

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

Kaymaram, F.<sup>\*1</sup>; Darvishi, M.<sup>2</sup>; Behzadi, S.<sup>2</sup>; Ghasemi, S.<sup>1</sup>

Received: April 2013

Accepted: June 2013

### 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;  $K=0.35 \text{ year}^{-1}$ . 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  $1.82 \text{ year}^{-1}$ . The instantaneous rate of natural mortality was obtained by Pauly equation ( $M=0.44 \text{ year}^{-1}$ ) and the instantaneous rate of fishing mortality ( $F$ ) estimated from  $Z-M=1.38 \text{ year}^{-1}$ .

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

---

1-Iranian Fisheries Research Organization, P.O.Box:116-13185, Tehran, Iran  
Persian Gulf and Oman Sea Ecology Center, P.O.Box:1579 Bandar Abbas, Iran  
\* Corresponding author's email: farhadkaymaram@gmail.com

## 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)**

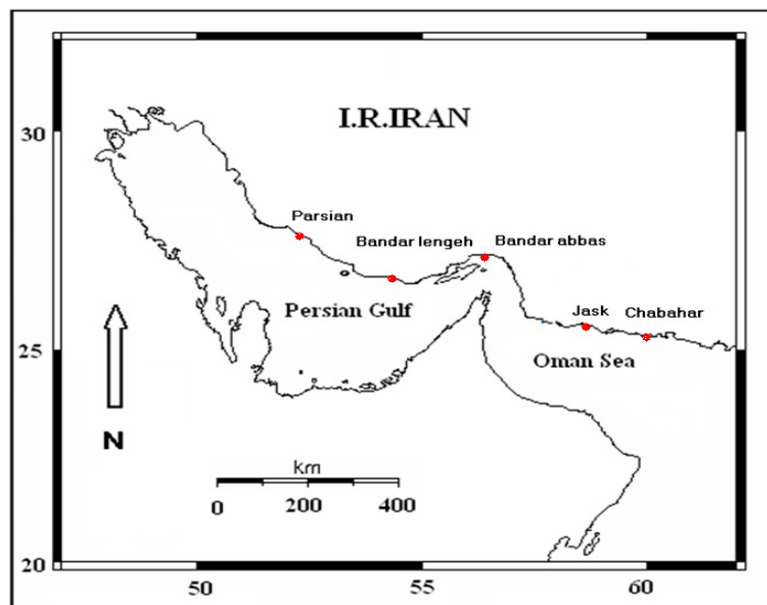
| Species            | Catch (mt ) |        |
|--------------------|-------------|--------|
|                    | 2010        | 2011   |
| <i>T.tonggol</i>   | 64450       | 80883  |
| <i>T.albacares</i> | 31485       | 28800  |
| <i>K.pelamis</i>   | 22285       | 17473  |
| <i>E.affinis</i>   | 16336       | 22266  |
| <i>S.commerson</i> | 10884       | 14794  |
| <i>A.thazard</i>   | 6172        | 6013   |
| <i>S.guttatus</i>  | 3170        | 3900   |
| <i>T.obesus</i>    | 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).

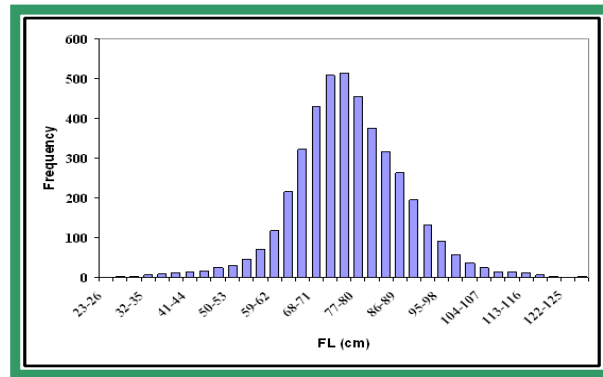
$$M = 0.8 * \exp [- 0.0152 - 0.279 * \ln L_{\infty} + 0.6543 * \ln K + 0.463 * \ln T]$$

Where:  $T$  is the mean temperature of surface water, which was considered in this study as  $26.5^{\circ}\text{C}$ .

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.



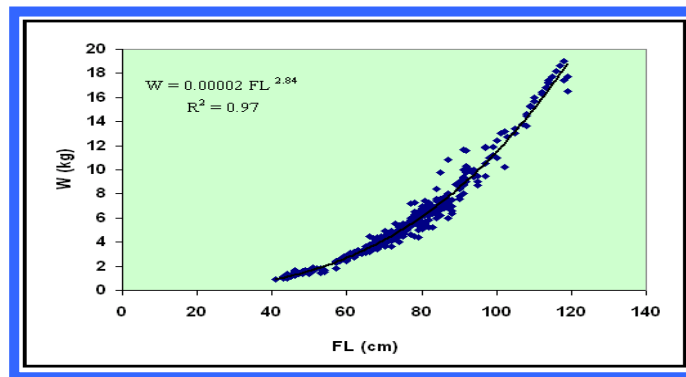
**Figure2: Length frequency distribution of *T. tonggol* in the Persian Gulf and Oman Sea (2006-07)**

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

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 ( $p > 0.05$ ).

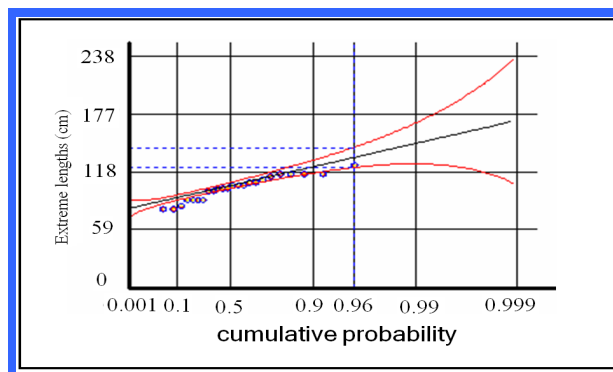
$$W = 0.00002 L^{2.84}$$



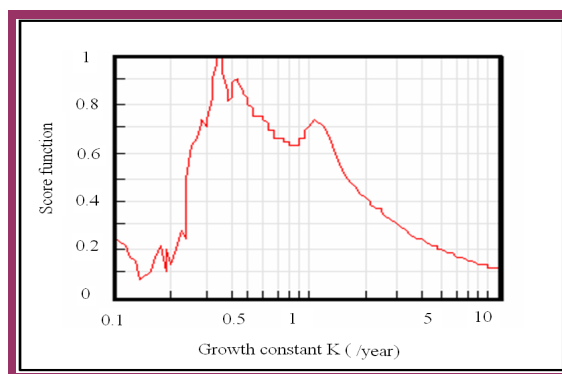
**Fig.3: Length-weight relationship of *T. tonggol* in the Persian Gulf and Oman Sea (2006-07)**

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

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  $26.5^{\circ}\text{C}$ . As the pelagic species grows to a large size very fast, the “M” value may be an over-estimation.

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 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

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  $L_{\infty}$  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.

### Acknowledgements

The authors sincerely acknowledge the cooperation of director and experts of the Persian Gulf and Oman Sea Ecological

Research Institute and Offshore Fisheries Research Center. This study was supported by IFRO.

### References

- Abdussamad, E.M., Saidkoya, K.P., Shubhadeep, G., Prathibha Rohit, K.K. and Joshi, B., 2012.** Fishery, biology and population characteristics of longtail tuna, *Thunnus tonggol* (Bleeker, 1851) caught along the Indian coast. *Indian Journal of Fisheries*, 2,7-16.
- Darvishi, M., Kaymaram, F., Talebzadeh, S.A. and Behzadi, S., 2003.** Population dynamics of five Scombrid fish in Hormuzgan Province (Iran). *Persian Gulf and Oman Sea Ecological Research Institute (In Persian)*. 183P.
- Davarpanah, E., 2007.** Estimation of growth parameters and mortality rates of *Thunnus tonggol* and determination of its exploitation pattern in coastal waters of Hormuzgan Province. (in Persian). M.Sc, thesis. Tarbiat Modares University. 95P.

- Formacion, S.P., Rongo, J.M. and Sambilay, V.C., 1991.** Extreme value theory applied to the statistical distribution of the largest lengths of fish. *Asian Fisheries Science*, 4 (1992):123-135.
- Gayanilo, F. C., Sparre., P. and Pauly, D., 1996.** The FAO ICLARM Stock Assessment Tools (FISAT), User,s guide. FAO Computerized Information Series (Fisheries).No. 8. ROME, FAO.126P.
- Griffiths, S. J., Pepperell, M., Tonks, W., Sawynok, L., Olyott, S., Tickell, M., Zischke, J., Lynne, J., Burgess, E., Jones, D. and Joyner, C., Makepeace. and Moyle, K., 2010.** Biology, fisheries and status of longtail tuna (*Thunnus tonggol*), with special reference to recreational fisheries in Australian waters. Fisheries Research and Development Corporation. CSIRO.
- Gulland, J.A., 1983.** Fish stock assessment: a manual of basic methods. Chichester, U.K.,Wileyinter science, FAO/Wiley series on food and agriculture, Vol. 1:223P.
- Iran Fishery Organization, 2012.** Fisheries data statistics of 2011.
- James, P.S., Pillai, B.R., Pillai, P.P., Jayaprakash, A.A., Gopakumar, G., Mohamed Kasim Sivasdas, M. and SaidKoya, K.P., 1993.** Fishery, biology and stock assessment of small tunas. *In: Sudarsan, D. and John. M.M., 1993. Tuna research in India. Fishery survey of India, Bombay.*
- Kaymaram, F., 2009.** Population dynamics and management of *Thunnus albacares* of the Oman Sea. Ph.D thesis. Islamic Azad University. Science and Research Branch, 125P.
- Khorshidian, K. and Carrara, G., 1993.** An analysis of length frequencies of *Thunnus tonggol* in Hormuzgan waters. *In: Ardill, J.D., 1994, Ed., Proceedings of the expert consultation on Indian Ocean Tunas,5th Session, Mahe, Seychelles, 4-8 Oct 1993.275P.*
- King, M., 2007.** Fisheries biology: Assessment and management. Fishing News Books.382 p.
- Pauly, D., 1980.** On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks.*J.Cons. CIEM. 39(2):175-92.*
- Prabhakar, A. and Dudley, R.G., 1989.** Age, growth and mortality rates of longtail tuna in Omani waters. Indo-Pacific Tuna Development and Management Programme. IPTP/89/GEN/16,90-96.
- Silas, E.G., 1985.** Tuna fisheries of the exclusive economic zone of India: Biology and stock assessment. Bulletin Center of Marine Fisheries Research Institute, 36,115-121.
- Sparre, P. and Venema, S.C., 1998.** Introduction to tropical fish stock assessment. Part 1. Manual.FAO Fisheries Technical Paper No. 306. 1, Rev. 1. Rome, FAO.407P.
- Supongpan, S. and Saikliang, P., 1987.** Fisheries status of tuna purse seiners (using sonar) in the Gulf of Thailand.rep.Marine.Fish.Div.Dep.Fish., 3:87P.
- Wetherall, J.A. Polovina, A.A. and Ralston, S., 1987.** Estimating growth and mortality in steady-state fish stocks from length-frequency data. ICLARM Conf. Proc., 13,53-74.
- Wilson, M.A., 1981.** The biology, ecology and exploitation of longtail tuna in Oceania. M.Sc. thesis, School of Biological Sciences, Macquarie University. Sydney. N.S.W.Australia. 195P.
- Yesaki, M., 1991.** A review of the biology and fisheries for longtail tunas in the Indo-pacific region. *In: Proceedings of the FAO Expert*



consultation on interactions of pacific tuna fisheries, Noumea, New Caledonia.336,370-387.

**Zar, J.H., 1996.** Biostatistical analysis. 3rd edition. Prentice-Hall Inc., New Jersey, USA. 662P.

## پارامترهای پویایی جمعیت ماهی هوور (*Thunnus tonggol*) در آبهای خلیج

### فارس و دریای عمان

فرهاد کی مرام<sup>۱\*</sup>؛ محمد درویشی<sup>۲</sup>؛ سیامک بهزادی<sup>۲</sup> و شهرام قاسمی<sup>۱</sup>

تاریخ پذیرش: خرداد ۱۳۹۲

تاریخ دریافت: فروردین ۱۳۹۲

### چکیده

به منظور ارزیابی پارامترهای ذخیره داده‌های فراوانی طولی ماهی هوور از مهر ماه ۱۳۸۵ تا شهریور ۱۳۸۶ مورد تحلیل قرار گرفتند. ماهی هوور عمدتاً توسط شیوه گیل نت صید می‌گردد. میزان صید گونه‌های تون و شبه تون ماهیان به مرز ۱۷۴۲۳۴ تن رسیده است که نزدیک به ۶۴ درصد آن ماهی هوور می‌باشد. طول بی‌نهایت این ماهی ۱۳۳/۷۲ سانتیمتر، ضریب رشد ۰/۳۵ در سال و رابطه طول و وزن  $W=0.0002 L^{2.83}$  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

۱- موسسه تحقیقات علوم شیلاتی کشور، تهران، صندوق پستی: ۱۳۱۸۵-۱۱۶

۲- پژوهشکده اکولوژی خلیج فارس و دریای عمان، بندرعباس صندوق پستی: ۱۵۹۷  
آدرس الکترونیکی نویسنده مسئول: farhadkaymaram@gmail.com