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Population dynamics of Randall's threadfin bream *Nemipterus randalli* from Pakistani waters, Northern Arabian Sea

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The *N. randalli* fish data consist of 1141 pair of length weight relationship and 24312 length frequencies were measured during 2009 - 2010 survey. The maximum length and weight were 25 cm and 251 g, respectively. The length-weight relationship were a = 0.035, b = 2.744 and R^2 = 0.972. The asymptotic length (L_∞) and growth coefficient (K) were estimated to 26.25 cm and 0.320 year^{-1}, respectively. The total mortality (Z) was 1.25 year^{-1}. The natural mortality (M) was 0.863, hence the fishing mortality (F) was Z–M = 0.387 year^{-1} for *N. randalli*. The yield per recruit analysis indicated that when t_c was assumed to be 2, F_{max} was estimated at 1.3 and $F_{0.1}$ at 1.3; while t_c was assumed to be 1, F_{max} was estimated at 1.1 and $F_{0.1}$ at 0.95. Currently age at first capture is about 1 year and $F_{current}$ was 0.387, therefore, $F_{current}$ was smaller than $F_{0.1}$ and F_{max}. The results during present study indicate that current fishery stock is in sustainable state. However, it is suggested that take some management steps to maintain the stock of *N. randalli* in Pakistani waters, Northern Arabian Sea.

[**Keywords:** Arabian Sea, *Nemipterus randalli*, fish stock assessment, growth, mortality]

Introduction

The fishing industry of Pakistan is an important source of foreign exchange earnings and employment. Pakistan coastline extends 1100 km from the southeast Indian border (Sindh coast) the northwest Iranian border (Balochistan coast). The Exclusive Economic Zone (EEZ) of 290, 000 km^2, and continental shelf from 200 to 350 nautical miles (N.M)[1] (UN commission March, 2015) from which Pakistan can explore and exploit its marine resources (Fig. 1).

The Sindh coast has a largest discharge of freshwater from Indus River which creates a rich ecosystem to serve as nursery grounds for many finfish and shellfish species[2]. In 2007 the total inland and marine fish production was 750,300t in Pakistan, from which 60% came from marine. The production of marine fisheries had decreased since 1999[3]. More than 250 demersal species are in Pakistani waters and most of them are commercially important. The fish stock has been decreasing due to the over-exploitation of fisheries resources since 1999 due to over consumption of marine resources[3]. Randall's threadfin bream *Nemipterus randalli* (Russell 1986) has a widely distribution in the western Indian Ocean including west and east coasts of India, Pakistan, Iranian waters, Red Sea south to Madagascar[4].

The Nemipteridae family is abundantly distributed in coastal waters of Pakistan. The inhabitant depth range between 22 to 225 m and mostly found in sandy and muddy bottom. *N. randalli* usually found in fish schools. The feeding habits is carnivorous and mostly feed on small fishes, crustaceans and mollusks' (cephalopods)[4]. The Nemipteridae family mainly consists of *N. japonicas* (Bloch 1791) and *N. randalli* (Russell 1986) and has economic importance in the trawl fishery of Pakistan. Due to inefficient fishery management and unenforced fisheries policies, the production of these fish species has been decreasing. Thus the knowledge about population dynamics, growth and mortality rate of these species is very important for a better fisheries management. The fish stock assessment is basic parameters to understand the population dynamics of fish to maintain the fish stock[5].

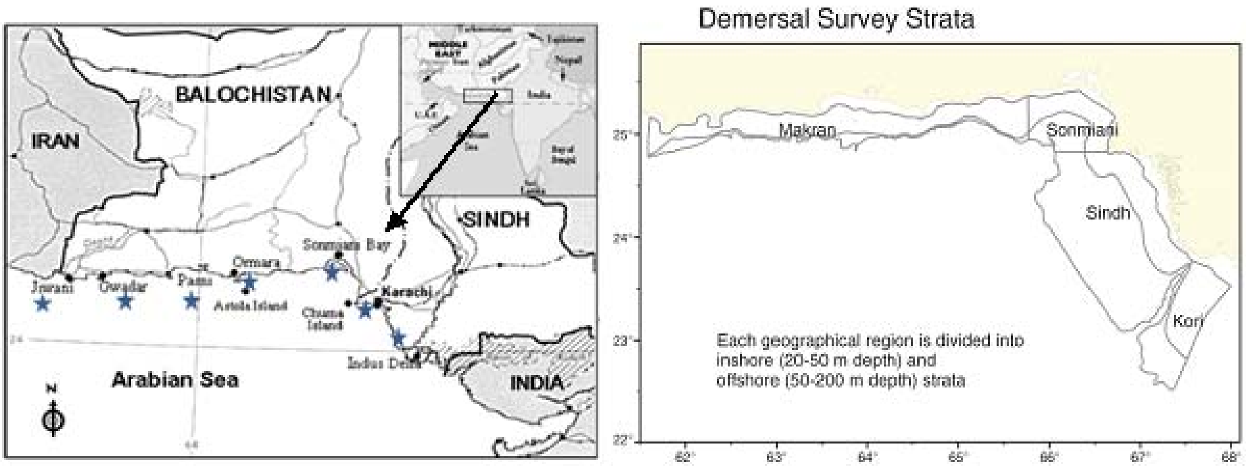

Fig.1—Pakistan coast line map, the sampling stations were randomly selected from demersal surveys strata during 2009 - 2010.

Nemipterus species are commercially important in many parts of the world. Most of work has been done on *N. japonicas* in contrast limited work has been done on *N. randalli* such as age and growth[6] length-weight relationship[7, 8] and record of *N. randalli* from southern Aegean Sea, Turkey[9]. Particularly there are no reports available on population dynamics of *N. randalli* from Pakistani waters, and also there was limited work on growth and mortality parameters available from different parts of the world.

This species has demand in the international markets such as China, Middle East and other Arab countries; about 75% of the landing of these fish in fresh and frozen state was exported to those countries from Pakistan.

Limited work has been done on the fish stock assessment from Pakistani waters like maximum sustainable yield of *Harpadon nehereus*, *Saurida tumbil* and Indian Squid[10, 11,12a], respectively, and stock assessment of *Saurida undosquamis*, *Nemipterus japonicus,* Indian Squid, Hairtail fishery and *Portunus pelagicus*[13,14,15b,16,17], respectively.

During present study most of the catch was caught from Sindh and Sonmiani area (Fig. 1). The catch was mostly found from muddy and sandy bottom and depth range were from 50 m and 150 m. Due to freshwater inflow from Indus River this area have rich mangrove ecosystem which is the best growing and nursery grounds for this fishery. During present study the fish mostly was caught from Sindh coastline. The best season for this fishery is August to November.

Present study, used length frequency data analysis to estimate the growth and mortality parameters. The length frequency data analysis method was frequently used where age-structure data are limited. The age-structure data especially from tropical waters were not easy to determine due to seasonal variations. The study of otolith rings or banding pattern were not visible[18] (e.g. in tropical fisheries).

The objectives of this study were to estimate growth, mortality and biological reference point parameters of the *N. randalli* from Pakistani waters, Northern Arabian Sea. These results may be helpful for fishery scientists and provide some basic knowledge for future studies. The present study may be helpful for fishery managers to maintain the stock of this species at a sustainable state.

Materials and Methods

Data collection methods

Four demersal trawl surveys were carried out from Pakistani waters during 2009 - 2010. The total of 250 stations was trawled. Three research vessels were used to conduct the demersal trawl surveys. During 2009 *R/V 'Ferdows-1'* Iranian research vessel were used. This vessel is a stern trawler (685 (GT) grass registered tonnage, 45.4 m length overall) and well equipped with Global Position System (GPS), ITI net sounder system, two echo sounders and bottom trawl (mesh size of codend 80 mm and headline 72 m). During 2010 *R/V Dr. Fridtj-of-Nansen* was used which is originally Norwegian research vessel (1444 (GT), gross tonnage, 56 m* 12 m, length overall, Breadth) with bottom trawl has headline of 31 m, footrope 47 m and 20 mm mesh size in the codend with an inner net of 10 mm mesh size. The trawl height was 4.5 m and distance between wings during towing about 21 m the sweeps were 40 m long and well equipped with all scientific and modern research facilities. The *third fishing vessel during 2010 Mahboob-E-Madina* is a local fishing vessel was used to conduct the research survey 69 grass tonnage (GT), 18.15 m length overall, 10.8 m beam bottom trawl with mesh size 50 mm and codend 25 mm) with depth sensor and GPS.

Total 250 demersal trawl stations were randomly carried out from Pakistani waters. For each trawl the date, time, trawl duration, bottom depth, GPS positions, towing speed, towing distance etc. were recorded. Each trawl was standard tow about 30 minutes with an average speed about at 3.5 knots. After each trawl the fish species were identified using taxonomic identification sheets and field guide[19, 20], the length-weight and length frequency data were recorded on board during those surveys.

The demersal trawl has been used during four different trawl surveys, 250 stations were trawled and *N. randalli* were caught from 116 stations in 2009 – 2010. The total of 1141 pair of length weight and 24312 length frequencies of Randall's threadfin bream (*N. randalli*) were measured. The 16030 in October - November during 2009, 394 in May - June, 666 in August and 7222 in November during 2010 were also shown in Figure 4. The fork length (FL) was measured in to cm and total weight was measured in to grams (g). The data were collected from the demersal trawl research surveys instead of from local fish landing harbors, it can be considered as representative of the all length frequency distribution of the fish species.

Length weight relationship

Length-weight relationship of Randall's threadfin bream was calculated by the power function of: $W = aL^b$ where L is length (FL, cm), W is the weight of the fish (g), *a* is a constant condition factor (intercept) and *b* is the slope of relationship.

Growth rate

Growth rate was estimated by fitting length frequency data in to the von Bertalanffy growth function (VBGF) $L_t = L_\infty(1 - \exp(-k(t - t_0)))$ where L_t was the predicted length (cm) at age t. L_∞ is the asymptotic length, K is the growth coefficient and t_0 was the hypothetical time at which length is equal to zero (usually negative), when fish egg hatch that time larvae must have weight and length that is why called hypothetical age which can be calculated using the empirical equation[21]

$$\log_{10}(-t_0) = -0.3922 - 0.275\log_{10} L_\infty - 1.038\log_{10} K$$

Mortality rate

Total mortality rate (Z) was estimated by using length-converted catch curve analysis method[21]. The natural mortality (M) was calculated using the equation of Pauly (1983)

$$\log_{10}(M) = -0.006 - 0.279\log_{10} L_\infty + 0.654\log_{10} 9(K) + 0.6434\log_{10}(T)$$

where K and L_∞ are VBGF growth parameters and T is the annual mean sea surface temperature which is 27 ° C in Pakistan waters. The instantaneous fishing mortality (F) was taken as differences between total and natural mortality: F = Z - M, whereas exploitation ratio (E) was taken from F/Z.

Biological reference points

Biological reference points (BRF) were calculated by Gulland[22] (1969), the optimum fishing mortality is $F_{opt} = M$.

Beverton-Holt Y/R analysis

Yield per recruit analysis was estimated following Beverton-Holt model

$$Y_w/R = FW_\infty e^{M(t_c-t_r)} \sum_{n=0}^{3} \frac{Q_n e^{-nK(t_c-t_0)}}{F+M+nK}(1-e^{-(F+M+nK)(t_\lambda-t_c)})$$

, where Y_w/R was yield per recruitment, t_c was the mean age of fish at first capture, t_r was the recruitment age, t_λ was the asymptotic age, Q was a constant value and equals to 1, -3, 3 and -1 when n was 0, 1, 2 and 3, respectively.[23]

Growth performance index

Growth performance index (Ø’) of the species was estimated based on equation[24].

$Ø' = \log_{10} K + 2\log_{10} L_\infty$ where K, L_∞ are VBGF growth parameters.

The length frequency data were analyzed by using computer software package FiSAT II (FAO-ICLARM stock assessment tool[25]).

Results

Length weight relationship

The total 1141 pair of length and weight data of both sexes combined was examined in this study. The minimum fork length is 2 cm and maximum length is 25 cm, the total weight ranged from 1 to 251 g, the dominant length range of *N. randalli* are from 11 to 16 cm (Fig. 2)

The length-weight relation for both sexes was calculated as W = 0.035* $L^{2.744}$ (R^2 = 0.972), n = 1141 (Fig.3).

Growth parameters

The estimated von Bertalanffy growth parameters for *N. randalli* using ELEFAN method in FiSAT II computer software package from pooled data were L_∞ = 26.25 (FL - cm) and 0.320 year^{-1} (K) (Fig. 4) and third parameters t_0 was calculated at -0.538. The goodness of fit model of estimation were Rn = 0.323.

Mortality rate

The length-converted catch curve analysis was commonly used where age data (from otolith or scale reading) are difficult to obtain. By applying VBGF growth parameters L_∞ = 26.25 (FL - cm) and K = 0.320 year^{-1} the annual instantaneous rate of total mortality (Z) were estimated which Z = 1.25 year^{-1}. The dark circles used for to calculate the total mortality (Z) through least square linear regression (Fig. 5). The dark circles were selected because smaller size were excluded and larger size fishes were only few. The annual instantaneous rate of natural mortality rate was calculated by using Pauly’s empirical formula and was calculated as M = 0.863 year^{-1} at an average sea surface temperature of 27 °C, therefore, the fishing mortality was calculated as F =Z–M = 0.387 year^{-1}. The exploitation ratio (E) was obtained from F/Z = 0.309

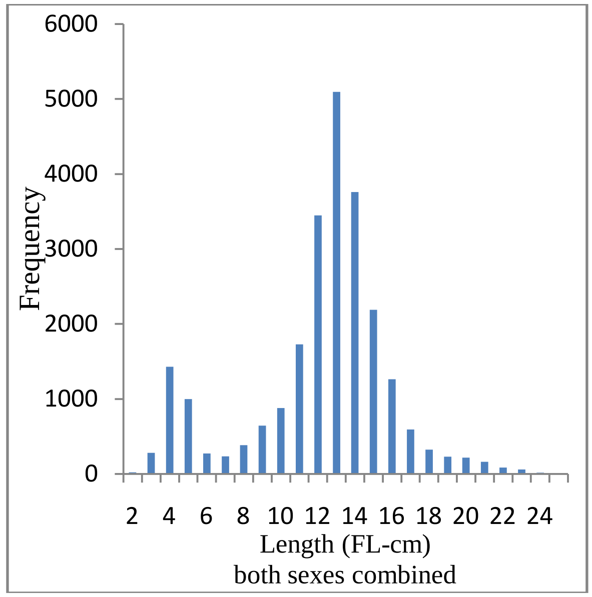

Fig.2—Length frequency distribution of both sexes of *N. randalli* with total number of length frequency 24312 ranging from 2 to 25 cm, using the trawl surveys data from the Pakistani waters during 2009 - 2010.

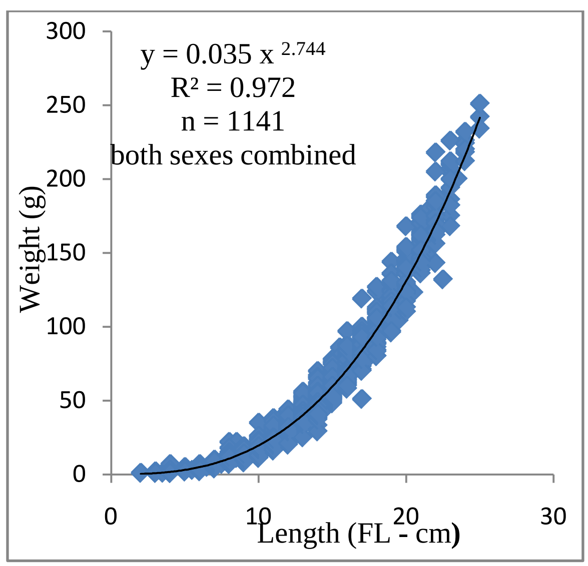

Fig.3—Length-weight relationship of both sexes combined of *N. randalli*, length and weight ranging from 2 to 25 cm to 1 to 251 g respectively, using trawl surveys data from the Pakistani waters during 2009 - 2010.

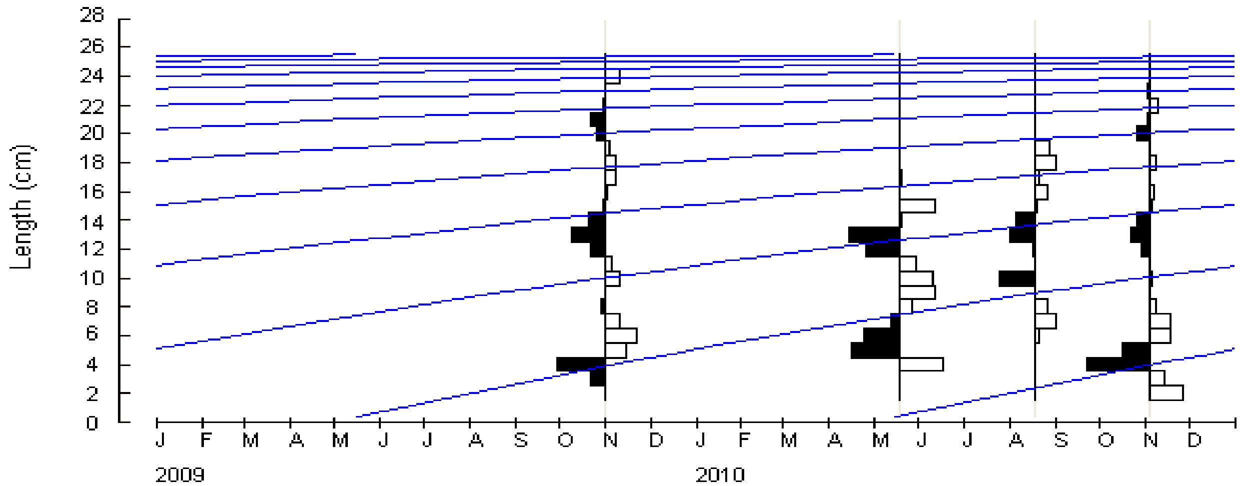

Fig.4—Length frequency distribution data and the growth curves estimated using ELEFAN for *N. randalli* (the von Bertalanffy growth parameters are L_∞ = 26.25 (FL - cm) and 0.320 year^{-1} (K)) using the trawl surveys data from the Pakistani waters during 2009 – 2010.

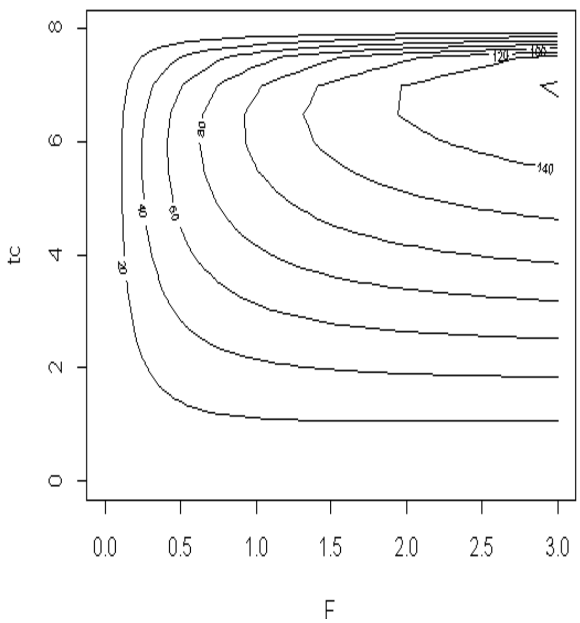

Fig.5—Yield per recruit contour map *of N. randalli* calculated from trawl survey data from Pakistani waters during 2009 – 2010. F = fishing mortality, tc was the mean age of fish at first capture.

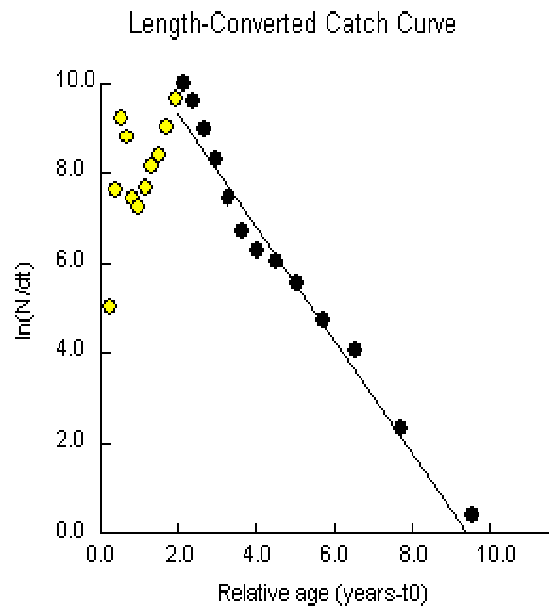

Fig.6—Length converted catch curve of *N. randalli* applying VBGF growth parameters (the von Bertalanffy growth parameters are L_∞ = 26.25 FL - cm and K = 0.320 year^{-1}) using the trawl surveys data from Pakistani waters during 2009 – 2010.

Biological reference points

Yield per recruit contour map is in Figure. 6 when the maximum age was 8 years. When t_c was assumed to be 2, $F_{\max}$ was estimated as 1.3 and $F_{0.1}$ at 3, when t_c was assumed to be 1, $F_{\max}$ was estimated as 1.1 and $F_{0.1}$ at 0.95.

Currently the age at first capture is about 1 year and $F_{current}$ was 0.387, therefore, $F_{current}$ was smaller then $F_{0.1}$ and $F_{\max}$. This indicated that current fishery is in a safe condition. When using Gulland[26] biological reference point, the F_{opt} was equal to M (0.836). The current fishing mortality rate is 0.83 year^{-1} was lower than the biological reference points.

Growth performance index

Applying VBGF growth parameters the growth performance index (∅′) was estimated at 2.34 for *N. randalli.*

Discussion

Length weight relationship

The slope *b* shows the better growth of the fish and lies between 2.5 and 3.5 (usually close to 3) if the value *b* higher than 3 it means the growth of fish is positive allometric and value of *b* is less than 3 it means that the fish growth is negative allometric[27], and the expected range of parameter *b* range of 2.5-3.5 and the relation is isometric when value $b = 3$[28]. The length weight relationship gives basic information of growth parameters and very helpful for fish stock assessment and fisheries management[23].

Limited work has been done on the length-weight relationship of *N. randalli* from the world from which we can compare results with our study which are described below:

For the *N. randalli*[29] estimated the value of slope $b = 2.877$ from Kakinada Indian coast[7], 2.687 from NE Mediterranean coast[6], 3.061 from Northeastern Mediterranean coast[8], and 3.08 from Southern Mediterranean sea were found. In this study, the slop *b* values was found for *N. randalli* $b = 2.744$ with $R^2 = 0.972$ which is close to the value from NE Mediterranean coast[7] and is also close to the previous studies from Kakinada Indian coast. But the value $b = 3.061$ and $b = 3.08$ from Mediterranean coast are higher than the present study which may be due to some ecological and environmental factors affecting the growth of fish from the difference in the *b* values may be due to sampling area, sampling methods, differences in age, maturity and sex, food availability and some ecological factors, annual differences in environmental conditions [28, 30].

Growth parameters

The estimated VBGF parameters of asymptotic length (L_∞) growth coefficient (K) and hypothetical length at age zero (usually negative) (t_0) of *N .randalli* were L_∞ = 26.25 cm $K = 0.320$ year $^{-1}$, $t_0 = -0.538$ respectively, shows the growth rate of the fish. The *Nemipterus* spp. growth parameters estimated by earlier workers using different methods of same species were in Table 1. The VBGF parameters values from Northeastern Mediterranean coast were L_∞ = 34.96 cm $K = 0.21$ year $^{-1}$ which were higher for L_∞ and smaller for *K* than the present study. The values from Kakinada Indian coast were L_∞ = 21.9 cm, K = 0.83 year $^{-1}$ which were lower for L_∞ and higher for *K* than the present study. The *K* and L_∞ values are related with each other when *K* values is higher the L_∞ values always be lower and positive t_0 value shows that juvenile grows very slowly than the negative t_0 value[31,32].

Overall values of different fish species of Nemipteridae family then the values are close to the present study of *N. randalli*. The different values of growth parameters may be because of different sampling time, trawl methods, environmental factors affecting on spawning and different geographical conditions[33] and also some other ecological characteristics species habitat different adaptation patterns were in their life[34].

Different regions indicate different growth rate of the stock[35]. In present study the VBGF growth coefficient was estimated using a non-parametric method which was commonly used in length frequency analysis of fish, which is basically *ad hoc* and does not depend on estimating the parameters of cohort distribution directly. So it makes only weak assumption about the distribution of sizes with the cohorts. The model length of each cohort are fixed to lie upon a curve described by growth models such as von Bertalanffy growth model, thus it makes a strong assumption about growth[36]. The results obtained from different waters in Table 1 are in the range of the present study of *N. randalli* from Pakistani waters. Therefore, we may assume that our results are satisfactory and can represents the fully length class of *N. randalli* species from Pakistani waters, Northern Arabian Sea.

Mortality rate

Mortality defines as the loss of fish from any fish population. To know the mortality rate parameters are an important of any fish stock to understand the population dynamics of any water body. Without knowing the mortality rate from the stock that how fast fish individuals are going to remove from the population it is not possible to estimate the stock to maintain their sustainable state. That is also helpful to fishery managers for better stock management.

There are two types, that fish mortality occurs in the fish population, first the natural mortality (M) which will be cause of fish diseases, chemical and physical environmental factors and the predation. Second is fishing mortality (F) which as caused by fishing activities. Natural and fishing mortality combine will cause the total mortality (Z) of fish stock. In this study the total mortality rate is estimated by length converted catch curve with the help of VBGF (L_∞ , K) growth parameters. The natural mortality is estimated according to Pauly's[37] (1980) empirical equation.

There is no previous published record of mortality rate were found of *N. randalli*.

Table 1 - Comparison of growth parameters of *Nemipterus* species from different areas and Seas

Area	*Species*	L_∞	K	t_0	Source
Indian coast	*N. japonicus*	34.0	0.52	-	Rajkumar et al. (2003)[47]
India	*N. japonicas*	33.9	0.52	-0.160	Murty (1987)[48]
India, Kakinada	*N. japonicus*	31.4	0.75	-0.173	Murty (1984)[49]
Bay of Bengal, Bangladesh	*N. japonicus*	24.5	0.94	-	Mustafa (1994)[38]
Arabian Sea, Pakistan	*N. japonicus*	28.8	0.46	-	Iqbal (1991)[45]
Kagoshima, South Japan	*N. bathybius* (F)	23.1	0.16	-4.4	Granada et al. (2004)[50]
Kagoshima South Japan	*N. bathybius*(M)	27.4	0.34	-0.76	Granada et al. (2004)[50]
Malaysia	*N. bipunctatus*	28.9	0.7	-	Pauly (1980)[37]
Vietnam	*N. virgatus*	38.0	0.17	-	Vinh (1999)[51]
Philippines	*N. peronii*	25.5	0.42	-	Ingles et al. (1984)[52]
Philippines	*N. oveniides*	25.5	0.42	-	Ingles et al. (1984)[52]
Eastern Indian coast, Kerala	*N. mesoprion*	27.54	0.85	-0.01	Joshi (2005)[53]
Indian coast, Bombay	*N. mesoprion*	27.4	0.76	-0.001	Chakraborty (2002) [54]
India, Mumbai	*N. mesoprion*	22.5	0.77	-	Murty et al. 1992[55]
N.S China Sea	*N. virgatus*	33.08	0.3	-0.86	Wang and Qiu (2004)[56]
Gulf of Suez, Egypt	*N. Japonicus*	33.65	0.45	-0.12	Amal (2012)[40]
Eastern Indian, Kakinada	*N. randalli*	21.9	0.83	-	Murty et al. (1982)[29]
Northeastern Mediterranean	*N. randalli*	34.96	0.21	-1.24	Erguden et al. (2010)[6]
Pakistan	*N. japonicus*	40.45	0.270	-0.616	Kalhoro et al. (2014)[14]
Pakistan	*N. randalli**	26.25	0.32	-0.538	present study

L_∞ = asymptotic length (cm), K = growth rate, t_0 = hypothetical age at which length of the fish is equal to zero. $\emptyset'$ = growth performance index, * first time reported from Pakistani waters, - no data in papers

Table 2 - Comparison of mortality rate of *Nemipterus randalli* with other species of *Nemipterus* spp.

Location	*Species*	*M*	*F*	*Z*	Sources
Bangladesh	*N. japonicus*	0.78	0.55	1.33	Mustafa (1994)[38]
Bangladesh	*N. japonicus*	1.32	3.93	5.25	Humayun et al. (1989)[57]
India, Kakinada	*N. japonicus*	1.1	1.53	2.64	Murty (1987)[48]
India, Madras	*N. japonicus*	2.52	0.45	2.98	Vivekanandan and James (1986)[58]
Gulf of Thailand	*N. peroni*	2.44	17.47	19.92	Somjaiwonget al. (1974)[59]
Philippines	*N. bimaculatus*	1.91	3.09	5.0	Corpuz et al. (1985)[60]
India, Mumbai	*N. mesoprion*	1.57	0.98	2.55	Chakraborty (2002)[54]
Egypt, Suez	*N. japonicus*	0.529	1.22	1.75	Amal (2012)[40]
Pakistan	*N. japonicus*	0.74	0.22	0.96	Kalhoro et al. (2014)[14]
Pakistan	*N. randalli**	0.863	0.387	1.25	present study

Z = total mortality, *M* = natural mortality, *F* = fishing mortality, *first time reported

Compare the estimated value of mortality rate of other *Nemipterus* species with current estimated value of *N. randalli* in Table 2. The mortality values in Table 2 are higher than the present value of *N. randalli* may be due to the different commercial demand, sampling area and also some ecological and environmental factor. Only the mortality rate values from Bangladesh were close to the present value[38] and the highest values of *N. peroni* from Gulf of Thailand were shown in Table 2.

This is the first published study on the mortality rate of *N. randalli* from the Pakistani waters and also from the world. This study may provide some basic information about the status of this commercial important fish species from Pakistani waters, and will raise some new findings in the further studies of this species.

According to our results natural (M), fishing (F) and total mortality (Z) were 0.863, 0.387, 1.25, respectively and the exploitation rate (*E*) was estimated at 0.309. The value of *E* may indicate that fishery during that period is in sustainable or in safe condition. This is based on Gulland[26] (1971) in which he stated that when *E* value is more than 0.5, then the stock is generally considered to be over fished. Therefore, we may suggest that the current status of this fish species is in safe condition but fishery managers should take some management steps to maintain the stock of this commercial fish species on sustainable state that can maintain the stock for future generation.

Biological reference points

Yield per recruit (YPR) is commonly used in fish stock assessment models to estimate the optimum fishing mortality and optimum age at first capture which can be used as biological reference points for the fishery[30]. When using YPR biological reference points for fishery management, $F_{0.1}$ is considered more suitable to set management targets than $F_{\max}$ for several reasons[48]. Because, when t_c was assumed to be 1, $F_{\max}$ was estimated as 1.1 and $F_{0.1}$ at 0.95, which are larger than the current fishing mortality of 0.387, it is recommended to maintain the current fishing efforts in Pakistani waters. It was considered that $F_{0.1}$ is more suitable to set fishery management steps rather than $F_{\max}$ for several reasons[39]. We would also recommend further studies such as egg per recruit analysis which may signify different aspects of fish stock structure before implementation of biological reference points to manage the stock of *N. randalli* from Pakistani waters. There is limited work done on population dynamics of *N. randalli* so it is difficult to compare the life history parameters with this study, but our work may raise some concerns into this aspect from the fishery science community.

Growth performance index

Growth performance index ($\emptyset'$) is based on VBGF parameters of asymptotic length L_∞ and growth K[24]. The growth performance index of *N. randalli* was estimated at $\emptyset' = 2.34$. There is no any previous study on growth performance index of *N. randalli* from the world but we can compare with other species of *Nemipterus* spp. like *N. japonicas* of same family. The values from Egypt are $\emptyset'$ = 2.71[40], 2.79[41] from India is 2.98[42], 2.91[43], from Bangladesh is 2.79[44] and from Pakistan is 2.58[45]. Those values are different because growth performance index is calculated from VBGF parameters which can be influenced by ecological factors[46]. On the other hand there is not big difference between those values; therefore, we may assume that the growth performance of this species (2.34) from Pakistani waters is close to the values of *N. japonicus* from different areas of the world.

Conclusion

The present study showed that the stock of *N. randalli* is in safe condition. While to maintain the sustainable state of *N. randalli* fishery, the fishery scientists and fishery managers has to work together. The fishery managers need to take more scientific and management steps like control on fishing license, control of mesh size of fishing trawls, discard of bycatch, proper check and balance on fishing activities specially during closed ban period season, and nursery area must be notified as sanctuaries. The Marine protected areas (MPAs) must be declared as non-fishing zone particular at estuary areas. The Estuary areas are favorable habitat for breeding purpose for fishery. Those kinds of fishery management steps will help to maintain the fish stock for the future.

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