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Population dynamics of Japanese threadfin bream *Nemipterus japonicus* from Pakistani waters

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Abstract

Japanese threadfin bream *Nemipterus japonicus* (Bloch, 1791) is among the most abundant and commercially important species in Pakistan. From the coast of Pakistan, four demersal trawl surveys in October–November 2009 and May–June, August, October and November in 2010 were carried out. The purpose of this study is to estimate the population dynamics and status of the stock of the *N. japonicus* from Pakistani waters based on the research trawl surveys from the research area. The data consist of n=784 length-weight pairs and n=7 530 length frequency with the maximum length and weight of 29 cm and 358 g respectively. The length frequency data were analyzed using ELEFAN method in FiSAT computer package. The parameters of length and weight relationship were b=2.778, a=0.032 and R^2=0.973. The estimated von Bertalanffy growth function parameters were L_∞=30.45 cm, K=0.270 year^{-1}. Based on length-converted catch curve analysis the total mortality (Z) during this study was estimated at 0.960 year^{-1}. The natural mortality coefficient (M) was 0.74 year^{-1} using Pauly's equation (the annual average sea surface temperature was 27°C), therefore, the fishing mortality coefficients (F) were 0.22 year^{-1}. The yield per recruit analysis indicated that when t_c was 2, F_{max} was estimated at 1.2 and $F_{0.1}$ at 1.1. When t_c was 1, F_{max} was estimated at 0.95 and $F_{0.1}$ at 0.8. Because current age at first capture is about 1 year and $F_{current}$ was 0.22, $F_{current}$ is smaller than $F_{0.1}$ and F_{max}, which indicated that the fishery is about in a safe condition. When using Gulland (1971) biological reference point, F_{opt} was equals to M (0.74). The current fishing mortality rate of 0.22 was smaller than the target biological reference point.

Key words: Pakistan, *Nemipterus japonicus*, length-weight relationship, growth, mortality

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1 Introduction

The fishing industry of Pakistan is an important source of foreign exchange earnings and employment. Pakistani coast line extends 1 100 km from the northwest Iranian border (Baluchistan coast) to the southeast Indian border (Sindh coast) with an Exclusive Economic Zone (EEZ) of 240 000 km^2 from which Pakistan can explore and exploit its marine resources (Fig. 1). The Sind coast has a large discharge of fresh water from Indus River which creates an ecosystem to serve as nursery grounds for many finfish and shellfish species (Snead, 1967). In 2007 the total inland and marine fish production was 750 300 t in Pakistan, of which 60% came from marine. The production of marine fisheries had decreased since 1999. The commercially important resources of marine includes about 250 demersal fish species, 50 small pelagic fish species, 15 medium-sized pelagic species and 20 large pelagic fish species and in addition there are also 15 commercial shrimp species and 12 cephalopods (squid, cuttlefish, octopus) and 5 species of lobster (FAO, 2009).

The Japanese threadfin bream, *Nemipterus japonicus* (family Nemipteridae) is widely distributed throughout the Indian Ocean and West Pacific (Russell, 1990). Ninety percent of the threadfin bream fishery of Pakistan is contributed by two species *Nemipterus japonicus* (Bloch, 1791) and *Nemipterus randalli* (Russell, 1986). The *N. japonicus* locally known as Lal pari in Sindhi and Kolonto in Balochi, has a widespread distribution throughout Pakistani waters. *N. japonicus* is a benthic species, mostly found in schools in coastal waters with muddy or sandy bottoms, with water depth of 5–80 m (Russell, 1990). *N. japonicus* is the low price food fish and a good source of food for poor people in Pakistan.

During our study the *N. japonicus* catch was throughout the Pakistan coastline but most of the catches were caught from Sindh coast and near Sonmiani Bay (Fig. 1). These areas are favorable habitat and fishing ground for this fish species due to freshwater flow from Indus River which provides better spawning grounds. *N. japonicus* spawns over extended periods in May to November with the peak spawning season in July–August (Joshi, 2010). We would recommend avoiding fishing activities during that period so that fish can breeds at least once in their life time. The present study shows that the utilization of this fish species in the research area is in a sustainable state.

N. Japonicus during the present study were commonly found

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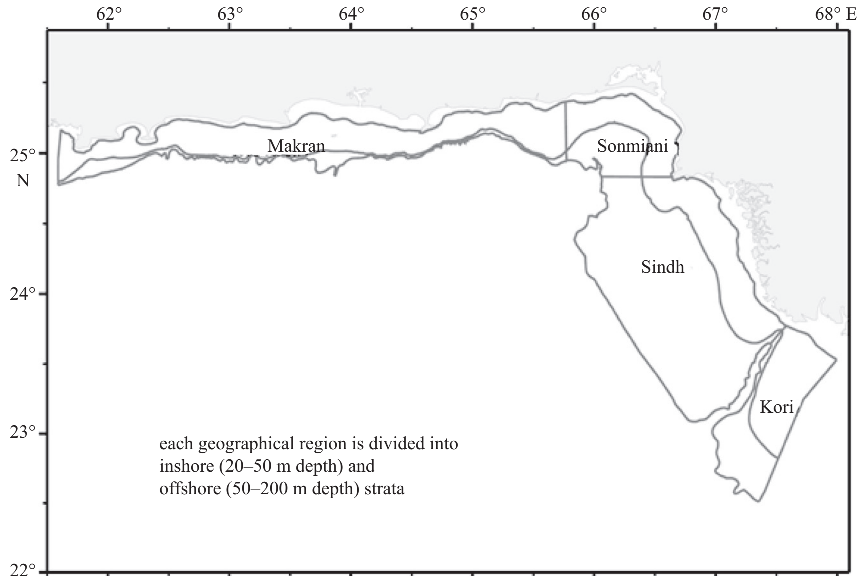

Fig.1. Map of Pakistani coast line. The sampling stations were randomly chosen from demersal survey strata during 2009–2010.

throughout all four demersal trawl surveys. They are commonly found on sandy and muddy bottoms and usually found in schools. Iqbal (1991) described the distribution of *N. japonicus* throughout the Pakistani waters and suggest that the optimum depth range for threadfin bream was between 50 m and 100 m.

Several studies have been done on *N. japonicus* in the world especially from the Indian Ocean region. *N. japonicus* constitutes an important part of the trawl catch in South China Sea (Eggleston, 1972; Lee, 1975; Weber and Jothy, 1977), Andaman Sea (Senta and Tan, 1975), W. Bay of Bengal (Krishnamoorti, 1971), Persian Gulf and Oman Sea (Valinassab et al., 2006).

N. japonicus has been studied on population dynamics (Vivekanandan and James, 1986; Zacharia, 1998; Rajkumar et al., 2003, Khan and Mustafa, 1989; Iqbal, 1991; Mustafa, 1994); on reproductive biology, maturity and spawning and fecundity (Krishnamoorti, 1974; Acharya, 1990; Bakhsh, 1994; Rajkumar et al., 2003; Manojkumar, 2004); food and feeding habits (Bakhsh, 1994; Manojkumar, 2004; Kerdgari et al., 2009); length and weight relationship (Murty, 1984; Bakhsh, 1994; Zacharia, 1998; Rajkumar et al., 2003; Manojkumar, 2004) and on morphological characteristics (Russel, 1990). However there is limited work done on population dynamics of *N. japonicus* from Pakistani waters.

The length based stock assessment was frequently used where age-structure data are limited (e.g., in tropical fisheries, Sparre and Venema, 1998). Based on length frequency data collected from four demersal trawl surveys in 2009—2010 from Pakistani waters, growth and mortality rates of Japanese threadfin bream (*N. japonicus*) inhabiting the region were estimated. The results obtained in this study can be helpful for fish stock assessment and fishery management in Pakistan.

2 Materials and methods

2.1 *Sample collection*

The samples were collected from four demersal trawl surveys in Pakistani waters during 2009–2010 (Fig. 1). The 250 total randomly stations were trawled and out of total from 110 stations we were caught *N. japonicus* during October–November 2009, and May–June, August, October and November in 2010. Total of 7 530 lengths of Japanese threadfin bream (*N. japonicus*) were measured, with 3 493 in October–November 2009, 2 260 in May–June, 245 in August, and 1 532 in November 2010. The seasonal distribution of 784 length and weight pairs, both sexes combined was 263 in October–November during 2009, and 169 in May–June, 78 in August and 274 in November during 2010. The fork length (FL) was measured in cm and weight was measured in grams (g).

2.2 *Analysis of data*

The length frequency data were analyzed using computer software package FiSAT II (FAO-ICLARM stock assessment tool, Gayanilo et al., 2003) in the present study we estimated parameters such as length-weight relationship, growth, mortality rate, biological reference points, growth performance index, virtual population analysis.

2.3 *Length weight relationship*

The total n=784 pair of length-weight relationship of observed length (L, cm (FL)) and weight (W, g) for Japanese threadfin bream was described by the power function: $W = aL^b$ where a is a constant condition factor and b is slope or allometric growth parameter.

2.4 *Growth parameters*

The growth of *N. japonicus* was described by von Bertalanffy growth function (VBGF) (Haddon, 2011) :

$$L_t = L_\infty(1-\exp(-K(t-t_0))) ,$$

where L_t was the length at age t, L_∞ was the asymptotic length, K was the growth coefficient and t_0 was the theoretical age at zero length which can be calculated using the empirical equation (Pauly, 1983):

$$\log_{10}(-t_0) = -0.392\,2 - 0.275\log_{10} L_\infty - 1.038\log_{10} K.$$

2.5 *Mortality rate*

From the estimated growth parameters values (L_∞, K), the annual total mortality rate (Z) was estimated using the length-converted catch curve analysis method (Pauly, 1983). The natural mortality coefficient was obtained by

$$\log_{10} M = -0.006 - 0.279\log_{10} L_\infty + 0.654\log_{10} K + 0.643\,4\log_{10} T\ ,$$

where L_∞ and K are the asymptotic length in cm and growth rate in per year respectively. T is the annual average sea surface temperature, which was 27°C in Pakistani waters. The fishing mortality (F) was calculated by subtracting M from Z, whereas the exploitation ratio (E) was obtained from F/Z.

2.6 *Biological reference points*

Biological reference point was put forward by Gulland (1969), the optimum fishing mortality is $F_{\text{opt}} = M$.

2.7 *Beverton-Holt Y/R analysis*

The yield per recruit was estimated following Beverton-Holt model

$$Y_{\text{w}} / R\ = FW_\infty \text{e}^{M(t_\text{c}-t_\text{r})}\sum_{n=0}^{3}\frac{Q_n \text{e}^{-nK(t_\text{c}-t_0)}}{F+M+nK}(1-\text{e}^{-(F+M+nK)(t_\lambda - t_\text{c})})\ ,$$

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_n was a constant value and equals to 1, -3, 3 and -1 when n was 0, 1, 2 and 3, respectively (Picther and Hart, 1982).

2.8 *Growth performance index*

Growth performance index (∅’) of *N. japonicus* was estimated after Pauly and Munro (1984):

$$\varnothing' = \log_{10}K + 2\log_{10}L_\infty.$$

3 Results

3.1 *Length-weight relationship*

A total of 784 pair of length and weight pairs were examined in this study, the minimum length was 4 cm and the maximum length was 29 cm, the total weight ranged from 1 to 358 g, and the dominant length range of *N. japonicus* are from 12 to 17 cm (Fig. 2).

The combined total length-weight relationship of both sexes was calculated as W=0.032$L^{2.778}$(R^2=0.973), n=784 (Fig. 3).

The seasonal distribution of length weight relationship parameters were the following: During October–November 2009, the minimum and maximum length were from 4 to 28 cm (FL) and weight range from 1 to 288 g, the length-weight relationship parameters were estimated at W=0.033$L^{2.757}$(R^2=0.984), n=263. During May–June 2010 the minimum and maximum length were from 4 to 18 cm (FL) with weight ranging from 1 to 104 g, the length-weight relationship parameters were estimated at W=0.014$L^{3.139}$(R^2=0.961), n=169. During August 2010 the minimum and maximum length and weight were ranging from 6 to 22 cm (FL) and 4 to 167 g respectively, and the length-weight relationship parameters were estimated at W=0.015$L^{3.063}$(R^2=0.958), n=78. During October–November 2010 the length weight range from 6 to 29 cm (FL), 7 to 358 g respectively, and results were estimated at W=0.056$L^{2.593}$(R^2=0.981), n=274.

3.2 *Growth parameters*

Using the ELEFAN method in FiSAT computer package (Pauly, 1983) the estimation of von Bertalanffy growth function parameters of *N. japonicus* were L_∞=30.45 (cm, FL) and 0.270 year^{-1} (K) (Fig. 4). The goodness of fit of model estimation were R_n=0.289.

3.3 *Mortality rate*

Using the input values of VGBF growth parameters (L_∞, K) into the length-converted catch curve analysis, total mortality rate from pooled data was estimated as Z=0.96 year^{-1} (Fig. 5). Using Pauly’s empirical formula, natural mortality was calculated as M=0.74 year^{-1} at an average annual sea surface temperature of 27°C, therefore the fishing mortality was calculated

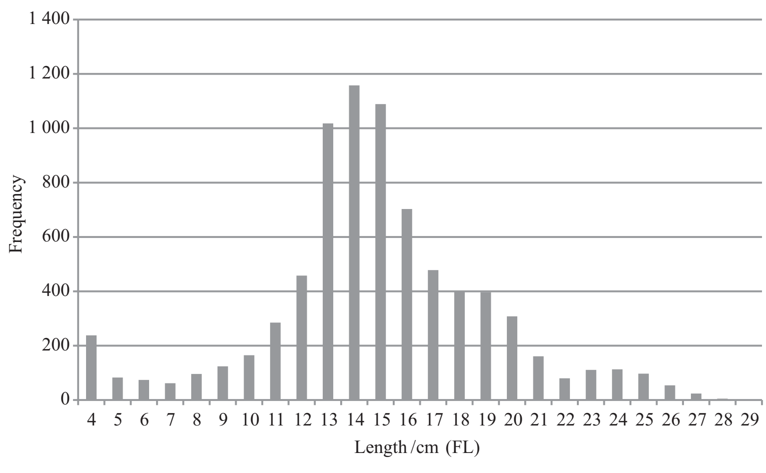

Fig.2. Length frequency distribution (n=7 530) ranging from 4 to 29 cm (FL) and the dominant length frequency range from 12 to 17 cm (FL) of both sexes combined of *Nemipterus japonicus* using the trawl survey data from Pakistani waters during 2009–2010.

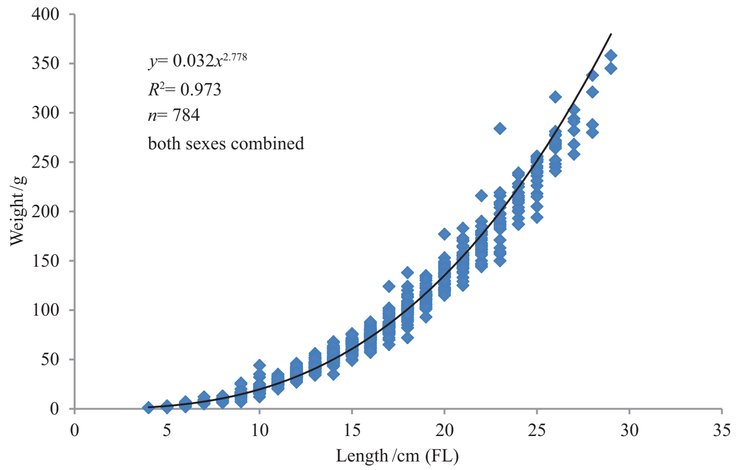

Fig.3. Length-weight relationships both sexes combined of *Nemipterus japonicus* length and weight ranging from 4 to 29 cm (FL) and 1 to 358 g respectively, using trawl surveys data from Pakistani waters during 2009–2010.

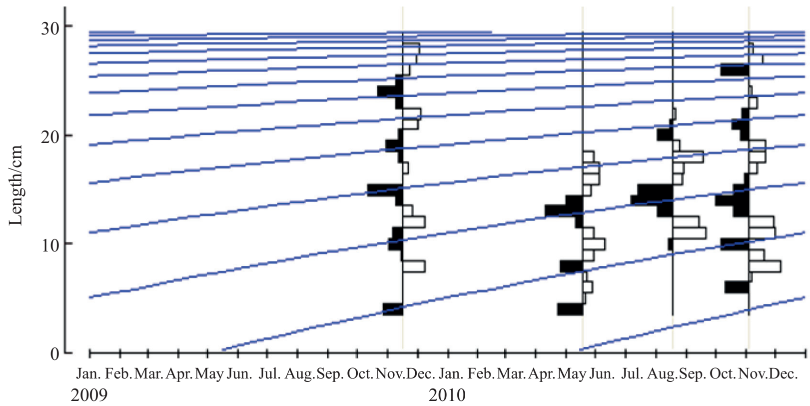

Fig.4. Length frequency distribution data (n=7 530) and the growth curves estimated using ELEFAN for *Nemipterus japonicus* were (L_∞=30.45 (cm, FL) and 0.270 year^{-1} (K)) using the trawl surveys data from Pakistani waters during 2009–2010.

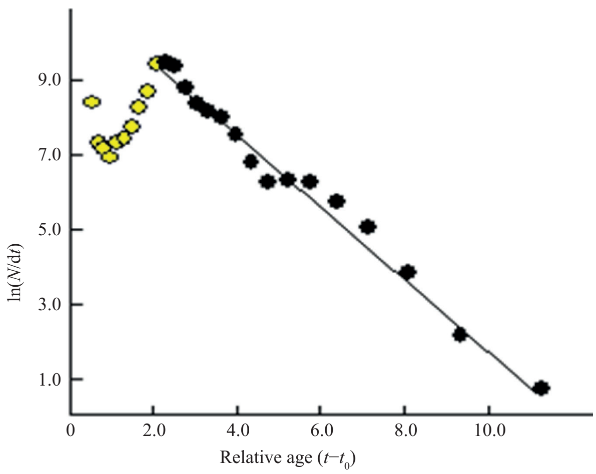

Fig.5. Length converted catch curve analysis of *Nemipterus japonicus* applying growth parameters (L_∞=30.45 (cm, FL) and K=0.270 year^{-1}) from Pakistani waters during 2009–2010. N means population number.

as F=Z–M=0.22 year^{-1}. The exploitation ratio (E) was obtained from F/Z=0.23.

3.4 *Biological reference points*

Figure 6 showed yield per recruit contour map when the maximum age was 8 year. When t_c was assumed to be 2, F_{max} was estimated at 1.2 and $F_{0.1}$ at 1.1. When t_c was assumed to be 1, F_{max} was estimated at 0.95 and $F_{0.1}$ at 0.8. Current age at first capture is about 1 year and $F_{current}$ was 0.22 therefore $F_{current}$ was smaller than $F_{0.1}$ and F_{max}. Using Gulland (1971) biological reference point F_{opt} was equal to M (0.74). The current fishing mortality rate 0.22 was lower than the target biological reference point.

3.5 *Growth performance index*

Growth performance index (∅’) was estimated at 2.399 for *N. japonicus* trawl surveys data from Pakistani waters during 2009–2010.

3.6 *Virtual population analysis*

The results of virtual population analysis (VPA) were analyzed from pooled data from four surveys and from the input of growth and length-weight relationship parameters (L_∞, K, a, b) given above. The output of the length structured VPA using FiSAT for *N. japonicus* are in Fig. 7 and shows that the maximum fishing mortality was at 24 to 26 cm (FL) length.

4 Discussion

4.1 *Length weight relationship*

Length weight relationship (LWR) gives information on the condition and growth parameters of fish which is the basis for stock assessment of fishes (Abdurahiman et al., 2004). This relationship is also helpful in estimating the gonad development, rate of fish feeding, and metamorphosis (Wootton, 1992). The values of b of 3 indicate that the growth of fish is isometric. When the b values are different from 3, it indicated that the growth of fish is allometric (Gayanilo et al., 2003).

The values of length weight relationship of *N. japonicus* in this study are compared with the results for the same species from different areas (Table 1). The estimated exponential b values were similar between previous studies and this study. There is little difference between males and females shows in Table 1. The differences may be due to the sampling differences such as timing, area, vessel and some ecological factors such as temperature, sex, age, food availability and spawning conditions.

4.2 *Growth parameters*

In this study the VBGF growth coefficient was estimated, using a non-parametric method 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 within the cohorts. The model lengths of each cohort are fixed to lie upon a curve described by growth models such as

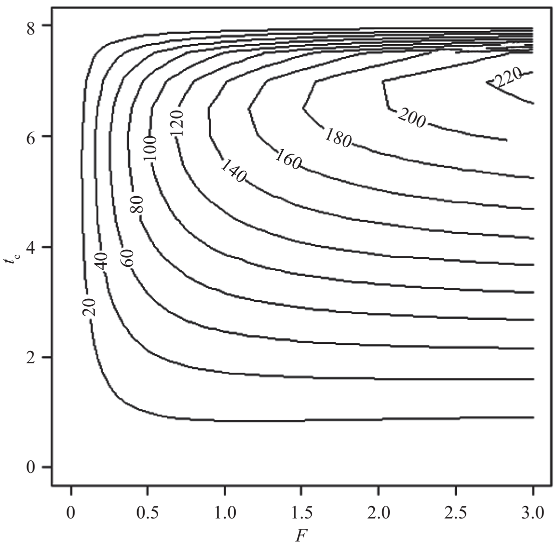

Fig.6. Yield per recruit contour map of *Nemipterus japonicus* using trawl surveys data from Pakistani waters during 2009–2010. F is fishing mortality and t_c is the mean age of fish at first capture.

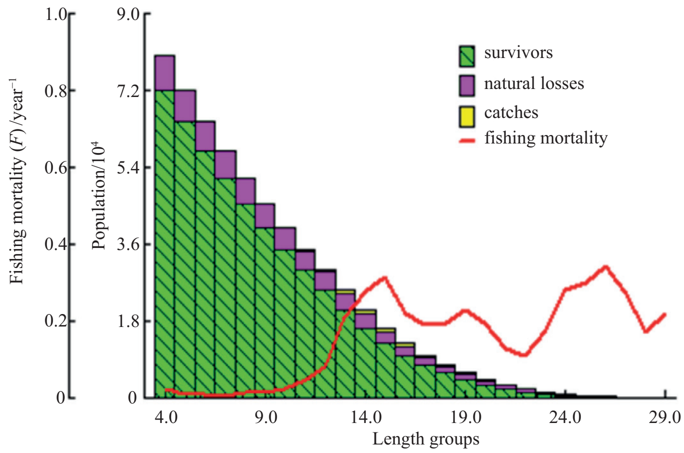

Fig.7. Length-structured virtual population analysis (VPA) of *Nemipterus japonicus* from Pakistani waters during 2009–2010.

Table 1. Summary of the estimated length weight relationship parameters compare with studies from different areas of the world of *Nemipterus japonicus*

Location	Slop "*b*"	Source
India	male 2.076	Krishnamoorthi (1971)
	female 2.942	
Kakinada, India	male 2.43	Murty (1984)
	female 2.95	
	pooled 2.69	
Madras waters, India	both sexes 2.94	Vivekanandan and James (1986)
Kuwait waters	both sexes 2.97	Mathews and Samuel (1989)
Veraval, India	male 2.66	Gopal and Vivekanandan (1991)
	female 2.90	
	both sexes 2.74	
Visakhapatnam, India	both sexes 2.70	Murty et al. (1992)
Jizan Region of Red Sea	males 2.42	Bakhsh (1994)
	females 2.76	
Kerala Coast, India	male 2.78	Sophy and Shahul Hameed (1994)
	females 2.988	
Karnataka, India	both sexes 2.66	Zacharia (1998)
Gulf of Aden	both sexes 2.66	Al-Sakaff and Esseen (1999)
Verval, India	male 2.99	Raje (2002)
	female 3.04	
	both sexes 3.004	
Peninsular west coast, Malaysia	both sexes 2.73	Ahmad et al. (2003)
Verval waters from Gujrat, India	both sexes 2.99	Manojkumar (2004)
Saurashtra coast, Gujarat, India	male 2.77	Kizhakudan et al. (2008)
	female 2.62	
Northern of Persian Gulf	males 2.99	Kerdgari et al. (2009)
	females 3.00	
Beibu Gulf, South China Sea	both sexes 2.94	Wang et al. (2011)
Chennai, India	male 2.84	Kizhakudan and Rajapackiam (2011)
	female 2.84	
	combined 2.84	
Ratnagiri, Maharashtra, India	males 2.76	Kumar et al. (2011)
	female 2.618	
Goa states, India	both sexes 3.02	Pawar et al. (2011)
Persian Gulf	both sexes 2.664	Raeisi et al. (2012)
Gulf of Suez, Egypt	both sexes 2.73	Amal (2012)
Pakistan	both sexes 2.778	present study

Note: *b*=slope.

von Bertalanffy growth model, thus it makes a strong assumption about growth (Pitcher, 2002).

The estimation of VBGF parameters of asymptotic length (L_∞) and growth coefficient (K) using the pooled data of *N. japonicus* from present study were compared with other studies in Table 2. These results were obtained using different data and different methods. Small differences in Table 2 may be due to some variations in population structure and environmental conditions, different trawl methods, timing and area and environmental parameters are affecting on spawning, yield and recruitment of marine fish (Banse, 1959; Ramamirthan and Rao, 1974; Jayaprakash, 2002). Overall the trawl samples that we collected from those surveys can fully represent the length class in the Pakistani waters we can assume that our study is satisfactory because the results are almost same with previous studies from the world.

4.3 *Mortality rate*

The mortality rates of the same species from different areas and the present study are in Table 3. The values in Table 3 were overall higher than the present study which may be due to the high commercial demand therefore resulting the higher fishing mortality and some other environmental factors which may affect on natural mortality.

In the light of the above results of mortality and exploitation ratio from present study the fish stock of *N. japonicus* from Pakistani waters is in a stable condition. Gulland (1971) stated that when the exploitation ratio is above 0.5 then the fish stock is considered at an over-exploitation state and Patterson (1992) also stated that the exploitation ratio should be maintained at the 0.4 level. Therefore the mortality of *N. japonicus* from Pakistani waters is in a stable condition but the fisheries managers should take some steps to maintain the stock of this important fish in Pakistani waters.

4.4 *Biological reference points*

Biological reference points from the procedures of Patterson (1992) were estimated as 0.74 year^{-1}. The yield per recruit anal-

Table 2. Summary of growth parameters estimates of *Nemipterus japonicus* in different regions

Location	L_∞	K	t_0	∅'	Source
India (Andra, Orissa)	30.50	0.314	−1.107	2.740	Krishnamoorthi (1973)
India	20.90	0.648	—	2.450	Krishnamoorthi (1971)
India	30.30	0.249	—	2.430	Kirshnamoorthi (1971)
Hong Kong (females)	34.10	0.190	—	2.340	Lee (1975)
Hong Kong (males)	38.20	0.130		2.280	Lee (1975)
Northern Myanmar (Burma)	37.00	0.235	—	2.510	Pauly and Sann Aung (1984)
Southern Myanmar (Burma)	37.00	0.243	—	2.520	Pauly and Sann Aung (1984)
Manila Bay, Philippines	30.00	0.700	—	2.800	Ingles and Pauly (1984)
Kakinada, India	31.40	0.751	−0.173	—	Murty (1984)
Carigara Bay, Philippines	23.50	0.730	—	2.610	Corpuz et al. (1985)
Samar Sea, Philippines	26.50	0.600	—	2.620	Corpuz et al. (1985)
Gulf of Aden	29.10	0.310	0.048	2.420	Edward et al. (1985)
Madras, India	30.50	1.004	0.226	2.970	Vivekanandan and James (1986)
India	33.90	0.520	−0.160	2.776	Murty (1987)
India	29.80	0.821	—	2.860	Deveraj and Gulati (1988)
Kedha State Pen, Malaysia	31.50	0.530	—	2.720	Isa (1988)
Kedha State Pen, Malaysia	31.40	0.550	—	2.730	Isa (1988)
Bay of Bengal, Bangladesh	26.50	0.600	—	2.620	Humayun et al. (1989)
Bangladesh	24.16	1.061	—	2.791	Khan and Mustafa (1989)
Pakistan	28.80	0.460	—	2.580	Iqbal (1991)
Veraval, India	33.70	0.733	−0.116	2.910	Gopal and Vivekanandan (1991)
Visakhapatnam, India	33.90	0.400	—	—	Murty et al. (1992)
Gulf of Suez	28.64	0.495	−0.122	2.609	Breikaa (1992)
Bay of Bengal, Bangladesh	24.50	0.946	—	2.750	Mustafa (1994)
Bombay, India	35.60	0.755	0.033	2.984	Chakraborty (1995)
Gulf of Suez	29.27	0.462	−0.198	2.597	Breikaa (1996)
Philippine	28.30	—	—	—	Lavapie et al. (1997)
Karnataka, India	33.50	0.900	—	3.030	Zacharia (1998)
Bay of Bengal, Bangladesh	25.60	0.940	−0.616	2.790	Mustafa (1999)
Peninsular west coast	34.80	0.850	—	—	Ahmad et al. (2003)
Visakhapatnam, India	34.00	0.520	—	—	Rajkumar et al. (2003)
Gulf of Suez	28.35	0.630	−0.435	2.794	El-Ganainy and Mehanna (2003)
Cochin, India (males)	31.80	0.690	—	—	Joshi (2010)
Cochin, India (females)	26.50	0.770	—	—	Joshi (2010)
Gulf of Suez, Egypt	33.65	0.450	−0.123	2.710	Amal (2012)
Pakistan	30.45	0.270	−0.616	2.399	present study

Notes: L_∞ is asymptotic length (cm, FL), K is growth rate, t_0 is hypothetical age at which length of the fish is equal to zero and ∅' is growth performance index. — means data not available in papers.

Table 3. Estimation of mortality rate of *Nemipterus japonicus* from different areas and compared with the present study

Area	Z	M	F	Source
Madras, India	2.98	2.52	0.45	Vivekanandan and James (1986)
Kakinada, India	2.64	1.11	1.53	Murty (1987)
Bangladesh coast	3.75	1.97	1.07	Khan and Mustafa (1989)
Visakhapatnam, India	2.12	0.94	1.18	Murty et al. (1992)
Bangladesh Bay of Bengal	1.33	0.75	0.55	Mustafa (1994)
Bombay, India	3.58	1.55	2.03	Chakraborty (1995)
Visakhapatnam, India	3.52	1.11	2.41	Rajkumar et al. (2003)
Peninsular west coast	3.76	1.58	2.18	Ahmad et al. (2003)
Cochin, India (male)	2.32	1.30	1.02	Joshi (2010)
Cochin, India (female)	2.06	1.30	0.76	Joshi (2010)
Cochin, India (pooled)	3.35	1.30	1.87	Joshi (2010)
Gulf of Suez, Egypt	1.75	0.529	1.22	Amal (2012)
Pakistan	0.96	0.74	0.22	present study

Notes: Z is total mortality, M is natural mortality and F is fishing mortality.

ysis (Fig. 6) indicated that when t_c was assumed to be 1, F_{max} was 0.95 and $F_{0.1}$ was 0.8. Currently, the age at first capture is about 1 year and $F_{current}$ was 0.22, this indicated that the current fishing mortality rate is lower than the biological reference point (F_{opt}, 0.74). Therefore it is recommended to maintain the current fishing efforts in Pakistani waters. Because the information and available data is limited, it is very difficult to compare the life history parameters in this study with the others, i.e. that what biological and ecological differences contributes with this process.

5 Conclusions

Fisheries resources of Pakistan are entirely open accessed and there is lack of effective management and planning. Because the present study showed that the stock of the *N. japonicus* fish species from research area is in a sustainable state, we would recommend that the stock should be maintained at the current fishing effort level and the adults must be protected specially during the spawning season so as to provide them with better breeding opportunities. A feasible fishery management measure for this species may be the closing season in Pakistan to protect the breeding stock especially in monsoon season.

Finally the nursery grounds of this economically important species must be protected from pollution especially from the Sind coastline because the Sind coast has the large discharge of fresh water flow from Indus River which creates an ecosystem to serve as nursery grounds for many shellfish and finfish (Snead, 1967) and in particular for this species. Therefore fisheries managers need to take good actions on these issues so as to get more and more benefits from our fisheries resources.

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