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FISHERY AND STOCK ESTIMATES OF TALANG QUEENFISH, *Scomberoides commersonnianus* (FAM: CARANGIDAE) FROM THE ARABIAN SEA COAST OF PAKISTAN

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Analysis of length weight, condition, growth, mortality and exploitation provided an insight into one of the most important fishery stocks of the Talang queenfish, *Scomberoides commersonnianus* landed at Karachi fish Harbour, sampled from July 2012 to June 2013. A sum of 1003 individuals was used to estimate population parameters of length weight relationships power b = 2.88, a = 0.011 $R^2 > 0.95$ indicated slightly negative allometric relationship between the parameters and length-length relationships showed strong linearity, interpreted from the $R^2 > 0.90$. The growth was estimated with the von Bertalanffy equation L_∞ = 136.5 cm, K = 0.25 year^{-1} and t_0 = -0.139 year. The natural (M = 0.40 year^{-1}), fishing (F = 0.76 year^{-1}) and total (Z = 1.17 year^{-1}, $CI_{95\%}$ 0.34–1.21) mortalities were estimated using length converted catch curve. The annual exploitation rate, U was estimated to be 0.45 year^{-1}. The B′/R and Y′/R estimated 0.63 and 0.04 respectively. Hence, annual instantaneous fishing mortality rate of 0.76 year^{-1} was by far in excess of the precautionary target and biological reference points (F_{opt} = 0.38 year^{-1} and F_{limit} = 0.50 year^{-1}) indicating that the resource was over-exploited, therefore reducing fishing pressure would be better for the sustainable exploitation of this species. Our results would also provide scientific support for underlying stock assessment characteristics of an important fish species.
Keywords: *S. commersonnianus,* finfish, dynamics, fishery.

INTRODUCTION

The family Carangidae is represented by forty two species is a dominant finfish group found in Pakistan (Fischer and Bianchi, 1984). It is geographically distributed in the Indo-West Pacific (tropical pelagic waters) (Riede, 2004). Of this family, genus *Scomberoides* comprises of three species namely *S. commersonnianus*, *S. lysan* and *S. tol*, their contribution is of great importance.

The talang queenfish, *Scomberoides commersonnianus* supports a highly and important fishery resource called as aal, saram and gazdani in local parlances. The capture production of *S. commersonnianus* has increased in the western Indian Ocean from 4994 to 11374 in 2001 and 2010, respectively (FAO, 2012) while separate data for this species is not available in Pakistan. However, according to the fisheries statistics genus *Scomberoides* has been reduced from 17779 t in 1999 and 9072 t in 2009 (MFD, 2012). Hence, major portion of the catch belongs to *S. commersonnianus* (Table 1). Information on the biology and fishery of the *S. commersonnianus* is scarce with exception of (Griffiths *et al*., 2005) reported biology, age growth and mortality of *S. commersonnianus* in northern Australian waters. In Pakistan, on the growth, mortality, exploitation and recruitment pattern in other species a recent work of (Panhwar *et al*., 2013a,b) studied and reported higher natural mortalities in two species of shads that is *Tenualosa ilisha* and *Hilsa kelee*. Nevertheless, Panhwar has suggested that maintaining current fishing level of the stock is better for sustainable exploitation of *Hilsa kelee* and reported 10% remaining stocks of the hilsa shad, *Tenualosa ilisha* that indicates severe threats to the hilsa population, thus stringent actions are required to recover the stock level by reducing fishing search and suggested to avoid undersized catch

Table 1. Area wise landing record of the Genus *Scomberoides*, total catch in (metric tones) and effort is in the form of number of fishermen, time series data from 1999–2009 in Pakistan.

Fishing area	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sindh	7721	6514	6471	6142	7101	8121	7548	7901	6335	5897	7102
Baluchistan	10058	9970	7078	4464	3932	2930	2313	1701	2214	3936	1970
EEZ	0	61	0	12	14	7	13	0	0	0	0
Total catch	17779	16545	13549	10618	11047	11058	9874	9602	8549	9833	9072
Abund.index	0.180	0.212	0.148	0.131	0.128	0.112	0.126	0.105	0.094	0.106	0.091

The data obtained from the Fisheries Statistics Book of MFD, West Wharf, fish harbour Karachi, Govt. of Pakistan.

during the fluvial migration.
Keeping in view the importance and major contribution of the carangids in the fishery resources of Pakistan, published information is rarely seen on the biology, growth, mortality, exploitation and recruitment. In this context, this study was intended to estimate population dynamics of the Talang queenfish, *S. commersonnianus* that will enable us in understanding state of the stocks and estimate biological reference point. Consequently the acquired outputs will help in the appropriate management measures of a worth full fishery resource.

MATERIALS AND METHODS

***Data collection and fishing methods*:** To avoid biasness in the fishery data, before the fish sorting at the central landing site, Karachi fish harbour, some 1003 individuals were examined during July 2012 to June 2013. Each individual were recorded to its total, fork, and standard length in (cm) measured and weighed in (g) on the portable balance of 5 kg and individuals more than 5 kg were weighed on the digital balance which is facilitate by the Fishermen's Co-operative Society (FCS) to the fishermen at the harbour. These fishes were mainly caught with gill nets, beach seines and trawls.
***Length weight relationship*:** The length weight relationship was estimated with the equation: $W = aL^b$ where W = weight, L = length, a and b = intercept and slope, the data were converted on natural log to fit linear or straight line of log length and log weight. The equation can be demonstrated logarithmically as: Log W = log a+b log L. The linear regression *LWR* and *LLR* relationships were estimated using NCSS. 8. Statistical package (Hintze, 2012).
***Relative condition factor (Kn)*:** Estimated with equation: $K_n = W / a\,L^b$ this equation can be written as

$$K_n = \frac{W}{\hat{W}} \qquad \text{Le Cren (1951)}$$

Where w = observed weight and $\hat{W}$ is the calculated weight from length weight equation
***Growth estimations*:** To estimate growth parameters (L_∞, K and t_0) of *S. commersonnianus*, the monthly length frequency data (N = 1003) were fitted to the von Bertalanffy (VBG) equation: $L_t = L_\infty\,[1\text{–}\exp\{-k(t-t_0)\}]$ (Quinn and Deriso, 1999), where L_∞ = asymptotic length (cm), k = growth coefficient / year and t_0 = theoretical age at (0) length according the VBGF: $\log_{10}(-t_0) = -0.3922 - 0.275\log_{10} L_\infty - 1.038\log_{10} k$ (Pauly, 1980). The growth performance index is used to compare fish growth with those reported on the same species from different parts of its distribution and estimated with equation: $\Phi' = \log_{10}(k) + 2{*}\log_{10}(L_\infty)$ (Munro and Pauly, 1983).
***Mortalities*:** Natural (M), fishing (F) and total (Z) mortalities were estimated with (Pauly, 1980) equation based on length-converted catch curve which was obtained by pooling monthly data sets and the natural logarithm (*ln*) of the number of individuals in respect age group (N) were plotted against their consequent relative age (t) (Pauly, 1980; Moses, 1988), while natural mortality was estimated with the empirical formula:

$$\log_{10} M = 0.0066\text{–}0.279\log_{10} L_\infty + 0.6543\log_{10} k + 0.4634\log_{10} T$$

Where T = the average annual sea surface temperature (SST = 26°C) recorded in the coastal water of Pakistan. The fishing mortality (F) was obtained by subtracting (M) from (Z) and exploitation ratio (E) was obtained from $\frac{F}{Z}$
***Recruitment, exploitation and biological reference point*:** To study entrance of the new recruits in the population, relative-yield and biomass-per-recruit analyses were conducted with growth and mortality parameters and selectivity ogives derived from probability capture data sets. The IER initial exploitation rate was calculated: $U = F\,(1\text{–}\exp(-Z)) / Z$ with the equation described Beverton and Holt (1957). The biological reference point (BRP) was estimated at $F_{opt} = 0.5\,M$ and $F_{limit} = \frac{2}{3} {*}M$.

RESULTS

A sum of 1003 individuals of *S. commersonnianus* ranging from 18 cm (30 g) to 130 cm (15700 g) and dominant fish size-group concentrated 30 to 50 cm TL and the lowest (3.13%) of the population was between 110 - 130 cm (Table 2). According to the fishery data decreasing trends 0.212 – 0.091 of CPUE in 2000 and 2009 respectively was noted in the landing of the genus *Scomberoides* in Pakistan (Table 1).
***Fishing gear and season*:** The commercially important carangid fishes mainly caught with gill nets, seines on hook and line and in trawls which often made locally. The seasonal variations in the landings of *S. commersonnianus* showed higher quantities in the (Katti) between the period of August to October and the smaller quantities in (Cheeta) April to May following in (Unaro) June to July due to the excessive monsoon currents and closed fishing season in the area (Bianchi, 1985).
***Growth estimates*:** The instantaneous growth coefficient (K) was estimated with the von Bertalanffy growth model estimates are L_∞ = 136.5 year^{-1}, K = 0.25 year^{-1}, t_0 = -0.139 year whereas values of the growth performance index GPI = 3.67 for *S. commersonnianus* (Fig. 2 & 4).
The length weight relationship *LWR* provided a good fit to length and weight data and values of parameter b were close to 3. The pooled data for combine sexes was estimated as $BW = TL$ with R^2 value 0.952. Hence, length-length relationships *LLR* was highly significant interpreted from the coefficient of determination value $R^2 > 0.9$ (Table 3). The condition factor *Kn* was estimated in various months whereas mean *Kn* = 1.05 and the highest *Kn* (1.26) in the month of July 2012 while the lowest (0.87) was in February 2013 (Fig. 1).

Table 2. Number of individuals examined in various months and size-classes in the population of *S. commersonnianus* in present study.

Size classes	Jul-12	Aug	Sep	Oct	Nov	Dec	Jan-13	Feb	Mar	Apr	May	Jun	%ages
10–19.9	0	3	0	0	0	0	0	0	0	0	0	0	0.30
20–29.9	1	36	4	19	23	1	1	0	0	7	7	18	11.6
30–39.9	26	14	39	41	54	13	10	9	1	3	11	5	22.5
40–49.9	17	1	22	19	27	56	11	16	32	37	4	3	24.4
50–59.0	6	0	2	3	7	3	0	3	7	2	5	12	4.99
60–69.9	3	2	2	10	3	9	8	10	4	3	7	10	7.08
70–79.9	6	4	3	6	2	9	18	8	11	17	6	36	12.5
80–89.9	0	2	0	6	1	9	10	15	4	11	11	10	7.88
90–99.9	0	0	4	3	2	4	0	4	2	6	2	9	3.59
100–109.9	0	1	1	2	5	2	1	2	1	2	9	4	2.99
110–19.9	0	1	0	1	0	0	0	2	1	0	1	2	0.80
120–129.9	0	1	1	1	1	0	2	0	2	1	1	0	1.00
130–139.9	0	0	0	0	0	0	0	0	0	0	1	0	0.10
Total	59	65	78	111	125	106	61	69	65	89	65	109	100%

Table 3. Parameter estimation of the length weight and length-length relationships in the present study.

Equation	*a*	*b*	$CI_{95\%}$ of *b*	S. E (*b*)	R^2
$W = aL^b$	0.011	2.88	2.84 – 2.92	0.0204	0.952
TL = a+b SL	1.30	0.986	0.977 – 0.99	0.004	0.990
SL = a+b FL	0.94	0.996	0.990 – 1.00	0.0034	0.990
FL = a+b TL	0.88	0.999	0.993 – 1.00	0.0031	0.995

Table 4. Population parameters and exploitation rates at the existing size at first capture L_{50} at maximum yield per recruit L_{max} estimated for *S. commersonnianus* in collected from July 2012 to June 2013.

M	F	Z	F_{opt}	F_{limit}	B'/R	Y'/R	U	Φ	Exploitation rate (L_{50})
0.40	0.76	1.17	0.38	0.50	0.63	0.04	0.45	3.67	$E_{0.1}$ (year-1) = 0.418 $E_{0.5}$ (year-1) = 0.283 E_{msy} (year-1) = 0.509

***Mortality estimates*:** The total mortality Z was estimated with the catch curve analysis incorporating commercial catches of 2012-2013 of the *S. commersonnianus* yielded $Z = 1.17$ year^{-1} estimates (Fig. 3). By subtracting estimates of natural from total mortality, this interprets to an annual instantaneous fishing mortality $F_{current} = 0.76$ year^{-1} at an exploitation rate $E = F / Z$ of 0.41 year^{-1} (Table 4).

***Recruitment, exploitation and biological reference points (BRP)*:** The recruitment pattern in the population of *S. commersonnianus* was significantly high during the breeding season indicating seasonal recruitment pattern, it prolonged during November 2012 to March 2013 with a peak in January 2013 whereas the lowest in July 2013 (Fig. 5), we estimated biomass-per-recruit was $B'/R = 0.396$ and yield-per-recruit $Y'/R = 0.008$ (Fig. 6). The biological reference points (BRP) were estimated as $F_{opt} = 0.38$, $F_{limit} = 0.50$ and $F_{current} = 0.76$ were calculated (Table 4).

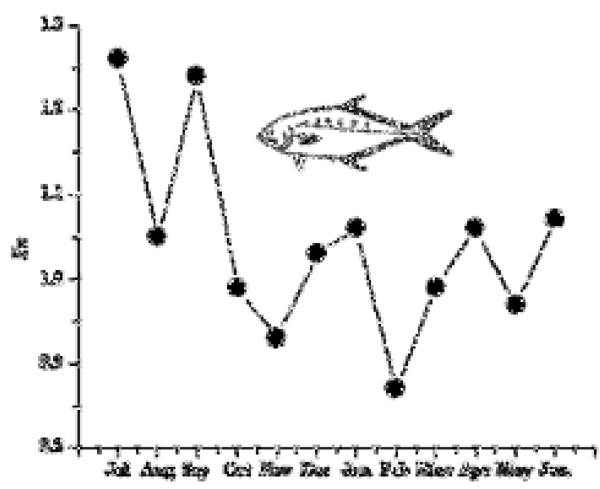

Figure 1. Relative condition factor (*Kn*) calculated from July 2012 to June 2013 estimated for *S. commersonnianus* in Pakistan.

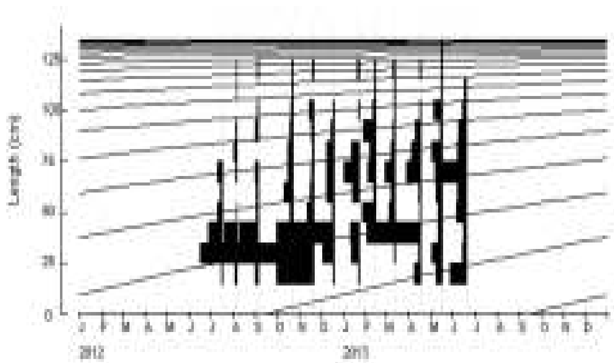

Figure 2. Using total length, von Bertalanffy growth curves estimated for *S. commersonnianus* in various months in this study.

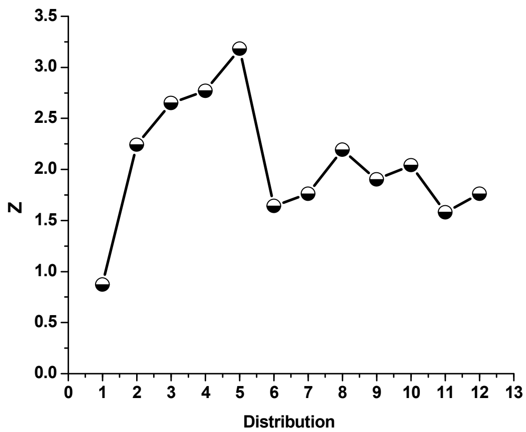

Figure 3. Total mortality distribution obtained using length converted catch curve (Mean Z = 2.05 and standard error 0.054) in the population of *S. commersonnianus* sampled in Pakistan.

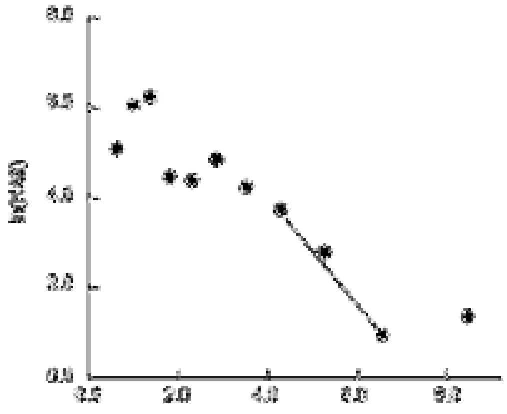

Figure 4. A length converted catch curve estimated for *S. commersonnianus* in Pakistan (L_∞ = 136.5 and k = 0.25).

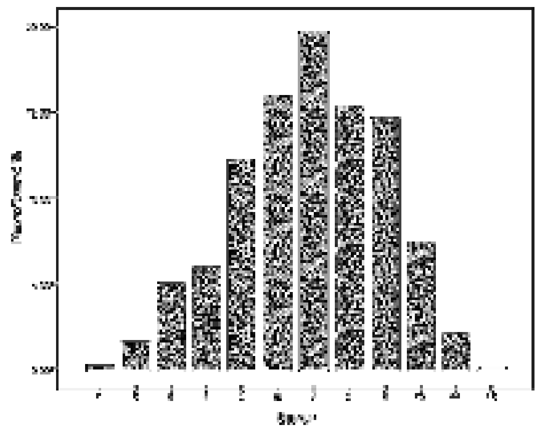

Figure 5. Recruitment pattern in the population of *S. commersonnianus* examined from July 2012 to June 2013 in Pakistan.

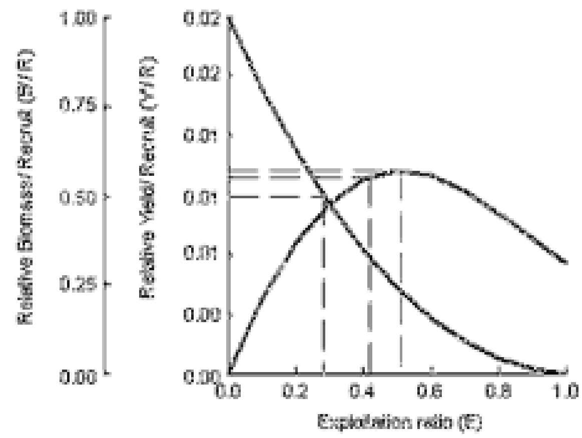

Figure 6. Estimation of biomass-per-recruit and yield-per-recruit (Lc/L_∞ = 0.243 and M/K = 3.04) calculated in this study.

DISCUSSION

In this paper, we have discussed population dynamics of the most fished species Talang queenfish, *S. commersonnianus* in Pakistan. In the sampled population maximum length was measured from 18 to 130 cm which is the largest length within the *Scomberoides* genus. Seasonal variations in the landings of *S. commersonnianus* showed higher quantities in the (Katti) between the period of August to October and the smaller quantities noted in (Cheeta) April to May following in (Unaro) June to July due to the excessive monsoon currents and closed fishing season in the area (Bianchi, 1985).

***Length weight and relative condition factor*:** Generally length weight relationship is considered as the building blocks of the stock assessment and population structure. On the length-weight relationship of *S. commersonnianus* limited information is available with exception from the Honda bay Palwan, Philippines only 88 individuals estimated and found high coefficient of determination 0.99 and from a lagoon of New Caledonia (47) individuals (Fishbase). The slightly negative allometric relationship in the length weight parameters was estimated. Maximum goodness of the fish condition was assessed with *Kn* in the month of March and the low *Kn* value estimated in February. This may be due to the spawning season of the fish which is August and September in the Baluchistan waters (Bianchi, 1985).

***Growth*:** It is generally assumed that the fish grow faster due to some reasons for instance when population density is decreased or when the habitats are improved. Importantly, as suggested (Gulland and Rosenberg, 1992) prior to the estimation of growth parameter we plotted and fitted VBGF against the length frequency data to confirm clear modes indicted by different colour patterns in the graphical plot (score gird) of the LFDA which tells whether the data is suitable for the estimation of growth parameters. The growth in the population of *S. commersonnianus* is not much attractive (0.25) assessed in this study. Hence, there is scarce of the published information available on the growth of the *S. commersonnianus* so we are unable to compare growth parameter from different parts of its distribution. On the other species such as (Panhwar *et al*. 2013) has estimated k = 0.94 in kelee shad, *Hilsa kelee* again Panhwar and Liu (2013) studied reasonable growth in hilsa shad, *Tenualosa ilisha* in Pakistan.

***Mortality*:** Using length converted catch curve we estimated higher mortalities in the lower size-classes during the age of 2–3 years. Our mortality estimations are quite close to the recreational mortality estimation of (Griffiths, 2005) in *S. commersonnianus* for recreational (M = 0.554) and commercial catch (M = 0.825) in Australia.

***Recruitment and exploitation*:** In general, catch per unit effort is often used as an index of abundance (IA) that describes a relative change with time and expected to represent the same proportional change in stock size (FAO, 2006). Recruitment pattern provides necessary information for understanding the biological processes of growth, mortality, recruitment, and migration of a fish population (Quinn and Deriso 1999).

***Conclusion*:** In this study, recruitment pattern indicates that *S. commersonnianus* spawns more than once in a year observed from the availability of the individuals measuring <15cm at the same time >100cm individuals were also captured. With this is mind, the biological reference point at optimum fishing mortality of (F = 0.516) proposed Gulland (1971), in our study fishing mortality rate of 0.76 was beyond the target biological reference point indicates to reduce fishing effort and implement to control on mesh size would be fruitful for the sustainable exploitation of the resource.

Nevertheless, due to the scarce of the information available on the life histories of the *S. commersonnianus* comparison of the parameters was not possible to insight the ecological impact and interactions. Our findings may contribute scientific support for underlying stock assessment characteristics and raise some concerns into the aspect of the population dynamics and fishery management.

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