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Assessment of ichthyofaunal biodiversity of trawling grounds off Malpe coast, Karnataka

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Abstract
The present study enables us to understand the fish species composition, seasonal variation and abundance during different months off Malpe coast. The data for the present study was collected from the trawlers operating from Malpe fishing harbour over a period from September-2014 to April-2015. A total 101 species belonging to 47 families and 16 orders were recorded during the study period. *Nemipterus japonicus* contributed highest landings followed by *Trichiurus lepturus*, *Nemipterus randalli*, and *Epinephelus diacanthus.* The cumulative curve (K-dominance curve) plot showed that density of fish species was high in the month of December 2014 and proved the number of species (Richness) more in the month of December 2014 compared to other months. The Bray-Curtis similarity (hierarchical clustering) from the overall cluster analysis, it was observed that the maximum similarity was observed between the month December 2014 and January 2015. Simper analysis was used to examine the contribution of each species to average resemblances between sample groups. The average similarity in group post-monsoon and group pre-monsoon was see by doing hierarchical clustering and the results showed that maximum similarity between post-monsoon and pre-monsoon. The stress value, which was overlying on the MDS plot (0.07), showed an excellent ordination of the samples collected. During the study period immediately after the ban period (Monsoon) there was good recruitment to the fishery.

Keywords: Ichthyofaunal biodiversity, trawling ground, Malpe coast

Introduction
Karnataka state has 300 km of coastline and 27,000 sq km of continental shelf area, rich in pelagic fishery resources. Swathilekshmi *et al.* stated that the mechanization of fishing operation in Karnataka was initiated with the introduction of 30 to 43 feet trawlers in 1957 for exploiting inshore demersal resources including shrimps [1]. There are 6 fishing harbours and 20 fish landing centres in the state. Mangalore and Malpe in South Karnataka and Karwar in the North Karnataka are the main landing centres.

The target species of trawlers in Karnataka were high valued prawns, squids, cuttlefish, threadfin breams and ribbonfish [2]. In Karnataka, bottom trawling was first introduced by the Japanese trawler M.S. Kaiko Maruin 1961. During 1963-67, vessels of Indo-Norwegian Project conducted systematic exploitation of fishing grounds. Initially trawlers operated 10-15 km offshore, but later shifted to shallow waters which promised good catch [3].

Trawlers are among the most fuel-demanding fishing vessels because of high towing resistance associated with the gears i.e. the netting drag alone typically accounts for 60% of the total gear resistance [4]. Fuel demand can be reduced by using larger meshes in the net forepart of the net (Wings and square) without affecting the trawl mouth area and thus the catch efficiency [5].

Srinath reported that the trawlers are the major mechanized fishing fleets which contribute to the fisheries production especially along the west coast of India and Indian marine fisheries production trend showed that 80% of the marine fisheries catch was from trawlers [6]. Prathibha and Alli studied on the fishery biology and stock of the Indian mackerel off Mangalore and Malpe coast and they reported that Indian mackerel, *Rastrelliger kanagurta* is one of the most important marine fish resources along Mangalore and Malpe coast contributed annual average production 9,700 tons during their study period i.e. 1997 to 2001 [7].

Biodiversity, the life sustaining system of the biosphere has intrinsic value and its components have ecological, social, economic, scientific, and educational, culture and aesthetic value. India being the mega diversity country has a vast coastal line of 8118 kms.

Marine fishery potential of the Indian Exclusive Economic Zone (EEZ) is estimated at about

3.93 mt [8]. About 58% of the resources is available at a depth of 0-50 m, 35% at 50-200 m and 7% from beyond 200 m depth. The catch was largely derived from the intensively fished shelf waters, about 1, 94,490 fishing crafts of various sizes and classes are under operation in marine fisheries, consisting of 72, 559 mechanized, 71,313 motorized and 50,618 non-mechanized fishing vessels [9].

Fig 1: Study area, Malpe fish landing center (Jetty) Lat.13°20'56.87"N; Long. 74°41'50.47"E

Materials and Methods

Malpe fishing harbour (Lat.13°20' 56.87" N; Long.74 °41'50.47" E) is one of the important landing centres of Karnataka coast. The data for the present study was collected from the trawlers operating from Malpe fishing harbour during the period from September-2014 to April-2015. From each boat the details on total quantity landed, species composition, horse power, type of boat and other fishing information was collected. Besides, the information on the diesel and ice for each fishing trip will be recorded. The data was analysed to assess the variations of fluctuation of the different species during different months.

A questionnaire was prepared to collect the data and due care was taken while preparing questionnaire to include all the relevant questions which are to be answered by the respondent to fulfil the laid down objectives of the present study. For collection of data trawlers were selected employing the stratified random sampling design developed by CMFRI [10] and sampling was done once in fortnight.

The diversity of finfish was calculated by Shannon- Weiner and Pielou's evenness indices. Since individual size of fish species differed greatly, the indices was expressed in terms of biomass and not in terms of number of individuals. Hill abundance was used to examine the variation in the number of dominant species. Species richness was calculated by Margalef's index. However, all the diversity indices were done by using the PRIMER V.6 analytical package developed by Plymouth Marine Laboratory, U.K.

The identification of fish was done based on fresh and preserved specimens. The collected fishes were preserved in 10% neutralised formalin. Each fish species in trawl catch was identified up to species level following Fish Base (http://fishbase.org) [11]; FAO identification sheet [12], IT IS (Integrated Taxonomic Information System) standard report (http://www.itis.gov) [13].

Results and Discussion

A total 101 species belonging to 47 families and 16 orders were recorded during the study period. *Nemipterus japonicus* contributed (16.5%) of total landings followed by *Trichiurus lepturus* (13.59%), *Nemipterus randalli* (11.48%), *Epinephelus diacanthus* (6.08%) *Lagocephalus inermis* (5.12%), *Rastrelliger kanagurta* (3.41%) to the total fish species, whereas the other species contributed less than three percent (Fig 2). Naomi *et al*. have reported on the trawl fishery of southern Karnataka, the major species recorded were *Nemipterus randalli* (16.8%) followed by *Lepturacanthus savala* (14.3%) and *Decapterus russelli* (14%). Almost similar types of finfishes were recorded during the present study.

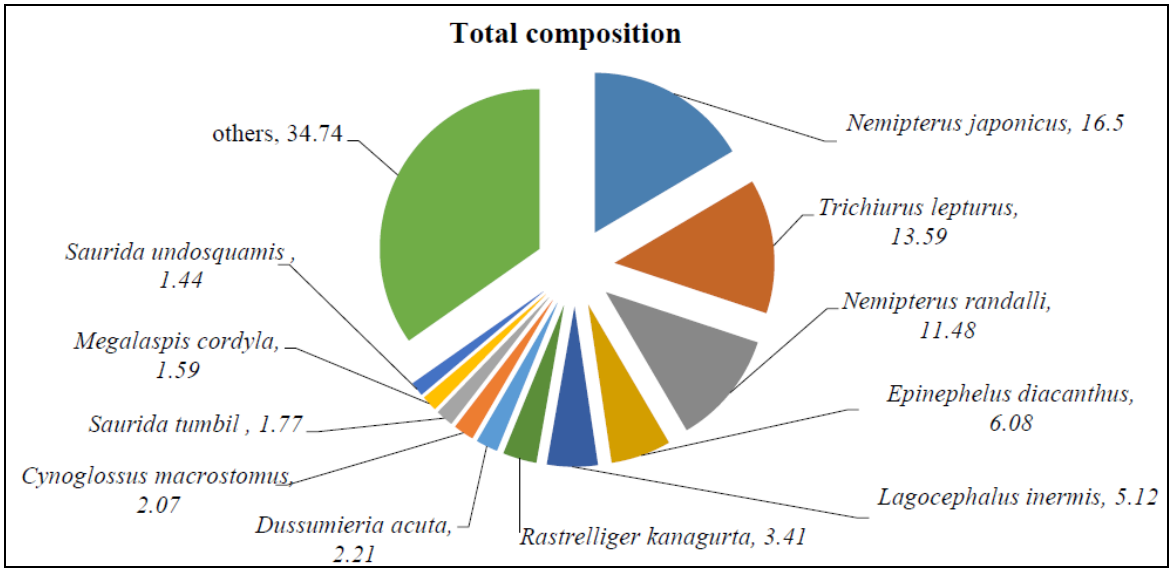

Fig 2: Diagrammatic representation of % biomass contribution of each species during the study period

The results of the diversity measurement using different indices on species richness, diversity and evenness for different month are presented in Table 1.The result showed that the species diversity and richness was more in post monsoon season compared to other seasons. Highest value was recorded in November 2014 (9.333) that coincided with the occurrence of highest number of individuals.

Table 1: Variation in different indices based on species abundance recorded during different months

Months	S	N	d	J'	H'(log10)	1-Lambda'	N1	N2
Sep. 2014	79	13706.92	8.188412	0.88603	1.681354	0.965679	51.74803	31.72641
Oct	91	18303.09	9.169801	0.919669	1.80167	0.978623	70.80736	54.98088
Nov	93	19054.48	9.335308	0.885428	1.742949	0.973503	58.62488	39.2764
Dec	90	25633.97	8.767027	0.858206	1.677142	0.966542	50.92439	31.81012
Jan.2015	86	23895.4	8.431334	0.856665	1.657216	0.964668	47.65279	29.26915
Feb	88	17453.15	8.907295	0.892429	1.735313	0.972526	57.61075	37.75847
Mar	84	16939.81	8.523817	0.899278	1.730462	0.972072	56.58964	36.61209
Apr	82	18081.29	8.263086	0.882875	1.689659	0.970988	50.55501	33.25743

The average value recorded was 1.714, whereas highest value recorded during the month of October 2014. The Simpson index (λ) ranged from 0.965 to 0.978. The average value recorded was 0.970 (Table 1). The value of Shannon –Wiener index (H') (at log $_{10}$) ranged between 1.078-1.438. The highest value recorded in post-monsoon season 1(1.438). The Simpson index (λ) ranged from 0.806- 0.930. Highest value recorded in post-monsoon season 1 (0.930).

Hill diversity number N_1, which is the measure of the number of the abundant species in the sample. Highest value for Hills diversity numbers (N1) and (N2) were recorded during the month of October 2014 and lowest during the month of January 2015 and September 2014 (Table 1) similar results have been reported by [14, 15].

The value of evenness index (J') ranged from 0.856 to 0.919. It was found to be lowest during the month of Jan.2015 and highest during September 2014 and October 2014.

The result from K-dominance curve was obtained by plotting percentage cumulative abundance against species rank K on a logarithmic scale.

The cumulative curve (K-dominance curve) expressed as the percentage of abundance in the sample, referred to as dominance plot shows that curve for month November 2014, which lie on the lower side, extended further and rise slowly due high density of species. The plot shows that density of fish species is high in the month of November 2014 and proved the number of species (Richness) more in the month of November 2014 compared to other months (Fig 3).

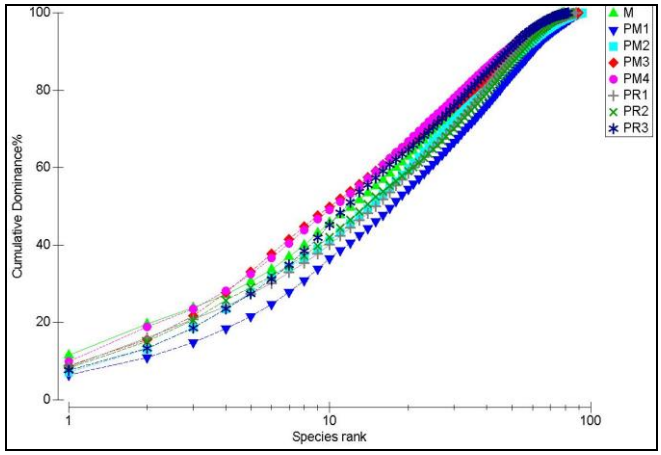

Fig 3: K-dominance curve for species biomass during the study period (Season wise)

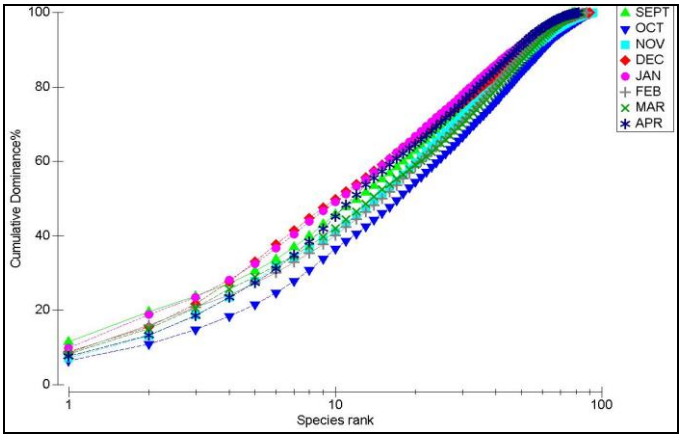

Fig 4: K-dominance curve for species biomass during the study period (Month wise)

In the present study, hierarchical cluster analysis technique was used to see the similarity in species composition and abundance during the study period.

Figure 4shows the results of the hierarchical clustering by using the group average linking between the months during the study period. From the overall cluster analysis, it was observed that the maximum similarity (81.46%) was observed between the month February 2015 and March 2015. During the study period the minimum interrelationship was between September 2014 and November 2014 (63.55%). Cluster analysis was also done to see the similarity between the season and months. The overall cluster analysis, it was observed that the maximum similarity in species composition and abundance was observed between the months December 2014 and January 2015 and minimum interrelationship was observed between September 2014 and November 2014 (63.55%) (Fig 5) and the maximum similarity between post-monsoon and pre-monsoon (Fig 6).

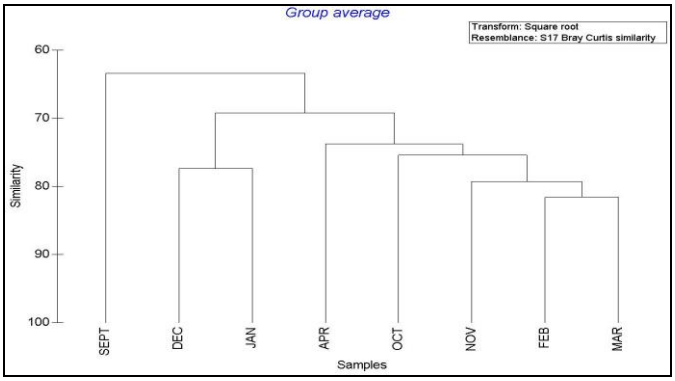

Fig 5: Hierarchical clustering during the study (Month wise)

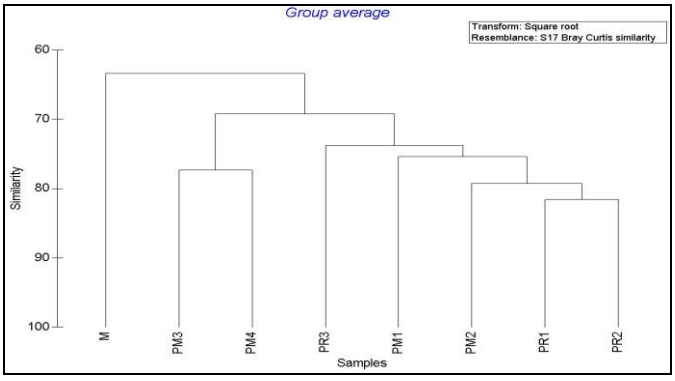

Fig 6: Hierarchical clustering during the study (Season wise)

The purpose of MDS is to construct a map of the samples, in a specified number of dimension, which attempts to satisfy all the condition imposed by the rank (dis) similarity matrix. The results of the study showed that samples lying closer have more similarity in the species composition and abundance, while samples lying far apart have more dissimilarity in species composition and abundance. The same pattern was also evident in the MDS plot where samples from Monsoon fell on one side and those from Pre-Monsoon and Post-monsoon fell other side but the Pre-monsoon shows (80%) similarity of the species composition and abundance during different seasons. The stress value, which was overlying on the MDS plot (0.07), showed an excellent ordination of the samples collected (Fig 7 and 8).

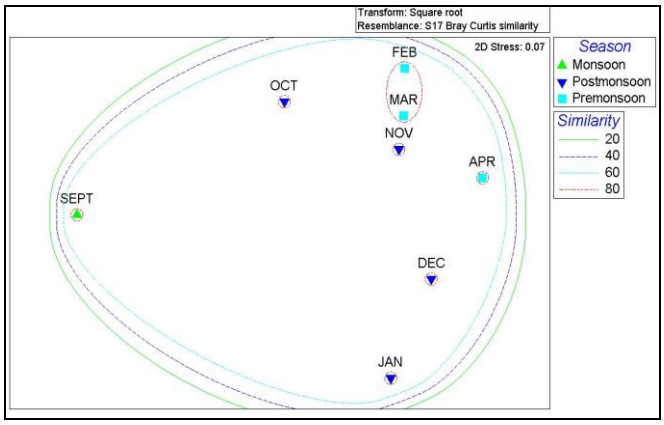

Fig 7: MDS plot showing variation similarity levels during the study period (Month wise)

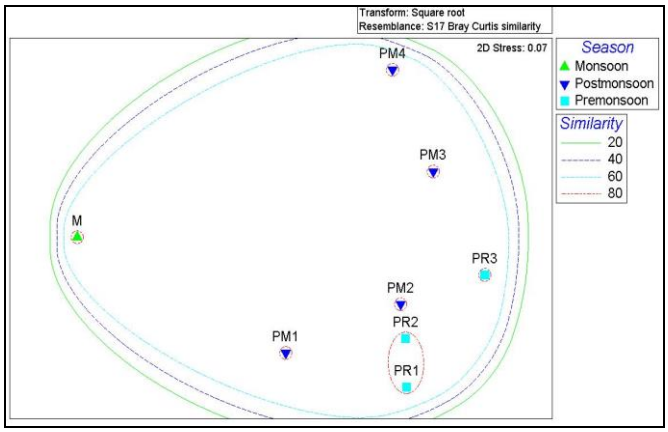

Fig 8: MDS plot showing variation similarity levels during the study period (Season wise)

In the present study, the 95% confidence funnel was generated to ascertain the variation in taxonomic distinctness during different months. The advantage of this 95% funnel is that all the samples can be plotted in the same funnel. The taxonomic distinctness values (lambda+) fell within the confidence funnel and there was no deviation from the normal distribution during the study period. The samples with higher diversity fell within the 95% contours. In the present study also all months fell within same funnel (Fig 9). It clearly shows that there was no deviation from the normal distribution. Similar results were reported by Khan *et al.* during 2005 [16].

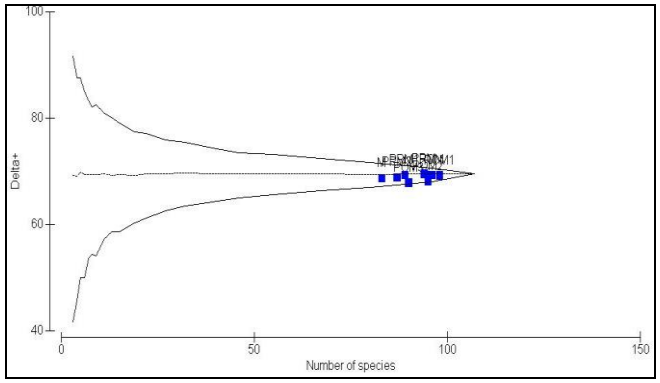

Fig 9: The 95% confidence funnel for variation in taxonomic Distinctness (lambda^{+})

Conclusion

Studies have indicated that the Malpe coast is one of the major fishing harbor and having rich biodiversity. During the study period, there was good recruitment to the fishery immediately after the ban period. Size limits can be legal minimum mesh size or legal maximum sizes, Gear regulations, License limitation, Uniform trawl ban (Seasonal) are the effective management measures to improve trawl fishing operation.

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