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MULTIVARIATE ANALYSIS OF ABUNDANCE AND DISTRIBUTION OF FISH SPECIES IN COAST OF GHANA, WEST AFRICA

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Marine fishes are currently experiencing population decline which has severe repercussions on food security, especially in fishing households. However, without assessing the distribution and abundance of these marine fishes, ensuring sustainable management will become impossible. Therefore, the study aimed at applying multivariate techniques to determine the biodiversity of fishes along the coast of Ahanta West, Ghana. Fish samples were collected daily through experimental fishing from November-December, 2011. Data obtained from the study were analyzed for ecological indices, species diversity, and community structure using PAST and PRIMER v6 software. From the results, *Pteroscion peli* (19.2%), *Galeoides decadactylus* (11.7%), and *Brachydeuterus auritus* (9.0%) were the dominant fishes. Multivariate analysis identified three main assemblages of fishes, at 18%. For the ecological indices, the species dominance index (SDI) ranged from 0.89 to 0.93, which indicated that the fish species were highly dominated by a few species. The Shannon Weiner index (SWI) and Species Richness index (SRI) spanned between 2.64 – 2.92 and 4.43 – 648 respectively, showing high diversity of fish species. It is concluded that the marine environment along the Ahanta West, Ghana is rich in fish species diversity, and hence, there is the need to regulate existing fishing operations for sustainable utilization and conservation of these commercially important fish species.

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INTRODUCTION

Fish species are important indicators of ecological health (Hashemi et al., 2015). This importance is due to their ability to integrate the effects of a range of environmental factors such as water quality, physical habitat, and biological interactions reflecting both current and long-term environmental effects (Whitfield and Harrisson, 2014). Fish occurrence, diversity, and distribution, which are fundamental attributes of fish communities, therefore represent essential knowledge for fisheries, conservation, and management (Kerschbaumer et al., 2020; Hashemi et al., 2015). According to Negi and Mamgain (2013), fish diversity, community structure, and species assemblages are interdependent on many factors (biotic and abiotic) that determine the success or failure of fish species assemblages. Understanding the factors involved in the structuring of fish assemblages and the response of fisheries resources to environmental variation is therefore invaluable to fishery management and species conservation (Schultz et al., 2012).

The fisheries resource of Ghana's coast has been characterized as a highly diverse and multi-species complex that cannot be managed without an understanding of the biological assemblage structure (Sylla et al., 2016). The highly complex biological assemblage structure of Ghana's fisheries requires the use of tools that will enable the identification and determination of how various environmental gradients affect the distribution of fishes. Multivariate analysis (Odulate et al., 2014) is an important tool in the sustainable management of fisheries in Ghana. Several studies concerning the structure of species assemblages, fish distribution, and abundance assessment in the Gulf of Guinea have been published. These studies include the study by Sylla et al. (2016) on the spatial distribution of coastal fish assemblage in Côte d'Ivoire's Exclusive Economic Zone (EEZ) and the study by Odulate et al. (2014) on multivariate analysis of fish species and environmental factors in marine coastal waters, southwest Nigeria. In Ghana, studies on fish distribution and abundance include the study by Aggrey- Fynn and Sackey Mensah (2012) on species diversity and relative abundance of fisheries resources found in beach seine along the central coast of Ghana and the study by Nunoo et al. (2007) on trends in fish species diversity found in nearshore marine waters along the coast of Ghana. These studies, however, did not apply multivariate analysis techniques and did not focus on the western sector of Ghana's coast. With Ghana's economy strongly dependent upon biological resources such as fish, which has resulted in a mutually dependent relationship between conservation of resources and development (Sylla et al., 2016), the country requires information on the distribution and abundance of fish species to ensure sustainable management. This study aimed to apply multivariate techniques to determine the changes in abundance and distribution of fish species in the coast of Ghana which could be used in aiding the sustainable management of fishery resources.

MATERIALS AND METHODS

Study Area

Akwidaa and Busua are both coastal fishing communities in the Ahanta West District (Figure 1). Akwidaa is located at latitude 4 ^{o} 45' 0 N and Longitude 2 ^{o} 1' 0 W on a tiny strip of land as part of a sandy peninsular in the 30m contour part of Ghana (Effah, 2015) while Busua is sandwiched between Butre and Dixcove about 30 kilometers west of Takoradi (Adjei and Sika-Bright, 2019). The district is characterized by a mean annual temperature above 26 ^{o}C and experiences a major raining season from May to August and a minor raining season from September to October (Effah, 2015).

Data Collection

Experimental fishing was done using both monofilament and multifilament gill nets of mesh sizes; 1(7/8), 3and 3(1/2) inches. Samples were collected daily from both sampling sites for two months from November – December, 2011. On the field, fish catch was identified to species level according to Schneider (1990). Length of fish samples were measured using wooden graduated measuring board to the nearest 0.1 cm while the weight was recorded using electronic scale to the nearest 0.01g

Figure 1. Map showing the study sites

Data Analysis

Species relative abundance

Data on total abundance of each fish species from the sampling sites were used to determine the percentage of relative abundance. The fish assemblage was described through taxonomic composition, spatial richness, and frequency of occurrence (FO).

Shannon-Weiner Index

Shannon Weiner diversity index (Ramos et al., 2006) considers both the number of species and the distribution of individuals among species. This index was calculated using the formula:

$-\Sigma\left[\left(\frac{\mathrm{ni}}{\mathrm{N}}\right)\times\ln\left(\frac{\mathrm{ni}}{\mathrm{N}}\right)\right]$(Shannon and Weaver, 1963)

where, n_i is the number of individuals in species i and N is the total number of individuals in the community.

Species Richness

This is the number of different species represented in an ecological community**.** Margalef index (*d*) was used to measure the species richness by using the formula;

$\frac{\mathbf{(S-1)}}{\mathbf{InN}}$(Margalef, 1967)

where, S is the number of different species represented in the sample and N is the total number of individual organisms in your sample.

Species dominance

Simpson dominance index (1-D) is the measure of diversity which takes into account the number of species present as well as the relative abundance of each species. This index was estimated using the formula:

$$\frac{1-\ \Sigma\, n(n-1)}{N(N-1)}\,(\text{Ogbeibu, 2005})$$

The value of 1 - *D* ranges between 0 and 1, where D implies dominance. With this index, 1 represents infinite diversity and 0, no diversity.

Species evenness

This refers to how close in numbers each species in an environment is. Pielou's evenness index was used to calculate the evenness of the fish species in the sample. This was estimated using the formula:

$$\frac{H'}{H'max}\,(\text{Pielou, 1969})$$

Where, H' is the number derived from Shannon diversity index and H'max is the maximum possible value of H' (if every species was equally likely)

Hierarchical cluster analysis and non-metric multidimensional scaling (nMDS), based on Bray–Curtis similarity were used for classification and ordination of sampling sites (Clarke & Warwick, 1994). According to Clarke and Warwick (1994), MDS preserves the rank order of the inter-samples distance, as opposed to the linear relationship of classical metric scaling (i.e. Principal component analysis, correspondence analysis). nMDS has the advantage of robustness being not sensitive to outliers (e.g. occurrence of one individual of large biomass in a site) and it has been widely used in the past to analyse demersal assemblages (Clark et al., 1996). Sampling location was examined with the Similarity Percentage (SIMPER) procedure to identify within-locations sample similarity and the species numerically responsible for sampling location identity. Dominating species defined by SIMPER are those with the highest contribution to the average similarity within particular zones.

RESULTS AND DISCUSSION

Species Abundance

In all, forty-eight (48) taxa were recorded from the study which is in variance with other studies carried out from the coast of Ghana. For instance, Amponsah and Amarquaye (2021) reported twenty-eight (28) species from the Sakumono landing site, Ghana. Nunoo and Azumah's (2015) studies revealed sixty-seven (67) species. Nunoo et al. (2006) from the coast of Sakumono documented sixty-three (63) species. Aggrey-Fynn and Sackey Mensah's (2012) studies reported from the coast of Winneba, Saltpond, and Cape Coast 28, 34, and 31 species respectively. The total number of species recorded from the study (48 species) was in variance with the aforementioned studies which could be ascribed to factors such as environmental conditions, time of sampling, sampling duration, type of fishing gear, biological activities of fish species, geographical location and the intensity of fishing activities (Amponsah and Amarquaye, 2021; Nunoo et al., 2006; Lefkaditou et al., 1998; Lasiak, 1984; Warlef and Merriman, 1944). A total number of 2580 individuals of the considered species were captured, with P. peli, G. deacdactylus, B. auritus, I. africana, and P. senegalensis as the most numerically abundant species (Table 1). The higher occurrence rate of dominant species including P. peli, G. decadactylus, and B. auritus could be due to their wide distribution in the marine environment and the demographic strategy of these species (Sylla et al., 2016). However, other studies (e.g., Amponsah and Amarquaye, 2021; Aggrey-Fynn and Mensah, 2012; Nunoo et al., 2006) have reported the dominance of these in the marine waters of Ghana. This finding suggests that these dominant species from the present study are favourably found on both the eastern and western coast of Ghana. Amponsah and Amarquaye (2021) concluded the conduciveness of environmental factors may have accounted for the occurrence of these dominant species on the coast of Ghana.

From Table 2, spatial variation of species revealed thirty-three (33) and forty-seven (47) species from Akwidaa and Busua fishing communities respectively. Factors such as high fishing pressure, insufficient alternative livelihoods, and runoff from farmlands (Fogarty and Murawski, 1998) may have contributed to the spatial variation in species composition. For instance, having a variety of alternative livelihoods (i.e., driving, plumbing, carpentry, tour guides, hotel workers, petty trading, etc), implies that inhabitants of the Busua fishing community are likely to exert low pressure on the fish stocks. On the contrary, the main alternate livelihood in the Akwidaa fishing community is farming, therefore inhabitants are most likely to exert high fishing pressure on fish stocks. Consequently, the high investment in farming activities by the majority of the inhabitants in the Akwidaa fishing community also has the propensity of facilitating a high runoff of toxic agrochemicals into the marine environment through its open lagoon. The lagoon which serves as a natural harbour for docking fishing vessels in the Akwidaa fishing community could have some negative implications on the spawning grounds of some diadromous fish species. Also, the active use of the lagoon as a dockyard result in a high runoff rate of oil discharge and harmful chemicals into the marine ecosystem which may alter the composition of fish (Ruma et al., 2017). Overall, the spatial variation in species composition at the sampling sites depicts the heterogeneous nature of the habitat, environmental conditions, the hydrogeology of the habitats, and the connectivity of the overall marine ecosystem (Pin et al., 2020; Araujo and Santos, 2000).

Table 1. Abundance and frequency of occurrence of the 48 taxa analyzed from the study areas

Species	Abundance	Relative abundance (%)
Pteroscion peli	496	19.22
Galeoides decadactylus	303	11.74
Brachydeuterus auritus	233	9.03
Ilisha africana	211	8.18
Pseudotholithus senegalensis	204	7.91
Parakuhlia macrophthalmus	142	5.50
Umbrina canarensis	119	4.61
Chloroscombus chrysurus	115	4.46
Sphyraena sphyraena	93	3.60
Pomadasys incisus	92	3.57
Sardinella aurita	90	3.49
Cynoglossus senegalensis	75	2.91
Selene dorsalis	66	2.56
Pomadasys jubelini	40	1.55
Pseudotolithus brachygnathus	37	1.43
Pseudotolithus typhus	36	1.40
Drepane africana	30	1.16
Raja mirelatus	26	1.01
Scorpaena histrio	22	0.85
Synodus synodus	22	0.85
Uranoscopus poli	19	0.74
Caranx hippos	14	0.54
Lutjanus fulgens	12	0.47
Sparisoma rubripinne	10	0.39
Elops lacerta	9	0.35
Pseudupeneus prayensis	8	0.31
Priacanthus arenatus	7	0.27
Acanthurus monroviae	5	0.19
Dasyatis margarita	5	0.19
Eucinostomus melanopterus	5	0.19
Pagellus bellottii	5	0.19

Table 1 (Contd.).

Cephalopholis nigri	3	0.12
Chaetodipterus lippei	3	0.12
Sargocentron hastatum	3	0.12
Chaetodon robustus	2	0.08
Chromis limbata	2	0.08
Citharus linguatula	2	0.08
Lagocephalus laevigatus	2	0.08
Orcynopsis unicolor	2	0.08
Pagrus caeruleostictus	2	0.08
Balistes punctatus	1	0.04
Brotula barbata	1	0.04
Dentex canariensis	1	0.04
Diodon hystrix	1	0.04
Epinephelus aeneus	1	0.04
Lethrinus atlanticus	1	0.04
Pagrus pagrus	1	0.04
Vanstraelenia chirophthalmus	1	0.04

Table 2. Spatial variation of species encountered during the sampling period

Species	Akwidaa	Busua
Acanthurus monroviae	√	√
Brachydeuterus auritus	√	√
Balistes punctatus	-	√
Brotula barbata	-	√
Caranx hippos	√	√
Cephalopholis nigri	-	√
Chaetodipterus lippei	-	√
chaetodon robustus	-	√
Chloroscombus chrysurus	√	√
Chromis limbata	√	√
Citharus linguatula	√	-
Cynoglossus senegalensis	√	√
Dasyatis margarita	√	√
Dentex canariensis	-	√
Diodon hystrix	-	√
Drepane africana	√	√
Elops lacerta	√	√
Epinephelus aeneus	-	√
Eucinostomus melanopterus	√	√
Galeoides decadactylus	√	√

Table 2. (Contd.)

Ilisha africana	√	√
Lagocephalus laevigatus	√	√
Lethrinus atlanticus	-	√
Lutjanus fulgens	√	√
Orcynopsis unicolor	√	√
Pagellus bellotii	-	√
Pagrus pagrus	-	√
Parakuhlia macrophthalmus	√	√
Pomadasys incisus	√	√
Pomadasys jubelini	√	√
Priacanthus arenatus	-	√
Pseudotholithus senegalensis	√	√
Pseudotolithus brachygnathus	√	√
Pseudotolithus typhus	√	√
Pseudupeneus prayensis	√	√
Pteroscion peli	√	√
Raja mirelatus	√	√
Sardinella aurita	√	√
Sargocentron hastatum	-	√
Scorpaena histrio	√	√
Selene dorsalis	√	√
Sparisoma rubripinne	√	√
Pagrus caeruleostictus	-	√
Sphyraena sphyraena	√	√
Synodus synodus	√	√
Umbrina canarensis	√	√
Uranoscopus poli	√	√
Vanstraelenia chirophthalmus	-	√

(√) means present; (-) means absent

Community structure

The cluster analysis and two-dimensional nMDS plot by hierarchical classification identified three distinct groups of fish species (*P. caeruleostictus, P. prayensis*, and *P. incisus*) at a similarity index of 18% as shown in Figure 2. To Odulate et al. (2014), cluster analysis aims to represent the (dis) similarity between species based on the value of multiple variables associated with them so that similar objects appear close to each other and dissimilar objects are depicted far from each other. For similarity tests, cluster analysis techniques are commonly used to study the community association based on distributional co-occurrence. In this study, the Bray-Curtis similarity matrix was used based on cluster analysis to find out the similarity level among the individual fish species. Hierarchical cluster analysis of the Bray-Curtis resemblance matrix was used to add further information to the nMDS plot. The calculated two-dimensional nMDS plot showed a Kruskal stress value of 0.11 (Fig. 3). Using a similarity level of 18%, three clusters were discriminated (Fig. 2). The categorization of the species into three (3) groups could be linked to the physiological process, species size, and whether dominant or important species at sampling stations. The categorization of species may therefore be caused by the different composition of each community and the relative change in the number of dominant species (Wang et al., 2013). Overall, the results of Cluster and nMDS analyses are favorable, giving way for meaningful conclusions to be deducted (Li et al., 2001).

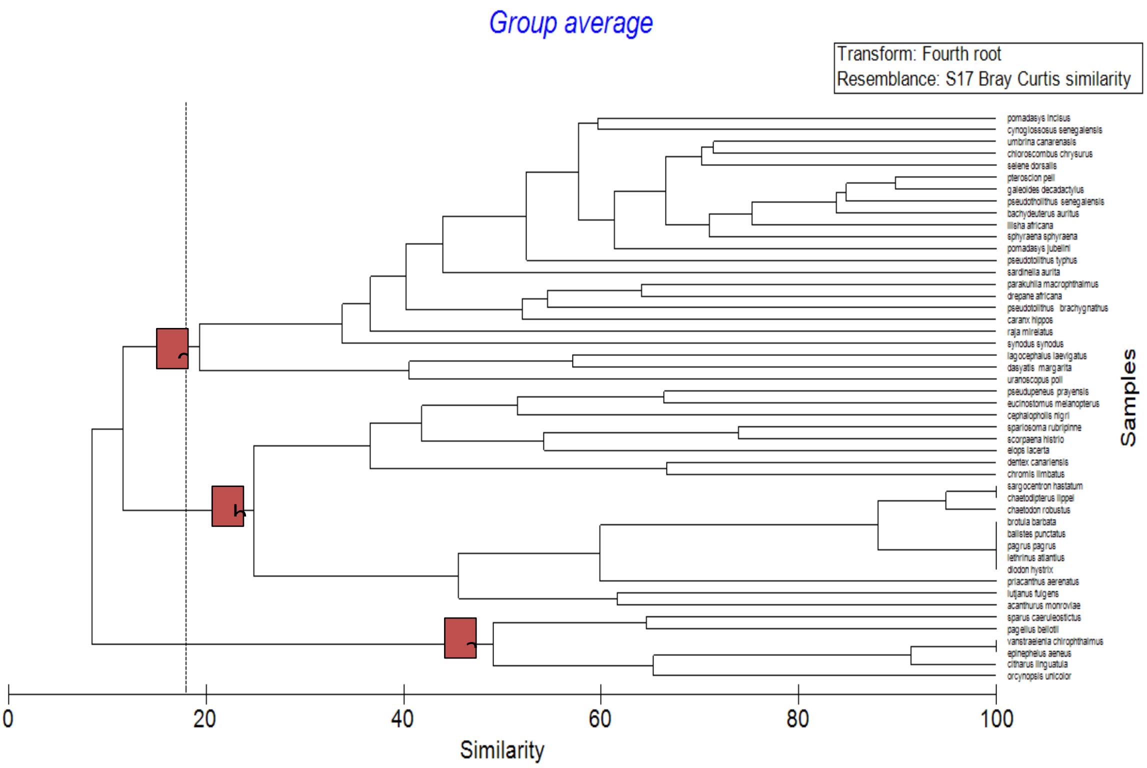

Figure 2. Bray–Curtis cluster of species distribution

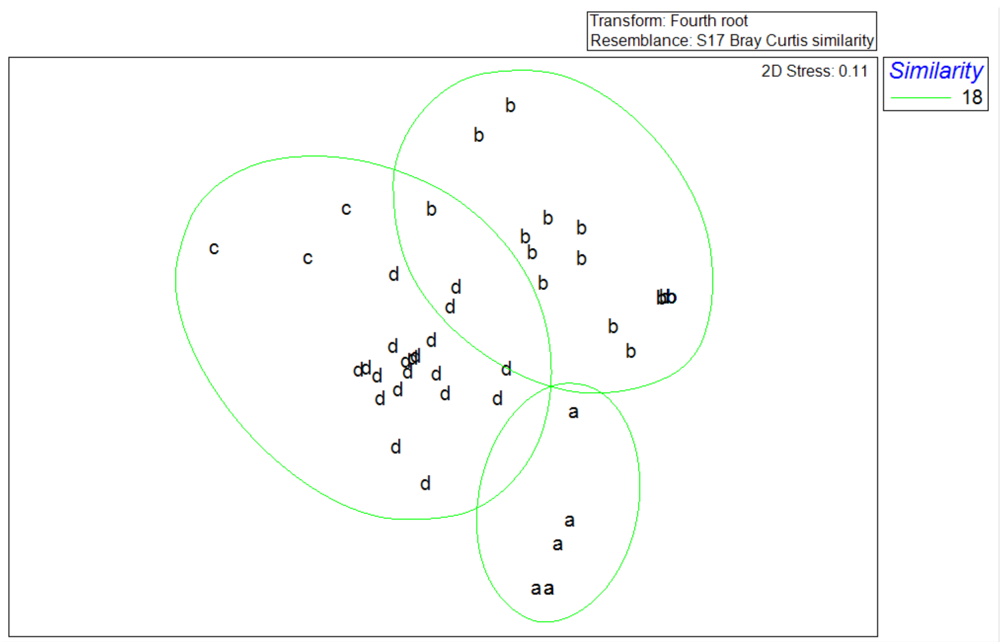

Figure 3. Non-Multidimensional scaling (nMDS) of species distribution

Table 3. Average similarity of fish species composition from Busua using SIMPER analyses.

Group Busua					
Average similarity: 44.36					
Species	**Av. Abund**	**Av. Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Pteroscion peli	1.80	6.99	2.45	15.75	15.75
Galeoides decadactylus	1.50	5.36	1.81	12.08	27.83
Pseudotolithus senegalensis	1.41	5.08	1.77	11.44	39.27
Brachydeuterus auritus	1.41	4.10	1.23	9.23	48.50
Umbrina canarensis	1.19	2.76	0.96	6.21	54.72
Cynoglossus senegalensis	0.82	2.36	0.70	5.32	60.04
Sphyraena sphyraena	0.98	2.28	0.77	5.15	65.18
Ilisha africana	1.10	2.21	0.59	4.98	70.16
Pomadasys incisus	0.99	1.97	0.73	4.43	74.59
Selene dorsalis	0.89	1.96	0.76	4.41	79.00
Synodus synodus	0.72	1.56	0.59	3.52	82.52
Chloroscombus chrysurus	0.80	1.48	0.60	3.34	85.85
Raja mirelatus	0.71	1.37	0.59	3.09	88.94
Pomadasys jubelini	0.49	0.91	0.46	2.05	90.99

Table 4. Average similarity of fish species composition from Akwidaa using SIMPER analyses.

Group Akwidaa					
Average similarity: 61.08					
Species	**Av. Abund**	**Av. Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Pteroscion peli	2.15	8.07	3.96	13.21	13.21
Galeoides decadactylus	1.98	7.88	12.25	12.90	26.11
Pseudotolithus senegalensis	1.73	7.05	9.93	11.54	37.64
Brachydeuterus auritus	1.72	6.62	5.65	10.84	48.49
Ilisha africana	1.40	4.98	1.97	8.16	56.65
Chloroscombrus chrysurus	1.28	3.52	1.28	5.77	62.42
Sphyraena sphyraena	1.09	3.50	1.30	5.73	68.14
Cynoglossus senegalensis	1.06	3.09	1.29	5.06	73.20
Selene dorsalis	1.0	2.85	1.00	4.67	77.87
Pomadasys jubelini	0.96	2.43	0.98	3.97	81.84
Umbrina canarensis	0.89	1.94	0.77	3.17	85.01
Pseudotolithus typhus	0.84	1.75	0.77	2.86	87.87
Parakuhlia macrophthalmus	0.87	1.43	0.59	2.35	90.22

Simper Analysis

The result of SIMPER analysis indicated that both groups were dominated by the four species *P. peli, G. decadactylus, P. senegalensis,* and *B. auritus*, together contributing to 44.36 % of the average similarity for Group Busua and 61.08 % for Group Akwidaa (Table 3 and 4). For groups combined, *I. africana, P. macrophthalmus, C. chrysurus,* and *U. canarensis* together contributed to 18.49% of dissimilarity (Table 5). The segregation of the species according to their contribution cumulatively in each zone gives precise information on the specific distribution. Unfortunately, no pronounced differences were evident in fish assemblages from Akwidaa and Busua, because both locations were dominated by the three-four key dominant fishes contributing cumulatively about 45% of the species abundance in both zones. Chao (1984) demonstrated that difference in the geographic characteristics of the sampling sites, the survey area, sampling time, and methods has the propensity of causing variation in the total number of species encountered. As a result, miniaturization is often observed, along with an increase in the number of tolerant compared to sensitive species, thereby altering the overall structure and composition of the fish community (Pitcher, 2010).

Table 5. Average similarity and discriminating fish species from Busua and Akwidaa using SIMPER analyses

Groups Busua and Akwidaa						
Average dissimilarity = 47.73						
	Group Busua	**Group Akwidaa**				
Species	**Av. Abund**	**Av. Abund**	**Av. Diss**	**Diss/SD**	**Contrib%**	**Cum.%**
Ilisha africana	1.10	1.40	2.36	1.44	4.94	4.94
Parakuhlia macrophthalmus	0.68	0.87	2.24	1.10	4.70	9.64
Chloroscombus chrysurus	0.80	1.28	2.18	1.24	4.58	14.22
Umbrina canarensis	1.19	0.89	2.04	1.24	4.27	18.49
Pomadasys incisus	0.99	0.67	1.94	1.23	4.06	22.56
Sardinella auritus	0.46	0.66	1.84	0.9	3.85	26.41
Sphyraena sphyraena	0.98	1.09	1.81	1.24	3.79	30.19
Selene dorsalis	0.89	1.00	1.75	1.11	3.66	33.85
Pomadasys jubelini	0.49	0.96	1.73	1.21	3.63	37.48
Brachydeuterus auritus	1.41	1.72	1.73	0.89	3.62	41.11
Pseudotolithus typhus	0.39	0.84	1.7	1.16	3.57	44.67
Cynoglossus senegalensis	0.82	1.06	1.66	1.11	3.47	48.15
Synodus synodus	0.72	0.09	1.64	1.1	3.43	51.57
Pteroscion peli	1.80	2.15	1.63	1.26	3.41	54.98
Raja mirelatus	0.71	0.31	1.58	1.08	3.31	58.30
Pseudotolithus brachygnathus	0.47	0.59	1.55	1.00	3.25	61.54
Drepane africana	0.34	0.64	1.54	0.97	3.22	64.77
Galeoides decadactylus	1.50	1.98	1.49	1.08	3.11	67.88
Pseudotholithus senegalensis	1.41	1.73	1.21	1.04	2.54	70.43
Caranx hippos	0.4	0.34	1.18	0.87	2.46	72.89
Uranoscopus poli	0.24	0.36	1.13	0.71	2.37	75.26
Elops lacerta	0.09	0.43	1.00	0.78	2.10	77.36
Scorpaena histrio	0.38	0.21	0.98	0.74	2.06	79.41

Table 5 (Contd.)

Sparisoma rubripinne	0.23	0.29	0.88	0.75	1.84	81.25
Pseudupeneus prayensis	0.31	0.18	0.85	0.71	1.79	83.04
Dasyatis margarita	0.27	0.18	0.81	0.72	1.69	84.73
Pagellus bellottii	0.38	0.00	0.72	0.74	1.52	86.24
Eucinostomus melanopterus	0.2	0.18	0.71	0.63	1.48	87.73
Lutjanus fulgens	0.26	0.12	0.68	0.56	1.43	89.16
Cephalopholis nigri	0.27	0.00	0.55	0.60	1.15	90.30

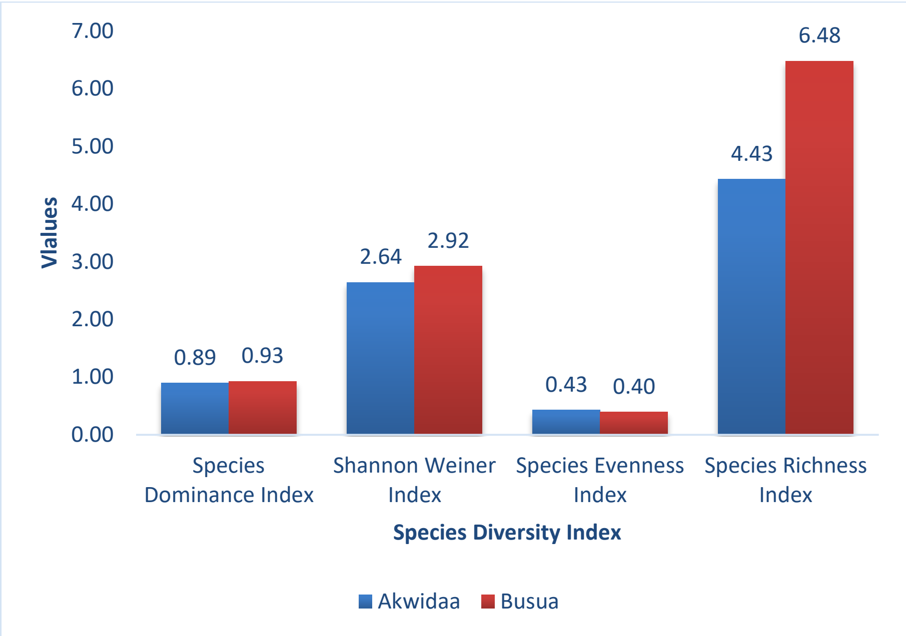

Figure 4. Species diversity indices recorded from the sampling stations

Diversity Indices

From the study, the Species Richness Index (SRI) was 4.43 and 6.48 for Akwidaa and Busua, respectively (Figure 4). Species richness is known to be crucial in the protection of resources (Odulate et al., 2014). The SRI recorded from the study was higher than the values reported by Amponsah and Amarquaye (2021) from the Sakumono coastal environment, Ghana. Nonetheless, the high SRI from the study corroborates with the findings by Spare and Veneman (1982) who documented that a tropical environment is characterized by high species richness with few dominant species. Shannon Weiner Index (SWI) was 2.64 and 2.97 for Akwidaa and Busua respectively. Amponsah and Amarquaye (2021) reported SWI values ranging from 1.83 to 2.23 from the coast of Sakumono, Ghana. Azumah and Nunoo (2015) reported the Shannon -Weiner index ranging from 1.87 to 2.51 from the nearshore of Tsokome, Ghana. The Shannon-Weiner index reported by Aggrey-Fynn and Sackey Mensah (2012) ranged from 2.54 to 2.83. The values obtained from the current study were lower than the values reported by the aforementioned researchers. According to Shannon (1949), the Shannon index value above 3 indicates that the structure of the habitat is stable and balanced; the values below 3 indicate that there are pollution and degradation of habitat structure. From the study, the Shannon index was less than three (3) which indicates possible pollution with the existence of some level of habitat degradation, attributable to high fishing levels and illegal means of fishing. Species Evenness Index (SEI) was 0.43 and 0.40 for Akwidaa and Busua respectively. The species' evenness range obtained from the current study ranged from 0.36 to 0.47 using the evenness index. The evenness reported by Aggrey-Fynn and Sackey Mensah (2012) was 0.67 to 0.77. The evenness index reported by Blay

(1997) from the Kakum River was 0.77. Azumah and Nunoo (2015) reported evenness ranging from 0.44 to 0.53 from the nearshore of Tsokome, Ghana. The values obtained from the current studies were lower than the values reported by other researchers. Species Dominance Index (SDI) was 0.89 and 0.93 for Akwidaa and Busua respectively. According to Lin et al. (2016), habitats with more interference, tend to have high SDI (> 0.6), consisting of only one or a few species, and relatively large populations. Meanwhile, in a relatively stable habitat with less interference, the SDI tends to be very low (< 0.5) with relatively similar proportions. In this survey, the SDI at both sampling stations was very high (>0.8) which suggests that the composition of dominant species is relatively balanced. Spatially, the relatively higher SDI at the Busua than recorded at Akwidaa suggests that the composition of dominant species within the ecosystem at the Busua sampling station is highly balanced (Yang et al., 2021). The variation in species diversity indices could allude to the migrating pattern of fishes, the difference in sampling period, type of fishing gear (Aggrey-Fynn and Sackey-Mensah, 2012; Nunoo and Azumah, 2015). In addition, the already declining nature of the marine species in Ghana could also be a contributor to the observed variation in species diversity. Also, according to Kousaai (2005), the variation in diversity indices may be attributed to the linkage of the marine environment and coastal lagoon systems which ensures the exchanges between fresh and marine waters. Sylla et al. (2016) opined that the variation in species diversity is dependent on the level of nutrients influx from the coastal lagoon linking each of these marine environments.

CONCLUSION

Overall, forty-eight (48) species were obtained from the present study with *P. peli, G. decadactylus*, and *B. auritus* as the dominant fish species. The spatial variation of species composition between the Akwidaa and Busua sampling sites suggests that the marine environment along the Busua sampling site is more viable than the Akwidaa sampling location. The Cluster and nMDS analyses revealed three (3) distinct groups of fish species obtained from the study with the SIMPER analysis showing the dominance of *P. peli* and *B. auritus* in both sampling stations. Findings from the species diversity indices suggest that species composition is highly balanced with high species diversity. The highly balanced ecosystems of the sampling locations may be disrupted by bad fishing practices. As such, it is recommended that fishing operations existing in these fishing locations be regulated in order to ensure the sustenance of the fishery for both present and future generations.

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CONFLICT OF INTEREST

There is no conflict of interest for this study.

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