (5°19'N, 0°38'W and 5°05'N, 1°16'W), between the period December 2007 and May 2009. The Winneba-Saltpond waters is an area where the artisanal fish catch is high (MFRD, 1993), probably linked to the suitable oceanographic conditions in the area (Aggrey-Fynn, 2008) and numerous connected coastal brackish water systems.

Fish specimens were collected at random from beach seine landings along the central coast during the study period. Landing sites were Winneba, Saltpond and Cape Coast (Fig. 1). Fish identification was done in the laboratory using manuals (Schneider, 1990; Kwei & Ofori-Adu, 2005). The identifications were to the family and species levels. Various fish species were counted and recorded for the estimation of proportions in the sub-samples collected from the landings. The relative abundance was calculated as the number of organisms of a particular kind, indicating a percentage of the total number of organisms (Krohne, 2001).

Coastal fish species diversity was calculated by using the Shannon-Wiener index (H^l) as follows:

$$H^2 = -\mathrm{S}\, pi\, (\ln pi) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where *pi* is the proportion of the ith species (Molles, 1999); the evenness (J^l) of diversity was calculated from Pielou's index (Pielou, 1966) given as:

$$J^l = H^l / H_{max} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where H_{max} = ln *s*, and *s* is the number of species in the community. Fish species similarity in 2007–2008, 2007–2009 and 2008–2009 were determined by Sørensen's coefficient (C_s) as follows:

$$C_s = \frac{2j}{a+b} \text{ (Krebs, 1999)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where *j* is the number of fish species common to both paired years, and *a* and *b* are the number of species occurring in either of the paired periods (Brower *et al*., 1990).

Results

Nearshore fish species that were sampled from beach seine operations at Winneba, Saltpond and Cape Coast beaches are presented in Table 1. A total of 56 species, belonging to 30 families, were recorded in the central coastal waters. The waters near Winneba recorded 28 species that occur in 18 families, whereas those near Saltpond and Cape Coast recorded 34 and 31 species each, belonging to 20 families, respectively.

Table 2 shows the number of organisms caught from beach seine operations from

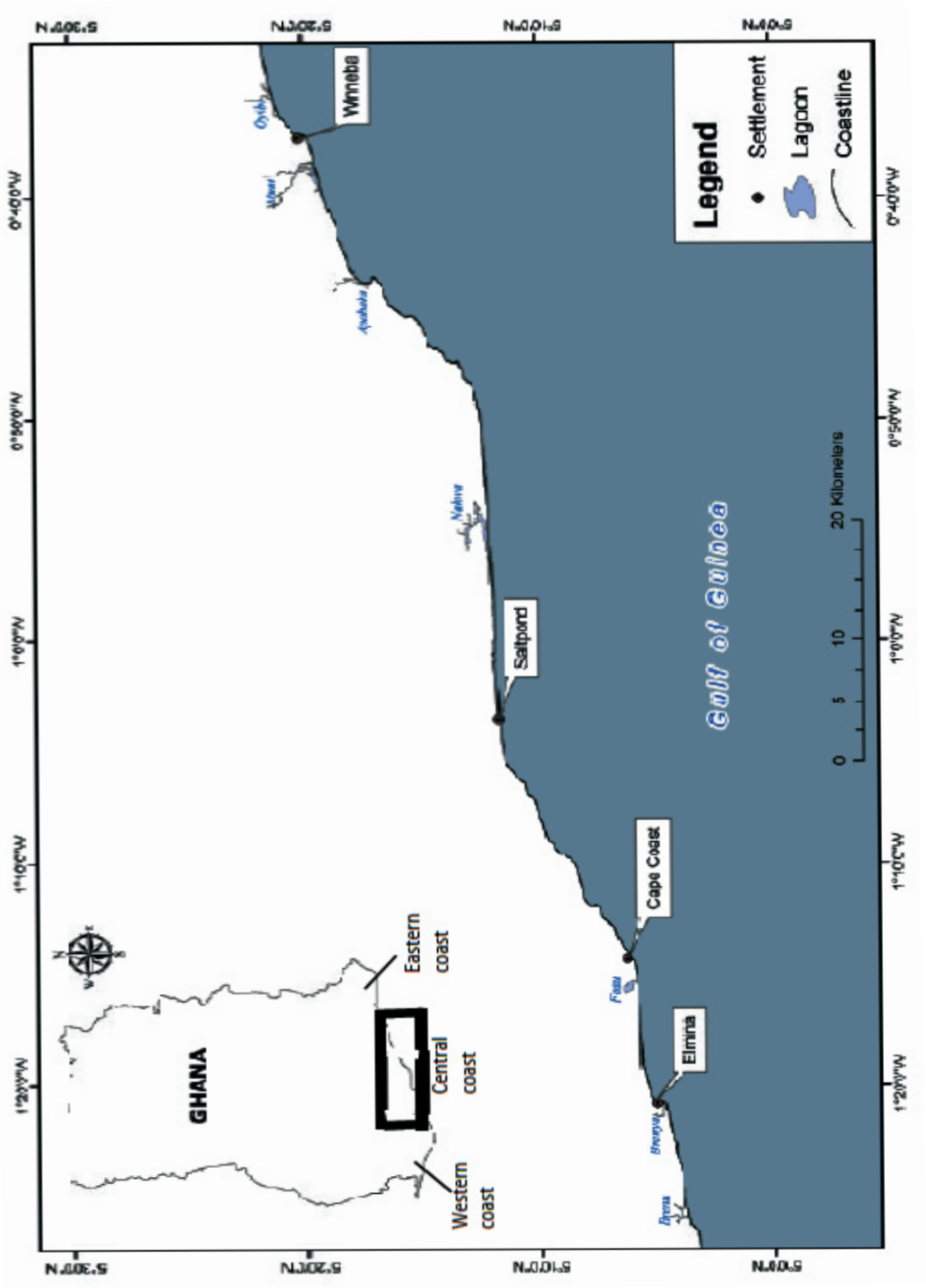

Fig. 1. Map showing the location of Winneba, Saltpond and Cape Coast fish landing beaches of central coast, Ghana

TABLE 1
Checklist of the fisheries resources found in beach seine gear at Winneba, Saltpond and Cape Coast in 2007–2009

	Family	*Species*	*Common name*	*Occurrence*		
				WNBA	*STPD*	*CC*
1.	Acanthuridae	*Acanthurus monroviae*	Monrovia doctorfish	*	*	
2.	Albulidae	*Albula vulpes*	Bonefish			*
3.	Balistidae	*Balistes punctatus*	Grey triggerfish			
4.		*Canthidermis maculatus*	Rough triggerfish	*		*
5.	Bothidae	*Syacium micrurum*	Channel flounder			
6.	Carangidae	*Alectis alexandrinus*	Alexandria pompano		*	*
7.		*Caranx crysos*	Blue runner			*
8.		*Caranx hippos*	Crevalle jack	*	*	
9.		*Chloroscombrus chrysurus*	Atlantic bumper	*	*	*
10.		*Decapterus punctatus*	Round scad		*	*
11.		*Decapterus rhonchus*	False scad			
12.		*Lichia amia*	Leerfish		*	*
13.		*Selene dorsalis*	African moonfish	*	*	*
14.		*Seriola dumerili*	Greater amberjack	*		
15.		*Trachurus trecae*	Horse mackerel	*		
16.	Centrolophidae	*Hyperoglyphe moselii*	African barrelfish			
17.	Clupeidae	*Ethmalosa dorsalis*	Bonga shad	*	*	*
18.		*Harengula rouxi*	Yellowtail sardinella	*		*
19.		*Ilisha africana*	West African ilisha	*	*	*
20.		*Sardinella aurita*	Round sardinella	*	*	*
21.		*Sardinella maderensis*	Madeiran sardinella	*		*
22.	Cynoglossidae	*Cynoglossus senegalensis*	Senegalese tonguesole	*	*	*
23.	Dasyatidae	*Dasyatis margarita*	Daisy stingray		*	
24.	Drepanidae	*Drepane africana*	African sicklefish	*	*	
25.	Engraulididae	*Engraulis encrasicolus*	European anchovy		*	
26.	Exocoetidae	*Hirundicthys speculiger*	Mirrorwing flyingfish			*
27.	Haemulidae	*Brachydeuterus auritus*	Bigeye grunt	*	*	*
28.	Hemiramphidae	*Hemiramphus balao*	Balao halfbeak			
29.		*Oxyporhamphus micropterus*	False halfbeak			*
30.	Lutjanidae	*Apsilus fuscus*	African forktail snapper			
31.		*Lutjanus agennes*	African red snapper			*
32.	Mugilidae	*Mugil cephalus*	Flathead grey mullet	*		
33.	Mullidae	*Pseudupenus prayensis*	West African goatfish	*	*	
34.	Palinuridae	*Panulinus regius*	Royal spiny lobster		*	
35.	Penaeidae	*Parapenaeus longirostris*	Deepwater rose shrimp		*	
36.		*Penaeus notialis*	Pink shrimp	*	*	*
37.	Polynemidae	*Galeoides decadactylus*	Lesser African threadfin		*	*
38.		*Pentanemus quinquarius*	Royal threadfin	*	*	
39.		*Polydactylus quadrifilis*	Giant African threadfin		*	
40.	Portunidae	*Callinectes amnicola*	Bigfisted swimcrab		*	
41.	Psettodidae	*Psettodes belcheri*	Spottail spiny turbot			*
42.	Sciaenidae	*Pseudotolithus brachygnathus*	Law croaker			*

43.		*Pseudotolithus senegalensis*	Cassava croaker	*	*	*
44.		*Pteroscion peli*	Boe drum	*	*	*
45.		*Umbrina canariensis*	Canary drum		*	
46.	Scombridae	*Katsuwornus pelamis*	Skipjack tuna		*	
47.		*Orcynopsis unicolor*	Plain bonito		*	*
48.		*Sarda sarda*	Atlantic bonito		*	
49.		*Thunnus* sp.	Tuna	*		
50.	Sepiidae	*Sepia officinalis*	Common cuttlefish	*	*	*
51.	Sparidae	*Pagellus bellottii*	Red pandora	*		*
52.	Sphyraenidae	*Sphyraena sphyraena*	European barracuda	*	*	*
53.	Stromateidae	*Stromateus fiatola*	Butterfish		*	*
54.	Tetraodontidae	*Epiphion guttifer*	Prickly puffer	*	*	*
55.		*Lagocephalus laevigatus*	Smooth puffer	*	*	
56.	Trichiuridae	*Trichiurus lepturus*	Largehead hairtail	*	*	*

Total: families = 30; species = 56; WNBA = Winneba beach, STPD = Saltpond beach, CC = Cape Coast beach

TABLE 2

Number of organisms and their relative abundance from beach seine in 2007 – 2009 in Winneba, Saltpond and Cape Coast

Fish species	*Numbers obtained*			*Relative Abundance (%)*		
	2007	*2008*	*2009*	*2007*	*2008*	*2009*
Acanthurus monrovie	2	2	2	0.4	0.1	0.1
Albula vulpes	–	–	9	–	–	0.4
Balistes punctatus	–	–	2	–	–	0.1
Canthidermis maculatus	1	–	1	0.2	–	0.05
Syacium micrurum	–	1	21	–	0.03	1.0
Alectis alexandrinus	4	18	111	0.7	0.5	5.0
Caranx crysos	–	4	9	–	0.1	0.4
Caranx hippos	3	14	–	0.5	0.4	–
Chloroscombrus chrysurus	147	636	201	26.0	19.2	9.1
Decapterus punctatus	–	20	–	–	0.6	–
Decapterus rhonchus	–	1	–	–	0.03	–
Lichia amia	–	31	1	–	0.9	0.05
Selene dorsalis	63	241	151	11.2	7.3	6.8
Seriola dumerili	2	2	8	0.4	0.1	0.4
Trachurus trecae	3	1	–	0.5	0.03	–
Hyperoglyphe moselii	13	–	–	2.3	–	–
Ethmalosa dorsalis	–	11	6	–	0.3	0.3
Harengula rouxi	–	1	6	–	0.03	0.3
Ilisha africana	78	486	109	13.8	4.7	4.9
Sardinella aurita	53	135	290	9.4	14.1	13.1
Sardinella maderensis	9	9	54	1.6	0.3	2.4
Cynoglossus senegalensis	3	13	92	0.5	0.4	4.2
Dasyatis margarita	1	1	–	0.2	0.03	–
Drepane africana	4	8	1	0.7	0.2	0.05

Engraulis encrasicolus	–	42	127	–-	1.3	5.8
Hirundicthys speculiger	–	–	1	–	–	0.05
Brachydeuterus auritus	33	755	432	5.8	22.8	19.6
Hemiramphus balao	–	86	7	–	2.6	0.3
Oxyporhamphus micropterus	–	5	–	–	0.2	–
Apsilus fuscus	–	–	10	–	–	0.5
Lutjanus agennes	–	–	67	–	–	3.0
Mugil cephalus	–	5	–	–	0.2	–
Pseudupenus prayensis	3	13	11	0.5	0.4	0.5
Panulinus regius	–	5	–	–	0.2	–
Parapenaeus longirostris	–	32	–	–	1.0	–
Penaeus notialis	8	115	38	1.4	3.5	1.7
Galeoides decadactylus	5	35	44	0.9	1.1	2.0
Pentanemus quinquarius	8	55	–	1.4	1.7	–
Polydactylus quadrifilis	2	21	–	0.4	0.6	–
Callinectes sp.	–	11	–	–	0.3	–
Psettodes belcheri	–	–	11	–	–	0.5
Pseudotolithus brachygnathus	–	–	1	–	–	0.05
Pseudotolithus senegalensis	16	90	55	2.8	2.7	2.5
Pteroscion peli	33	149	61	5.8	4.5	2.8
Umbrina canariensis	–	2	–	–	0.1	–
Katsuwornus pelamis	–	8	–	–	0.2	–
Orcynopsis unicolor	–	5	6	–	0.2	0.3
Sarda sarda	1	–	2	0.2	–	0.1
Thunnus sp.	8	28	–	1.4	0.8	–
Sepia officinalis	11	17	22	1.9	0.5	1.0
Pagellus bellottii	1	–	31	0.2	–	1.4
Sphyraena sphyraena	39	182	59	6.9	5.5	2.7
Stromateus fiatola	1	–	127	0.2	–	5.7
Epiphion guttifer	–	3	14	–	0.1	0.6
Lagocephalus laevigatus	2	8	–	0.4	0.2	–
Trichiurus lepturus	8	2	6	1.4	0.1	0.3
Total	565	3311	2206			

Winneba to Cape Coast in various periods, the relative abundance calculated, species diversity, equitability and periods similarities estimated. In 2007, coastal fish species that were obtained in large quantities relative to the other fishes in the beach seine landings include *Chloroscombrus chrysurus* (26.0%), *Ilisha africana* (13.8%) and *Selene dorsalis* (11.2%). In 2008, species such as *Brachydeuterus auritus* (22.8%), *Chloroscombrus chrysurus* (19.2%) and *Ilisha africana* (14.7%) were recorded in large amounts relative to the other fish species. The 2009 recordings showed that the following fish species were in high relative abundance: *Brachydeuterus auritus* (19.6%), *Sardinella aurita* (13.1%) and *Chloroscombrus chrysurus* (9.1%). Organisms that were in low relative abundance for the three periods were

Acanthurus monrovie, Penaeus notialis, Galeoides decadactylus and *Trichiurus lepturus*. Table 3 shows that species diversity estimated in 2009 was the highest, 2.83, and that of 2007 and 2008 were 2.54 each. Species equitability was 0.77 in 2009 and 0.67 in 2008. Sørensen's similarity estimated for 2007/2008 was 0.69, 2007/2009 was 0.66 and 2008/2009 was 0.67.

The species diversity range obtained in this study using Shannon-Wiener index was 2.54–2.83 and is highly comparable to that estimated by Blay (1997) in the Kakum river estuary (2.47), which enters the sea off Cape Coast. Again, the species richness recorded from 2007 to 2009 in this study were quite comparable to the measure of relative diversity, J^{l} , which was highest, 0.77 in 2009

TABLE 3

Species diversity, equitability and similarity indices of the beach seine fisheries resources in central coast

Indices	*2007*	*2008*	*2009*
Species diversity (H')	2.54	2.54	2.83
Equitability (J	0.74	0.67	0.77
Cj (Sorenson's Similarity):	2007/2008 = 0.69,	2007/2009 = 0.66,	2008/2009 = 0.67

Discussion

Fisheries resources that were obtained during the period of study were of diverse in nature. They include species in the families Acanthuridae, Balistidae, Carangidae, Clupeidae, Drepanidae, Mugilidae, Penaeidae, Sciaenidae, Scombridae, Sepiidae and many more. The relative abundance of the main fishery resources exploited in the central coast of Ghana are juvenile coastal pelagic such as *Chloroscombrus chrysurus* (26.0% in 2007), *Ilisha africana* (14.7% in 2008) and *Sardinella aurita* (13.1% in 2009), and demersal fish species such as *Brachydeuterus auritus* (22.8% in 2008). Most of the fish species and shrimps obtained had been reported to occur in the eastern coast of Ghana (Nunoo *et al.*, 2007), western Gulf of Guinea (Mehl *et al*., 2004, 2005) and the entire Gulf of Guinea (Schneider, 1990).

and lowest, 0.67 in 2008. The J^{l} in 2009 was comparable to that of 2007 (J^{l} = 0.74) in the central coast. Also, the equitability estimation was 0.67–0.77 in this study as compared to 0.67 and 0.74 in Benya lagoon (Man-made open lagoon) and Kakum river estuary, respectively, all in the central coast of Ghana (Blay, 1997).

The closely related estimations of species diversity and equitability in separate studies suggest that there is a closer link between the coastal fishery resources and the fishes in the brackish water systems, more especially the open lagoons and estuaries, in the central coast. This linkage could be explained in terms of large marine fishes migrating to feed and spawn in the lagoonal and estuarine habitats (Armah & Amlalo, 1998; GCLME, 2006), and, by so doing, the juvenile fishes are nursed in the brackish water systems before they move to the marine habitat. This observation was buttressed in the quotient of

similarities estimated in this study for the various pairs of periods which ranged from 0.66–0.69 (Table 2). It indicates that the fish species caught in the central stretch of the Ghanaian coastal waters were similar, and this could be a major baseline for fish species diversity, which may guide the future monitoring of the effect of the emerging offshore petro-chemical activities in Ghanaian waters.

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