Population dynamic parameters of *Thunnus tonggol* (Bleeker, 1851) in the Persian Gulf and Oman Sea

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Abstract

Length frequency data of the longtail tuna, *Thunnus tonggol* collected from October 2006 to September 2007 were analyzed for evaluation of the stock parameters. *T. tonggol* is mainly caught by gillnet method. Yearly tuna and tuna-like catches in Iran are of the order of 174,234 mt, close to 46% of which are longtail tuna. The VBG parameters for longtail tuna were: $L\infty$ =133.72cm; K=0.35 year^{-1}.The length –weight relationship was estimated as: $W=0.00002\ L^{2.83}$.The instantaneous rates of total mortality (Z) was estimated by using the Powell-Wetherall plot as 1.82 year^{-1}. The instantaneous rate of natural mortality was obtained by Pauly equation (M=0.44 year^{-1}) and the instantaneous rate of fishing mortality (F) estimated from Z-M=1.38year^{-1}.

Keywords: Growth and mortality parameters, *Thunnus tonggol*, Persian Gulf, Oman Sea

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Introduction

Tuna fishes, scombridae family, are one of the most important parts of the marine fishery production of Iran, and are traditionally exploited by artisanal fisheries in the Persian Gulf and Oman Sea. Annual total commercial landings of tuna fishes are 174,234mt which around 46% of total landings consist of longtail tuna (Table 1). Most of the catches are caught by drift gillnet and trolling.

The main tuna species caught in the Iranian waters are:

Longtail tuna (*Thunnus tonggol*), yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), kawa kawa (*Euthynnus affinis*) and frigate tuna (*Auxis thazard*).

Table 1: Total landings of Scombridae species in the Iranian waters (2010-11) (IFO, 2012)

Species	Catch (mt)	
	2010	2011
T.tonggol	64450	80883
T.albacares	31485	28800
K.pelamis	22285	17473
E.affinis	16336	22266
S.commerson	10884	14794
A.thazard	6172	6013
S.guttatus	3170	3900
T.obesus	0	105
Total	154782	174234

Few studies have been undertaken on longtail tuna and basically the published data on *T. tonggol* are limited. Estimation of growth parameters and mortality rates of *T. tonggol* and determination of its exploitation pattern in coastal waters of Hormuzgan province have been studied by Davarpanah (2007). Also biological and population dynamic parameters of tuna species were studied in the Persian Gulf and Oman Sea by using fishery- dependent data (Kaymaram, 2009). The objectives of this study were to estimate the population dynamics of *T. tonggol* including growth and mortality parameters in the northern Persian Gulf and Oman Sea.

Materials and methods

Length and weight data were collected randomly from five traditional fish-landing sites: Chabahar, Jask, Bandar Abbass, Bandar Lengeh and Parsian (Fig.1) from October 2006 to September 2007.

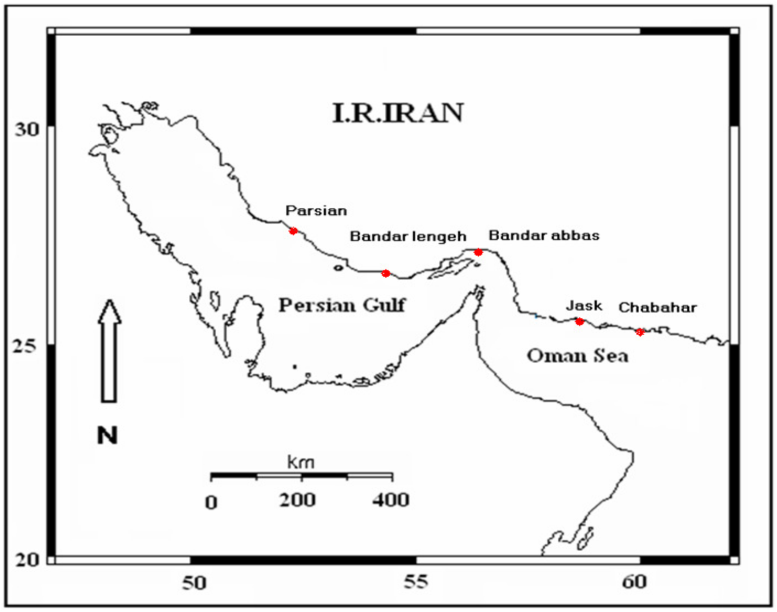

Figure:1: Sampling sites of *T. tonggol* in the north Persian Gulf and Oman Sea

The fishes were randomly measured and weighed to an accuracy of the nearest cm (fork length) and 50 g, respectively. The monthly length frequencies pooled, then were grouped in 3 cm intervals. The total sample size was 4313.

Length – Weight relationship was determined by using the equation $W = aFL^b$, in order to verify if calculated b was significantly different from 3(allometric), the Student's t-test was employed (Zar, 1996).

Predicted maximum length was obtained by extreme value theory (Formacion et al., 1991).

Growth parameters (K, $L\infty$) were estimated by FISAT II software (FAO-ICLARM Stock Assessment Tools) (Gayanilo et al., 1996; King, 2007) by using Shepherd's method for scan of K value, $L\infty$ and Z/K was estimated by Powell-Wetherall plot (Wetherall et al., 1987).

The instantaneous rates natural mortality (M) was obtained using the Pauly's empirical formula (1980). (multiplied by 0.8 as recommended by Pauly for pelagic species).

$M = 0.8*\exp[-0.0152 - 0.279*\ln L\infty + 0.6543*\ln K + 0.463*\ln T]$

Where: T is the mean temperature of surface water, which was considered in this study as 26.5°C.

Fishing mortality (F) was then estimated (F=Z-M) (Sparre and Venema, 1998).

Results

The length frequency distribution used in the analysis are presented in Figure 2.

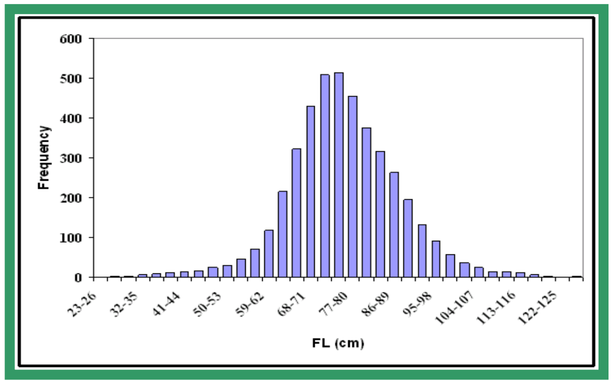

Figure2: Length frequency distribution of *T. tonggol* in the Persian Gulf and Oman Sea (2006-07)

The average length of the fish was estimated 74±11.2cm. The minimum and maximum of the length were observed in 26 and 125cm, respectively. Most of the individuals were found between 77 to 80cm.

The parameters of the length-weight relationship $W = a\ L^b$ were calculated after linear transformation and regression analysis. Length-weight relationship was shown in Figure 3. .The regression coefficient b was not significantly different from (b=3), in which shows the isometric growth (p>0.05).

$W=0.00002\ L^{2.84}$

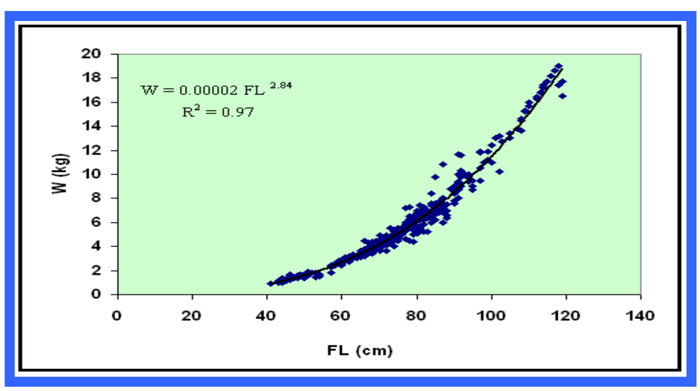

Fig.3: Length-weight relationship of *T. tonggol* in the Persian Gulf and Oman Sea (2006-07)

The range of 95% confidence interval for extreme fork length was 122.11-142.49cm (Fig. 4). Estimated asymptotic length was 133.72cm.

The growth coefficient (K) was calculated by scan of K value as 0.35 per year (Fig. 5).

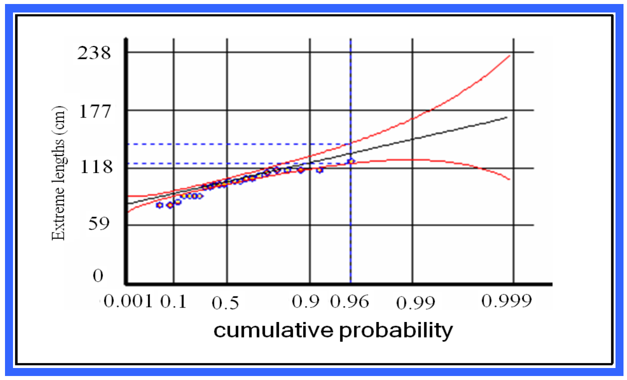

Fig.4: Predicted maximum length of *T. tonggol* based on extreme value theory in the Persian Gulf and Oman Sea

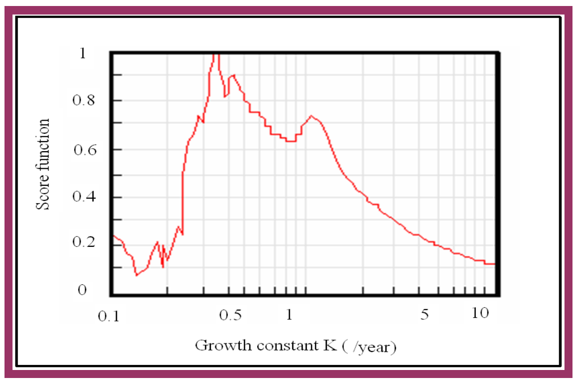

Fig.5: Scan of K value of *T. tonggol* in the Persian Gulf and Oman Sea

Z/K and asymptotic length were estimated by Powell-Wetherall plot 5.2 and 133.79 cm, respectively. Coefficient correlation was r=0.9.

where mean sea surface temperature considered in this study as 26.5˚C. As the pelagic species grows to a large size very fast, the "M" value may be an over-estimation.

The natural mortality coefficient "M" was estimated at 0.55 by employing the equation of Pauly,

Hence the value was multiplied by 0.8 to get a revised estimate of "M" as 0.44.

F=Z-M= 1.82-0.44=1.38

Discussion

Iranian gillnet catches of longtail tuna in Hormuzgan Province are seasonal and showed some differences in the size composition between the Iranian and Omani fisheries on the northern and southern shores of the Oman Sea which could be the result of a size-related migration or of differences in the mesh size of the gillnets used (Khorshidian and Carrara,1993).

The parameters of the length-weight relationship were estimated as:

a=0.00002

b=2.84

The results of different studies about length-weight relationship parameters were presented in Table 2.

Table 2: Comparison of length- weight relationship parameters on *T. tonggol* in different areas

Authors	Area	Base of length	a	b
James et al.,1993	India	TL	0.00008	2.71
Khorshidian and Carrara,1993	Iran	FL	0.00150	2.43
Griffiths et al., 2011	Australia	FL	0.000050	2.82
Darvishi et al., 2003	Iran	FL	0.000040	2.70

Estimated asymptotic length and growth coefficient appear to vary markedly between studies using different estimation techniques and among regions. This is probably a result of very different length ranges of fish presented in each study region or the size selectivity of the sampling methods such as gillnets. These factors would therefore affect estimates of L∞ and the instantaneous growth rate (K). A comparison of the growth curves and growth model parameter estimates in each study from various regions is provided in Table 3.

Table 3: Summary of growth studies on *T. tonggol*

Author	Area	Asymptotic length (cm)	Growth coefficient (per year)
present study	Persian Gulf	133.7	0.35
Wilson, 1981	Gulf of Papua	122.9	0.41
Silas et al.,1985	India waters	93	0.49
Prabhakar and Dudley,1989	Oman Sea	133.6	0.23

The natural mortality coefficient (M) of longtail tuna was 0.55 which multiplied by 0.8 as suggested by Pauly (1983) for the fast moving pelagic species like the longtail tuna that gave the coefficient value of M=0. 44 is in line with estimate obtained in 1992-93 as 0.49 in the same area (Khorshidian and Carrara, 1993). These two estimates through the Pauly's formula appears to be very low when compared to natural mortality of 0.8 per year obtained in Indian waters by James et al. (1993). A comparison of Z, M, F of *T.tonggol* from various countries is given in Table 4. Since M is linked with the longevity and the latter to the growth coefficient K, the M/K ratio is found to be constant among closely related species and within the similar taxonomic groups (Beverton and Holt,1959; Jaybalan et al., 2011). The M/K ratio usually ranges between 1 and 2.5 (Beverton and Holt, 1959). In the present study, the M/K ratio for *T.tonggol* was calculated 1.25.

Fishing mortality was more than three times of the natural mortality and can be attributed to the presence of large proportion of smaller fishes in the catch compared to the maximum size in the catch (Abdussamad et al., 2012).

Table 4: Estimations of mortality rates for *T. tonggol*

Region	F (per year)	M (per year)	Z (per year)	Author
South-west Indian coast	3.60	0.77	4.37	Abdussamad et al., 2012
North-west Indian coast	2.95	0.77	3.72	Abdussamad et al., 2012
Persian Gulf and Oman Sea	2.64	0.49	3.13	Khorshidian and Carrara,1993
Persian Gulf and Oman Sea	1.38	0.44	1.82	present study

The total mortality (Z) obtained in this study seems to be under estimated in comparison with other studies such as 3.84 reported in Gulf of Thailand by Supongpan and Saikliang (1987) and 3.13 by (Khorshidian and Carrara, 1993) (Table 4).

Morphometric studies of longtail tuna indicated that differences exist between subpopulations of this species throughout its range of distribution (Yesaki, 1991). According to Gulland's definition of unit stock, further studies to identify stock and its distribution should be carried out in different areas of Indian Ocean (Sparre and Venema, 1998). It should be emphasized that whole areas such as Australia, India, Thailand, Oman, Iran and other countries located in the Indian Ocean should be covered in future studies.

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پارامترهای پویایی جمعیت ماهی هوور (*Thunnus tonggol*) در آبهای خلیج فارس و دریای عمان

فرهاد کی مرام[1*]؛ محمد درویشی[2]؛ سیامک بهزادی[2] و شهرام قاسمی[1]

تاریخ دریافت:فروردین ۱۳۹۲ تاریخ پذیرش:خرداد۱۳۹۲

چکیده

به منظور ارزیابی پارامترهای ذخیره داده‌های فراوانی طولی ماهی هوور از مهر ماه ۱۳۸۵ تا شهریور ۱۳۸۶مورد تحلیل قرار گرفتند. ماهی هوور عمدتاً توسط شیوه گیل نت صید می گردد. میزان صید گونه‌های تون و شبه تون ماهیان به مرز ۱۷۴۲۳۴ تن رسیده است که نزدیک به ۶۴ درصد آن ماهی هوور می باشد. طول بی‌نهایت این ماهی ۱۳۳/۷۲ سانتیمتر ،ضریب رشد ۰/۳۵ در سال ورابطه طول و وزن $W=۰/۰۰۰۰۲\ L^{۲/۸۳}$ می‌باشد.

ضریب مرگ و میر کل با استفاده از روش پاول ودرال ۱/۸۲ در سال، مرگ و میر طبیعی ۰/۴۴ در سال و مرگ و میر صیادی ۱/۳۸ در سال تخمین زده شد.

کلمات کلیدی: پارامترهای رشد و مرگ و میر، ماهی هوور، خلیج فارس و دریای عمان

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