Available online at: www.mbai.org.in doi: 10.6024/jmbai.2017.59.1.1958-02

Reef fish diversity of bottom set gillnet landings at Pamban, Tamil Nadu, India

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Received: 29 Dec 2016, Accepted: 31 May 2017, Published: 10 Jun 2017

Original Article

Abstract

The coral reef areas of Gulf of Mannar support a rich fauna of fishes and bottom set gill net is one of the important gears employed in this area. Reef fishes landed at Pamban fish landing centre by bottom-set gillnets operated in Gulf of Mannar, for a period of three years from January, 2009 to December, 2011 were studied based on fortnightly sampling. A total of 69 species belonging to 29 families were recorded during the study and as per IUCN, two species, *Himantura uarnak* and *Rhinoptera javanica* are included under the Vulnerable category. The landings amounted to 1761 tonnes during the period with a maximum contribution of 44% during 2011 and it was the minimum during 2010 with a share of 27%. Species-wise landings indicated the dominance of *Lethrinus nebulosus* (11.5%) followed by *Neotrygon kuhlii* (10.6%). The richness and diversity indices showed a gradual increase from 2009 to 2011 and all the year wise points in the funnel plot for variation in taxonomic distinctness (λ^+) are within the expected limit. The qualitative and quantitative abundance along with different diversity measures are presented and discussed in this paper. The results of the present investigation suggest that the bottom set gill net fishery is in a healthy condition with respect to Pamban fish landing centre.

Keywords: *Reef fishes, gill-net fishery, fish abundance, coral reef ecosystem, Gulf of Mannar*

Introduction

Bottom set gill net is being operated in the coral reef areas of Gulf of Mannar which is locally known as 'Mandal valai'. These nets are fixed on the sea floor with weights and floats and mesh size varies from 100 to 200 mm in order to catch fishes of different sizes. Tamil Nadu ranks second in marine fish landings of India with a share of 18.5% in 2014 (FRAD-CMFRI, 2015). Mechanised gillnets form 4.2%, while gillnets contributed the bulk of the total catch among the motorized sector (59%) of marine fish landings along the Tamil Nadu coasts (Mohamed and Vivekanandan, 2011). Even though gillnet is one of the major gears operated in Gulf of Mannar, information on the fishery, especially that landed by bottom-set gillnet is less studied. Hence, an attempt is made to analyse the fishery resources landed by bottom-set gillnets at Pamban which is one of the major fish landing centres in this region.

Material and methods

Fortnightly samples were collected from Pamban light house fish landing centre (Lat.13º 04.53' N and Long. 80º 27.69' E) landed by bottom-set gillnets from Gulf of Mannar (GOM), for a period of three years from January, 2009 to December, 2011. For sampling, stratified multistage random sampling developed by Central Marine Fisheries Research Institute was followed.

The area of the GOM under the Indian EEZ is about 15000 sq. km., where commercial fishing takes place in about 5500 sq. km. The fishes landed were identified up to species level using FAO identification sheets (Fischer and Bianchi, 1984), Smith and Heemstra (1986) and Munro (2000). The weight as well as number of each species landed was estimated. Species-wise, family-wise, month-wise, season-wise and year-wise catch data was generated and analysed for proper interpretation. For easy comprehension, the calendar year was divided into four seasons *viz.* post monsoon (January-March), summer (April-June), pre monsoon (July-September) and monsoon (October-December) following Rajasegar and Sendhilkumar (2009).

Conventional diversity indices like Shannon diversity index (H' log e), Margalef's richness index (d), Pielou's evenness index (J') and Simpson index (1-Lambda') were derived to understand the fish diversity in different years. To compare the diversity between the years, dominance plot was drawn (Lambshead *et al.*, 1983; Clarke and Warwick, 2001) by ranking the species in decreasing order of abundance. The data were fourth root transformed before the computation of diversity indices, similarity and cluster analysis. The similarity in species composition was studied by calculating the Bray-Curtis coefficient (Clarke, 1999).

The similarity matrices were constructed using the Bray-Curtis similarity measure and the similarity is 100% if the two samples are totally similar while it is 0 if the two samples are totally dissimilar. In the cluster analysis, hierarchical agglomerative clustering, the Bray-Curtis similarity was used to construct the map (Clarke and Warwick, 2001). New diversity indices have statistical support to compare the biodiversity within different years and it was derived by using taxonomic diversity index (Δ), average taxonomic distinctness index (Δ^+), and variation in taxonomic distinctness (λ^+) as per Clarke and Warwick, 2001. Delta$^+$ and Lambda$^+$ do not involve systematic bias of low sample size which is considered to be a desirable property for any index. Also, Δ^+ is the measure of mean path length through the taxonomic tree connecting every pair of species and λ^+ is the variance of these pairwise path lengths which reflects the unevenness of the taxonomic tree. To find out the deviation from the normal distribution and to test the variance between the samples, Δ^+ and λ^+ values were used for plotting the 95% funnel plots. All the univariate and multivariate analyses for the diversity profile were done using the PRIMER (v.6) software (Clarke and Gorley, 2006).

Results and discussion

Species composition

A total of 69 species belonging to 29 families and 44 genera were recorded during the study (Table 1). A maximum of 8 species was observed under the family Lutjanidae followed

Table 1. List of reef fish species with their family landed during the study period

No.	Family	Species	2009	2010	2011
1	Dasyatidae	*Himantura uarnak*	P	P	P
2	Dasyatidae	*Pastinachus sephen*	P	A	A
3	Dasyatidae	*Neotrygon kuhlii*	A	A	P
4	Myliobatidae	*Rhinoptera javanica*	P	P	P
5	Myliobatidae	*Aetobatus narinari*	P	P	A
6	Carcharhinidae	*Carcharhinus melanopterus*	A	P	P
7	Chirocentridae	*Chirocentrus dorab*	P	P	P
8	Carangidae	*Caranx hippos*	P	P	P
9	Carangidae	*Selaroides leptolepis*	P	P	P
10	Carangidae	*Alectis indica*	P	P	P
11	Carangidae	*Carangoides coeruleopinnatus*	P	P	P
12	Carangidae	*Megalaspis cordyla*	A	P	P
13	Carangidae	*Scomberoides tala*	P	P	P
14	Carangidae	*Scomberoides tol*	P	P	P
15	Lethrinidae	*Lethrinus nebulosus*	P	P	P
16	Lethrinidae	*Lethrinus miniatus*	P	P	P
17	Lethrinidae	*Lethrinus ornatus*	P	P	P
18	Lethrinidae	*Lethrinus harak*	A	A	P
19	Lethrinidae	*Lethrinus mahsena*	P	A	P
20	Scaridae	*Scarus ghobban*	P	P	P
21	Scaridae	*Scarus rubroviolaceus*	A	A	P
22	Lutjanidae	*Lutjanus argentimaculatus*	A	P	P
23	Lutjanidae	*Lutjanus gibbus*	P	P	A
24	Lutjanidae	*Lutjanus fulviflamma*	P	P	P
25	Lutjanidae	*Lutjanus quinquelineatus*	P	A	A
26	Lutjanidae	*Lutjanus bohar*	P	P	P
27	Lutjanidae	*Lutjanus lutjanus*	P	P	A
28	Lutjanidae	*Lutjanus russellii*	A	P	P
29	Lutjanidae	*Lutjanus lemniscatus*	A	P	P
30	Serranidae	*Epinephelus merra*	P	P	P
31	Serranidae	*Epinephelus tauvina*	P	P	P
32	Serranidae	*Epinephelus malabaricus*	P	P	P
33	Serranidae	*Epinephelus bleekeri*	P	P	P
34	Serranidae	*Epinephelus fasciatus*	A	A	P
35	Serranidae	*Epinephelus undulosus*	A	P	A
36	Serranidae	*Cephalopholis sonnerati*	A	P	P
37	Haemulidae	*Plectorhinchus albovittatus*	P	P	P
38	Haemulidae	*Plectorhinchus diagrammus*	P	P	P
39	Siganidae	*Siganus canaliculatus*	P	P	P
40	Siganidae	*Siganus javus*	P	P	P
41	Siganidae	*Siganus virgatus*	A	A	P
42	Ephippidae	*Platax teira*	P	P	P
43	Ephippidae	*Ephippus orbis*	A	A	P
44	Sphyraenidae	*Sphyraena barracuda*	P	P	P
45	Sphyraenidae	*Sphyraena jello*	P	P	P

46	Mullidae	*Parupeneus indicus*	P	P	P
47	Pomacentridae	*Abudefduf vaigiensis*	P	P	P
48	Terapontidae	*Terapon theraps*	P	P	P
49	Acanthuridae	*Acanthurus gahhm*	P	P	P
50	Acanthuridae	*Acanthurus mata*	P	P	A
51	Acanthuridae	*Acanthurus xanthopterus*	P	P	P
52	Acanthuridae	*Acanthurus triostegus*	P	P	P
53	Acanthuridae	*Zebrasoma velifer*	A	P	A
54	Nemipteridae	*Scolopsis vosmeri*	A	P	P
55	Nemipteridae	*Nemipterus furcosus*	A	A	P
56	Kyphosidae	*Kyphosus cinerascens*	A	A	P
57	Latidae	*Psammoperca waigiensis*	P	A	A
58	Caesionidae	*Caesio cuning*	A	P	A
59	Labridae	*Coris formosa*	A	A	P
60	Labridae	*Hemigymnus melapterus*	A	P	A
61	Rachycentridae	*Rachycentron canadum*	P	A	A
62	Plotosidae	*Plotosus lineatus*	P	A	A
63	Belonidae	*Strongylura leiura*	A	A	P
64	Belonidae	*Tylosurus crocodilus*	A	A	P
65	Holocentridae	*Sargocentron rubrum*	P	A	A
66	Platycephalidae	*Cociella crocodilus*	A	P	A
67	Platycephalidae	*Platycephalus indicus*	A	A	P
68	Monacanthidae	*Aluterus monoceros*	A	A	P
69	Tetraodontidae	*Arothron hispidus*	A	A	P

P = Present A = Absent

by Carangidae and Serranidae with 7 species each. In another study conducted in 9 fish landing centres along Gulf of Mannar, Murugan *et al.* (2014) recorded 14 species belonging to family Lutjanidae landed by bottom set gill nets. In the present study, the number of species recorded under the family Lutjanidae is less as it is from a single fish landing centre. Abdussamad *et al.* (2006) observed seven species under the family Lutjanidae as the common species contributing 99% of the catch of Lutjanidae while studying fishery off Tuticorin along the Gulf of Mannar coast which is in agreement with the present study. Among the 69 species recorded, 54 species belonged to the order Perciformes. During the three year study, the maximum number of species was recorded during 2011.

Abundance

The total reef fish landings by bottom set gill nets at Pamban amounted to 1761 tonnes during the period from January 2009 to December 2011 with a monthly average of 48.9 tonnes. Among the years, a maximum of 44% was contributed during 2011 and it was the minimum during 2010 to the tune of 27%. Season-wise landings also showed major peaks during pre-monsoon and monsoon seasons of 2011. This was due to heavy landings of *Neotrygon kuhlii* and *Himantura uarnak* during premonsoon and *Neotrygon kuhlii* and *Lethrinus nebulosus* during the monsoon season of 2011. Among the 29 families recorded, Dasyatidae (Rays) contributed the maximum with 18% followed by Carangidae (16%), Lethrinidae (15%), Haemulidae (13%) and the rest of the families formed only less than 10% each (Fig.1). The dominant species under the major families were *N. kuhlii* (Dasyatidae), *Scomberoides tol* (Carangidae), *L. nebulosus* (Lethrinidae) and *Plectorhinchus albovittatus* (Haemulidae). The abundance of elasmobranchs was also noticed in Tuticorin region of Gulf of Mannar by James (1973). He also observed good returns of sharks, rays and skates in bottom-set gill nets when compared to landings by other gears in the area.

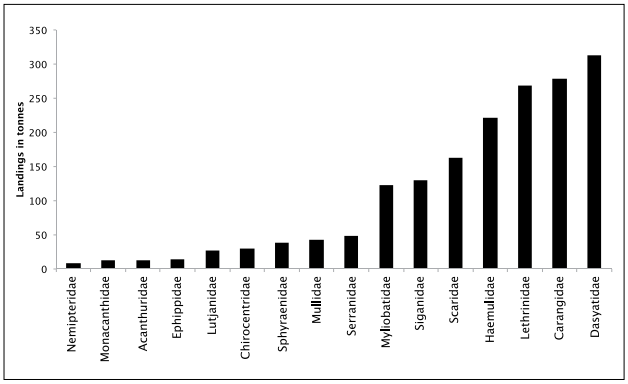

Fig.1. Familywise reef fish landings during the study period

Species wise landings indicated the dominance of *L. nebulosus* (11.5%) followed by *N. kuhlii* (10.6%) among the 69 species landed (Fig. 2). The dominance of *L. nebulosus* among the landings of fishes of the family Lethrinidae was reported from Tuticorin waters along the Gulf of Mannar by Abdussamad *et al.* (2006). As per the IUCN status, two species, *Himantura uarnak* and *Rhinoptera javanica* recorded during the present study are included under the Vulnerable category.

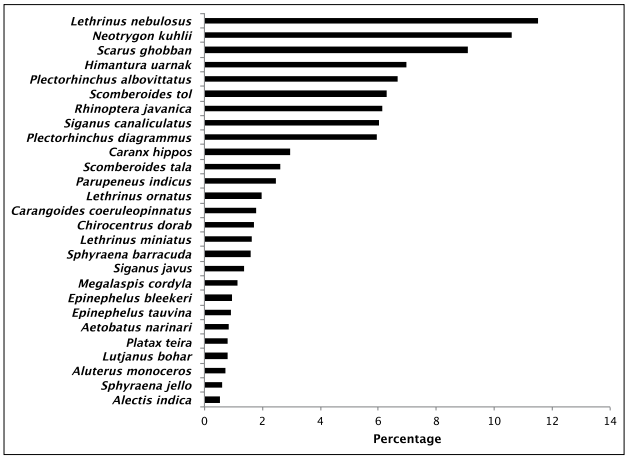

Fig.2. Species wise abundance of reef fishes landed during the study period

Biodiversity

The diversity indices along with some attributes of community

Table 2. Diversity indices and taxonomic attributes during the study period

Year	S	N	d	J'	H'(loge)	1-Lambda'	Delta	Delta+	Lambda+
2009	43	491.27	6.78	0.96	3.60	0.97	50.95	56.33	230.32
2010	48	541.47	7.47	0.97	3.74	0.98	51.09	54.76	223.13
2011	54	631.78	8.22	0.97	3.88	0.98	53.90	56.65	202.10

structure in different years are given in Table 2. Shannon-Wiener's diversity index (H') which is the most commonly used diversity measure did not show much variation between the years, which indicate that species composition in the three years remained almost the same. It showed a gradual increase from 3.60 in 2009 to 3.88 in 2011.

Margalef's index (d) which incorporates the number of individuals (N) and species number (S) also showed a gradual increase from 2009 to 2011. The equitability or Evenness index (J') is almost the same in different years indicating the evenness of distribution of individuals among the different species. In the dominance plot, the curve for 2011, which lies on the lower side, extends further and rises slowly due to presence of more number of species when compared to the rest of the years (Fig. 3).

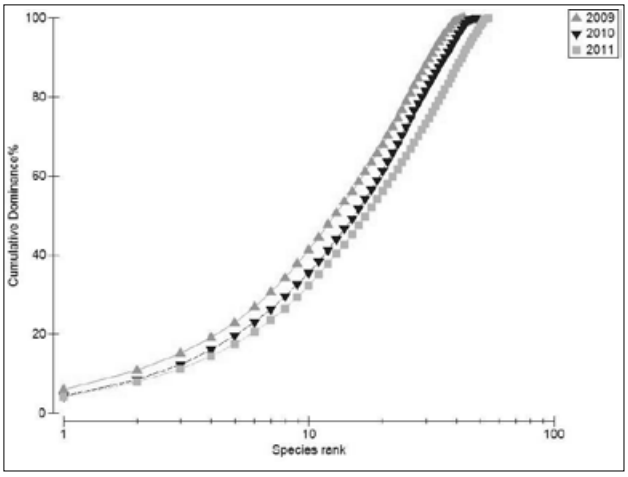

Fig.3. Dominance plot of reef fishes landed during the study period

The similarity in species composition and abundance among different years as derived from Bray-Curtis similarity matrix indicated maximum similarity of 81.8% between 2009 and 2010 (Table 3). Thus, the cluster analysis revealed grouping between 2009 and 2010 with maximum similarity and 2011 got linked to them at 73.4% similarity (Fig. 4).

Table 3. Bray-Curtis similarity of reef fishes landed in different years

Year	2009	2010	2011
2009			
2010	81.84424		
2011	69.95754	76.76924	

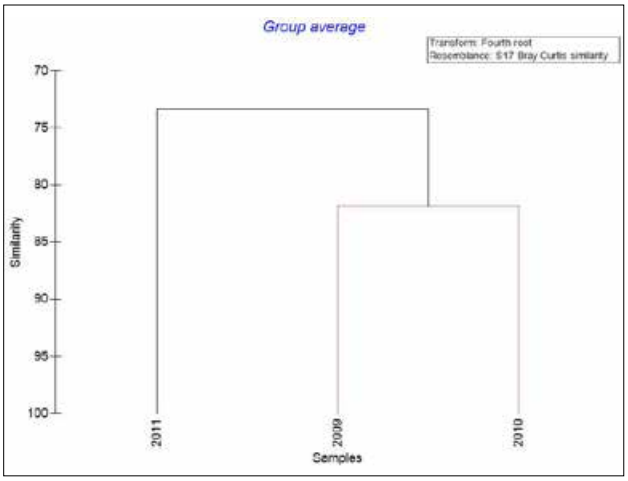

Fig.4. Dendrogram of reef fishes landed in different years

The degree to which species in a sample are taxonomically related to each other can be measured using the newly introduced biodiversity indices namely, average taxonomic distinctness (Δ^+) and variation in taxonomic distinctness (λ^+). The average taxonomic distinctness during 2010 was slightly less than that of other two years which indicate that the taxonomic distance between species was the lowest during 2010. The variation in taxonomic distinctness (λ^+) ranged between 202.10 in 2011 and 230.32 in 2009 (Fig.5). Hence, the unevenness of the taxonomic tree structure was greater during 2009 when compared to that of other two years. Even though the number of species was more during 2011, λ^+ was more during other years indicating the presence of more numbers at higher levels in the taxonomic tree during 2011. As all the values of λ^+ lies inside the funnel plot, it is assumed that they are within the expected limits.

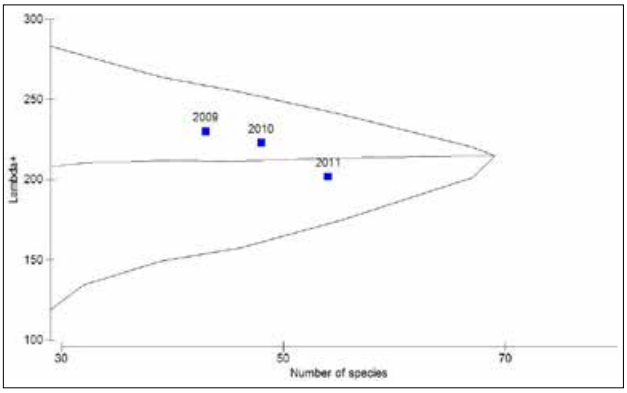

Fig.5. Funnel plot for variation in taxonomic distinctness (λ^+) in different years

Previous studies on biodiversity indices and relative measures with respect to bottom set gillnet landings from Gulf of Mannar is not available and this report forms the first report of this kind from the Pamban fish landing centre. Venkataraman and Wafar (2005) opined that the exact number of species associated with coral reefs of India is still to be found and same is the case with the Gulf of Mannar. According to Kumaraguru *et al.* (2006), nearly 125 species of reef fishes are available in Gulf of Mannar. This is more than that recorded during the present study as it is recorded from the entire Gulf of Mannar ecosystem by all gears as well as by underwater surveys.

The present investigation revealed that the year wise landings by bottom set gill nets showed an increase at Pamban fish landing centre with respect to the number of species and weight. The landings by weight increased from 504 tonnes in 2009 to 784 tonnes in 2011, and by number of species, it showed a gradual increase from 43 species in 2009 to 54 species in 2011. The diversity indices also showed a gradual increase from 2009 to 2011 and average taxonomic distinctness indices are within the expected limit. Thus, it can be assumed that the bottom set gill net fishery remains healthy at this fish landing centre. However, more concerted efforts needs to be done on the monitoring of reef fisheries which will provide information about the diversity of reef-associated fishes, exploitation rate and impact of fishing activities in the reef region. Intensive studies by underwater surveys using SCUBA diving also have to be carried out for the assessment of reef fish diversity.

Acknowledgements

The authors are grateful to the Director, C.M.F.R.I., Dr. Mary K. Manisseri, Dr. Rani Mary George and to Dr. G. Gopakumar, former Heads of Divisions, CMFRI for providing facilities and encouragements. The help rendered by Shri. V. J. Thomas, Shri. A. Gandhi, Smt. P. M. Geetha, Shri. K. M. Sreekumar and Shri. M. Seeni during the period of study is greatly acknowledged.

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