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Growth and mortality parameters of *Euthynnus affinis* in the northern part of the Persian Gulf and Oman Sea

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Abstract

Neritic tuna species are as important as tuna species for coastal countries in the Indian Ocean. *Euthynnus affinis* is one of the neritic species which was caught as a by catch in the Persian Gulf and Oman Sea. In order to come up with the responsible fishing pattern, there was a need to identify population dynamic parameters. Data were collected randomly from three major fish-landing sites Jask, Bandar Abbas and Bandar Lengeh in the northern part of the Persian Gulf and Oman Sea from 2005 to 2007.
The average of fork length estimated 66 cm. The parameter b in the present study ($W = a.FL^b$) were close to 3 and indicating that *E. affinis* had isometric growth. The growth parameters of L_∞ and K were computed 95.06cm and 0.67 (1/year) respectively and results showed that *E. affinis* grows very fast in the first 2 years. These parameters indicated that *E.affinis* was found to attain a fork length of 49 cm at the end of first year. The fork length attained at the end of 2, 3 and 4 year to be 69, 79and85 cm respectively. Growth performance index (ǿ) calculated 8.7 which was in agreement with the finding of the other studies in the Indian Ocean. Total, natural and fishing mortalities and exploitation rate were estimated 2.58, 0.76, 1.82 (1/ year) and 0.7 respectively.

Key words:

Euthynnus affinis, growth & mortality parameters, Persian Gulf and Oman Sea

INTRODUCTION:

Tuna and Seer fish species were distributed widely in the Persian Gulf and Oman Sea. The major tuna and Seerfish species caught in both the Persian Gulf and Oman Sea are Longtail tuna (*Thunnus tonggol*), Kawakawa (*Euthynnus affinis*), Frigate tuna (*Auxis thazard*), Narrow-barred Spanish mackerel (*Scomberomoruscommerson*), Indo-pacific king mackerel (*Scomberomorus guttatus*), but Yellowfin tuna (*Thunnus albacares*) and Skipjack tuna (*katsuwonus pelamis*) are found only in the Oman Sea and these two species do not migrate to the Persian Gulf. *E.affinis* is one of the neritic tuna species which is caught by other tuna gill nets as by-catch in the Persian Gulf and Oman Sea. *E.affinis* catch in the southern waters of Iran was fluctuated from 3939 t in 1997 to 8779 t in 2006 and increased to 22266 tons in 2011(IFO,2012) (Figure1). Most artisanal fisheries using drift gillnets of 95 to120 mm mesh size target *S.commerson* which *E.affinis* also is one of the by catches.

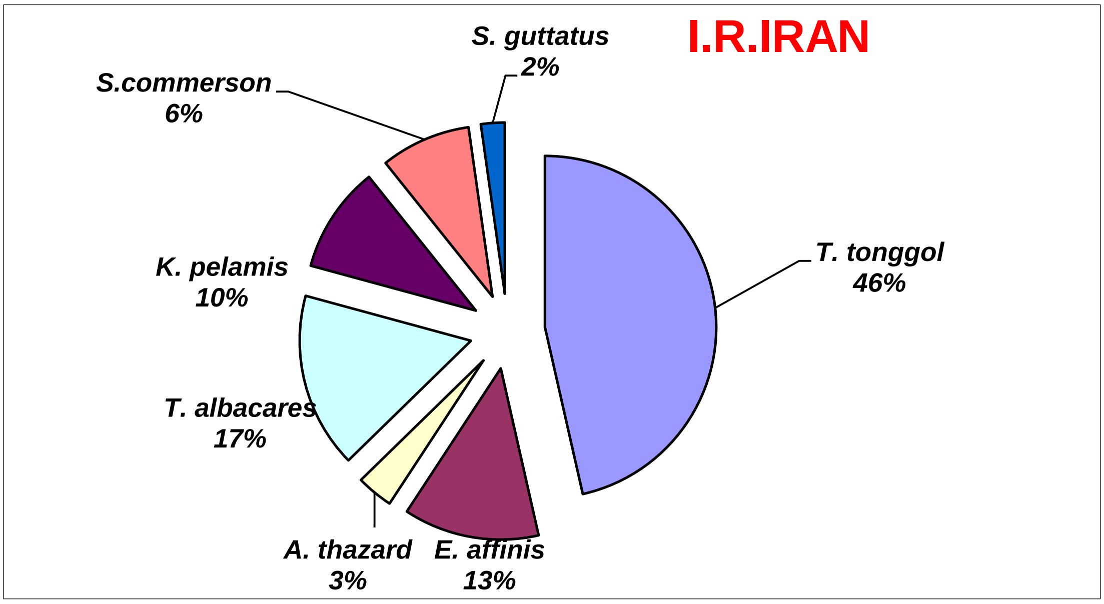

Fig. 1.The percentage of *E. affinis* catches in total production of tuna and seer fishes in 2011 (IFO, 2012)

Some results of studies on population dynamics and biological characteristics of *E.affinis* in the Indian Ocean reviewed (Rohit *et al.*, 2012); (Darvishi *et al.*, 2003) ;(Thaghavi Motlagh *et al.*, 2010); (Pillai *et al.*, 2002).

The objectives of study were to review the previous studies on population dynamics and to estimate growth and mortality parameters of *E.affinis* in the Persian Gulf and Oman Sea to find some indices on the procedure of neritic tuna management in the area.

MATERIALS AND METHODS:

Length and weight data were collected randomly from three fish landing sites: Jask, Bandar Abbas and Bandar Lengeh in the north of the Persian Gulf and Oman Sea (Figure 2), from September 2005 to October 2007.

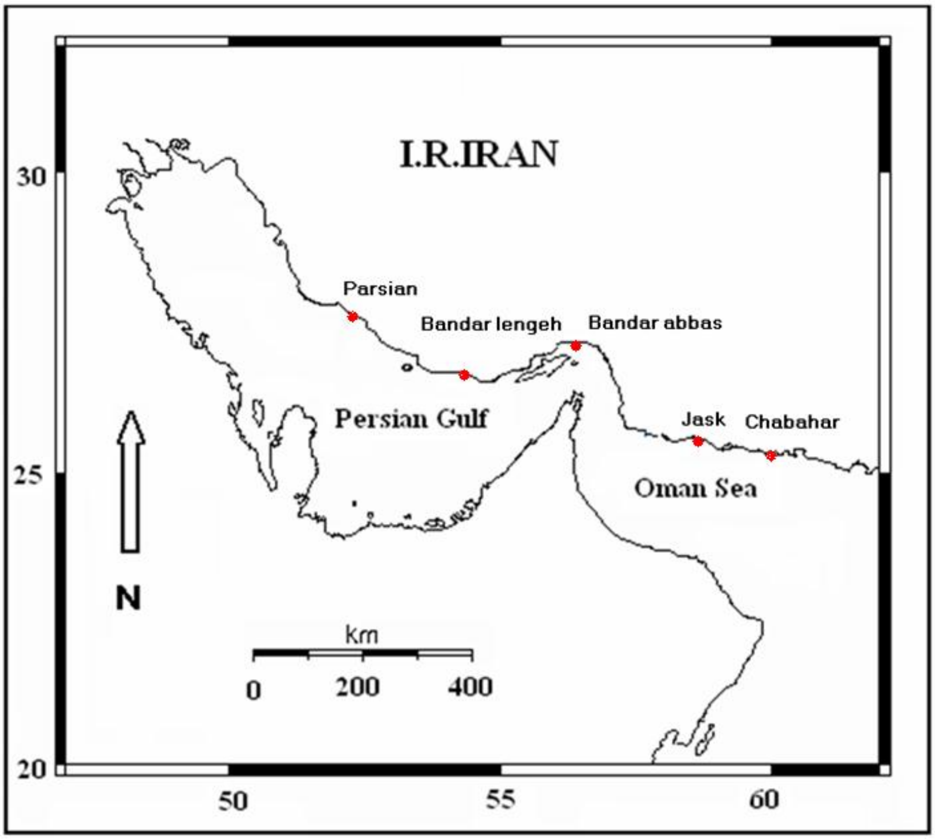

Fig 2.Landing sites for sampling of *E.affinis* in the north of the Persian Gulf and Oman Sea

The fishes were simply measured and weighed to the nearest cm (fork length) and 100 g respectively (King, 2005).

The parameters of the length–weight relationship were estimated through logarithmic transformations (Biswas, 1993).

$W = a\ FL^b$
W = Weight (Kg)
FL = Fork Length (cm)
LnW=Lna+bLnFL

If the calculated number of "b" does not have a significant difference with 3, the species has isometric growth. The below equation was used to test this difference (King, 2005).

The length frequencies were pooled monthly from different landing sites and subsequently grouped into classes of 3 cm intervals.

The data were analyzed using FiSAT II software (FAO-ICLARM Stock Assessment Tools) (Gayanilo *et al.*, 2003). The fitting of the best growth curve was based on the ELEFAN 1 program (Pauly& David,

1981), which allows the fitted curve through the maximum number of peaks of the length frequency distribution.
The von Bertalanffy growth equation for length was taken in form of:

$L_t = L_\infty (1\text{-}\exp(-K(t\text{-}t_0)))$ (Sparre and Venema, 1992)

Growth parameters (K, L_∞) and total mortality (Z) were estimated by using Shepherd's method (scan of K value) and length-converted catch curve methods (Sparre&Venema, 1992) (Wetherall *et al.*, 1987).

In order to compare results of this study with other studies the growth performance index (ǿ) was estimated:

$$ǿ = \mathrm{Log}(K) + 2\,\mathrm{Log}(L_\infty) \text{ (Pauly and Munro, 1984)}$$

Natural mortality coefficient (M) was calculated with the equation of Pauly (1980) (M value multiplied by 0.8).

$$\mathrm{Log}\,M = 0.0066 - 0.279\,\mathrm{Log}\,L_\infty + 0.6543\,\mathrm{Log}\,K + 0.4634\,\mathrm{Log}\,T$$

Where T is the mean temperature of surface water, which was considered in this study as 27 ^{0C}.

Fishing mortality (F) was then estimated (F = Z – M) (Sparre&Venema, 1992).

RESULTS:

The fork length of *E.affinis* ranged from 28 to 88 cm, with average 66 cm (Figure 3).

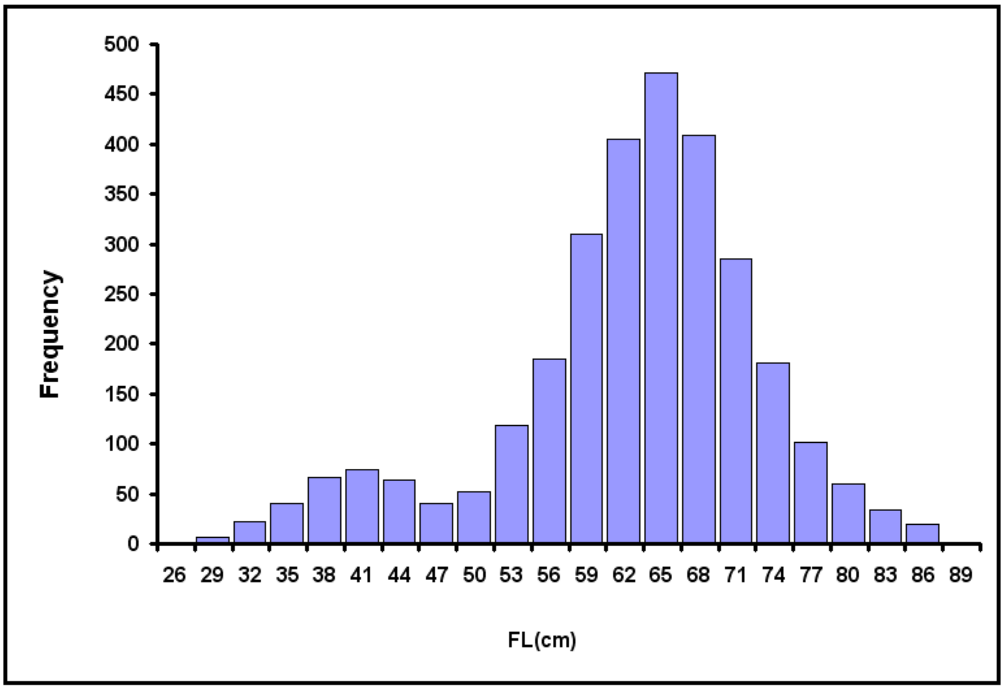

Fig 3. Fork length distribution of *E.affinis in* the Persian Gulf and Oman Sea

The "b" parameter value in the length-weight relationship model ($W=aFL^b$) for both female and male were 2.87 (Figure 4) that was closed to 3 and indicating isometric growth for *E.affinis.*
The K-scan technique indicated an L_∞ of 95.06 Cm FL and a K value of 0.67 per year) for the original data set (Figure 5&6). The growth performance index (ǿ) estimated as 8.7.

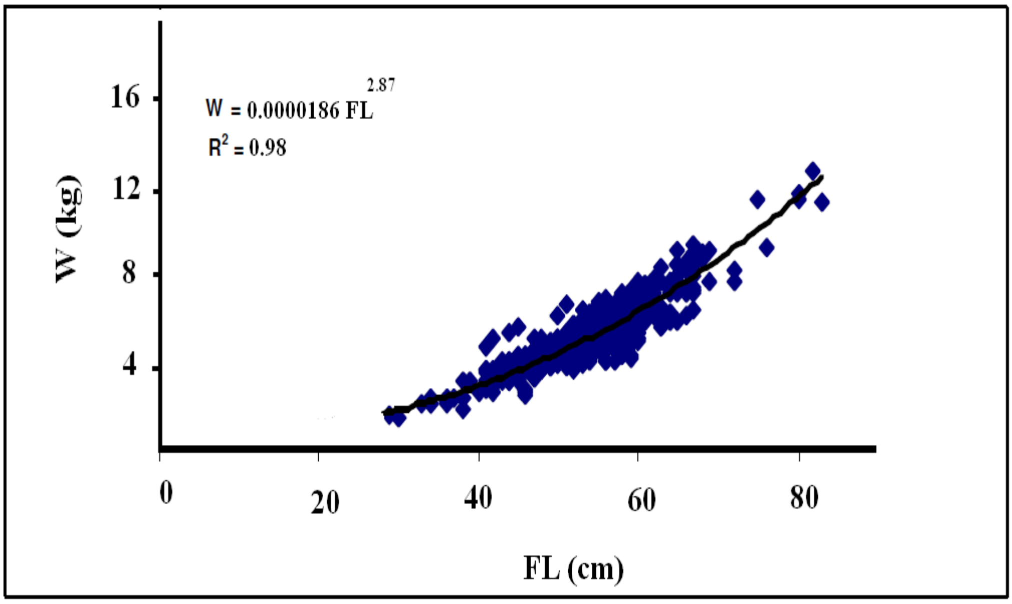

Fig 4. The length- weight relationship curve of *E.affinis* in the Persian Gulf & Oman Sea

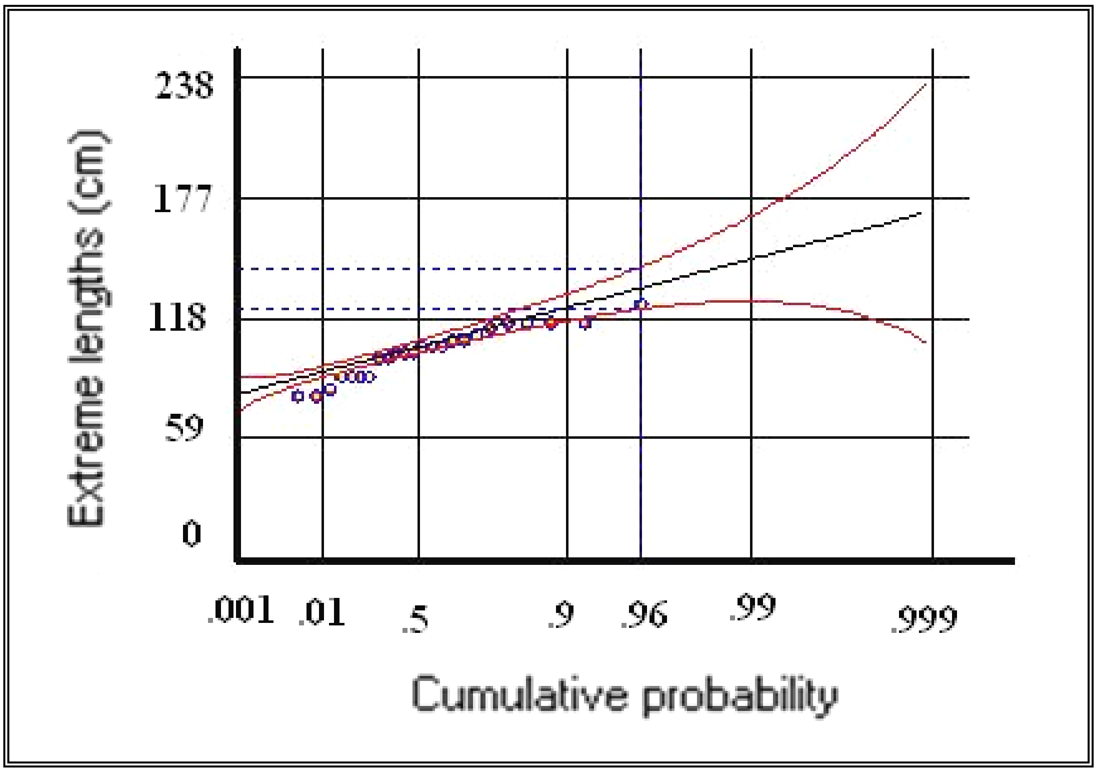

Fig 5. Cumulative probability graph for estimate of L_{max}

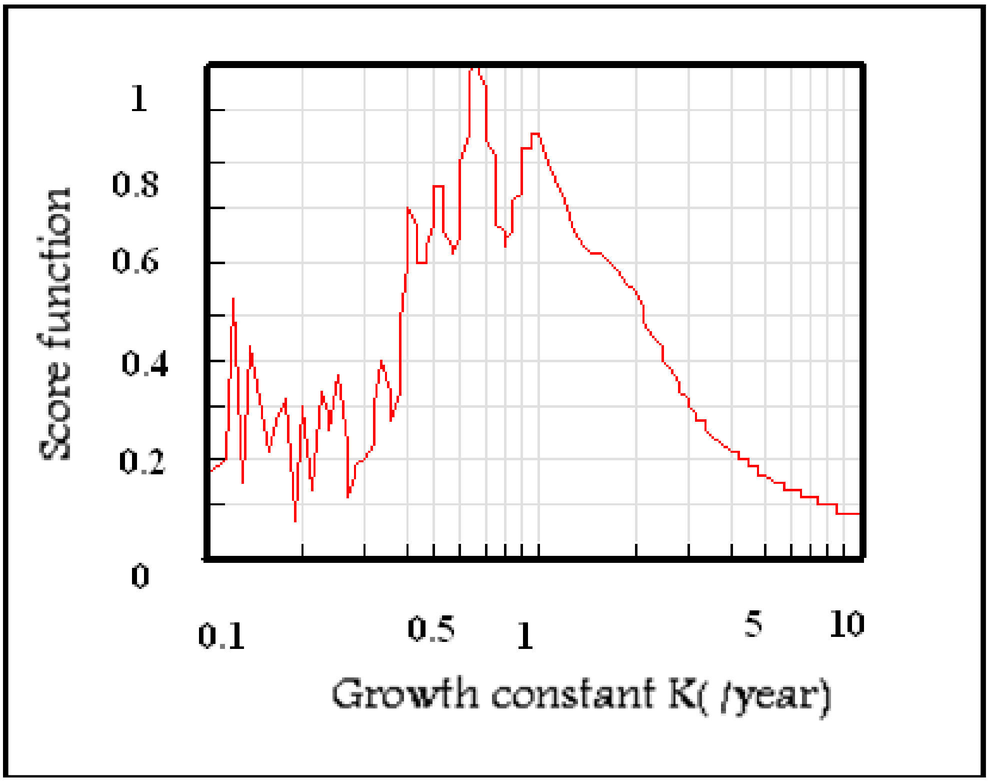

Fig 6.K-Scan value curve by Shepherd's method and best fitting for *E.affinis*

The yearly growth curve of this species using the von Bertalanffy growth parameter and above parameters indicated that fork length attained at the end of 1, 2, 3 and 4 year to be 49, 69, 79 and 85 cm respectively (Figure7&8).

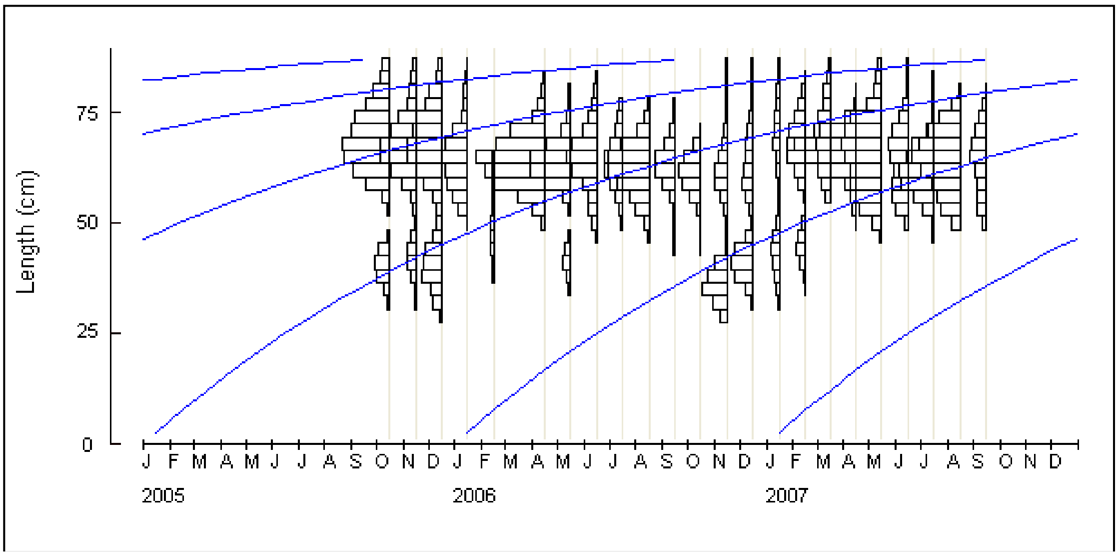

Fig 7.Growth curve of of *E.affinis* ELEFAN I superimposed on the restructured length-frequency diagram (L_∞ = 95.06 (Cm) and K = 0.67 (1/ year)

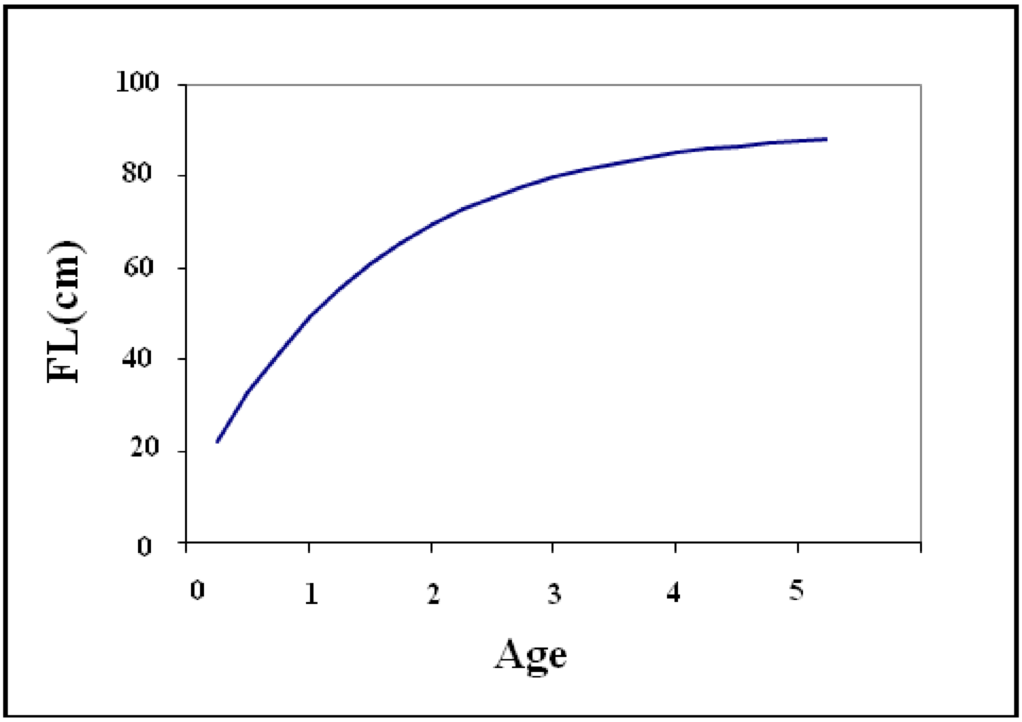

Fig 8.Growth curve of *E.affinis* (Relative length at age) in the Persian Gulf & Oman Sea

Total mortality coefficients from length-converted catch curve indicated an annual estimate 2.58 per year (Figure 9).

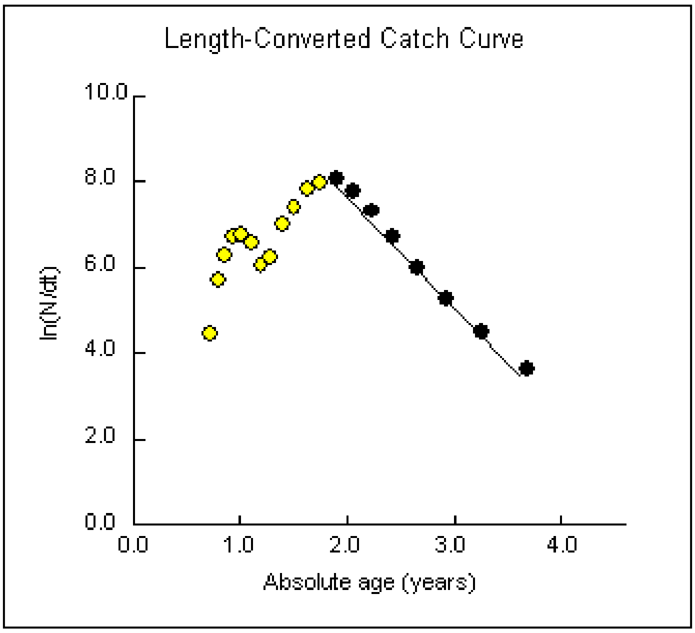

Fig 9. Length-converted catch curve of *E.affinis* in the Persian Gulf & Oman Sea (Z=2.58 (1/year))

The natural mortality coefficient, M, was estimated 0.76 (Multiplied to 0.8). The fishing mortality (F) and exploitation rate (E) were 1.82(1/year) and 0.7 respectively. Relative recruitment pattern graph was presented in figure 10.

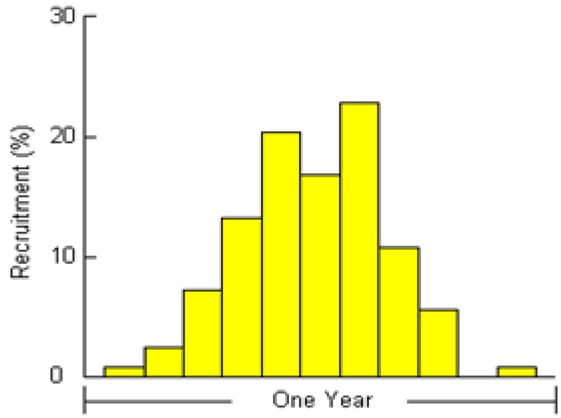

Fig 10.Recruitment pattern graph of *E. affinis* in the Persian Gulf & Oman Sea

DISCUSSION:

The size range of *E.affinis* in this study was from 28 to 88 cm. Silas *et al.* (1985) have reported that *E.affinis* along the Indian Coast is supported by fishery having a length range of 12-76 cm and later on Kasim and Abdussamad (2003) observed that the fishery of *E.affinis* along east coast was supported by 18-83 cm length class fishes with 54-56 cm as modal class. These size ranges were due to engaging different gears.
In our study the calculated number for "b" has not shown any significant difference with 3. Table 3 presented the estimates coefficients of the general equation ($W= aL^b$) in the Indian Ocean.

Table 3.The parameters a & b in length- weight relationship of *E. affinis* (Indian Ocean)

Area	**"a"value**	**"b"value**	**Reference**
Indian Ocean	0.0138	3.0287	Silas,1967
India	0.0254	2.889	Rohit *et al.*,2012
India	0.0190	2.95	James *et al.*, 1993
Iran	0.0186	2.87	Present Study

The values of a and b differ not only in different species but in the same species depending on sex, maturity stage, feeding intensity, *etc* (Biswas, 1993).
The values of L_∞ and K were calculated as 95.06 cm and 0.67(1/year). Length- frequency analyses using various methods produced a wide range of growth parameter estimates for the same data set, and lead to conflicting management decisions (Dudley *et al*., 1992).

Differences in growth rates between regions indicated stock separations which has, in some cases, supported a genetic difference (Begg and Sellin, 1998). But in general, the most suitable definition in the context of stock assessment was given by Gulland who stated if possible differences within the groups can be ignored without making the conclusions reached invalid, a subgroup of a species can be treated as a stock (Gulland, 1983).
Growth comparison of fish based on a single parameter K or L_∞ is misleading (Pauly, 1979) and some authors such as Pauly & Munro (1984) and Moreau (1987) have proposed indices of overall growth performances (ǿ) based on the two parameters L_∞ and K, because these are correlated and produced by growth rates that are constantly changing with time and size. Growth performance index was found to be 8.7 that were in the range of 7.60 to 8.82 in other reported studies (Table 4).
Correlated parametric values adjust themselves to provide a similar growth pattern represented by ǿ (Sparre and Venema, 1992). Notably, the ǿ values estimated for north Persian Gulf and Oman Sea stock were comparable to those for other stocks of *E.affinis* in the Indian Ocean, suggesting a similar growth pattern across different areas (Table 4).
Although the difference in the growth parameters estimated by earlier authors may be due to the fact that the data used for different analytical methods by them were obtained by different gears such as drift gillnets, hooks and lines, troll and trawls (Pillai *et al*., 2002), or might be associated with sampling error or variation in fishing intensity or environmental conditions (Taghavi Motlagh *et al.*, 2010). More generally, data from neighboring countries which cover the stock migration route , may be combined to discern the modal progression of cohorts and hence derive reliable growth parameter estimates. This emphasizes the need for joint assessment of the shared stock.

Table 4. Estimates of growth parameters (L_∞ and K), growth performance index of *E.affinis* (Indian Ocean)

Area	K (1/year)	L_∞(cm)	ǿ	Author
Thailand	0.46	76	7.80	Yesaki,1982
Sri Lanka	0.69	59.5	-	Joseph *et al.*,1987
Iran	0.69	86	8.50	Talebzadeh *et al.*,1997
India	0.9	81	8.87	Pillai *et al.*,2002
Sri Lanka	0.52	76.8	-	Dayaratne & Silva,1991
India	0.79	81.7	-	Khan,2004
India	0.56	81.92	-	Rohit *et al*.,2012
India	0.56	72.5	-	Ghosh *et al*.,2010
Iran	0.51	87.66	8.28	TaghaviMotlagh *et al*.,2010
Iran	0.67	95.06	8.7	Present Study

Earlier studies on the growth of *E.affinis* from different regions have indicated that growth as in most tuna species is fast with the fish having longevity of 2 to 8 years (Rohit *et al.*, 2012). *E.affinis* is a fast growing fish attaining a size of 49, 69, 79 and 85 cm at the end of first, second, third and fourth year respectively in this study. Khan (2004) indicated *E.affinis* to be fast growing species, attaining a length of 44.6,64.9 and 77.4 cm at the end of first, second and third year respectively.

Total, natural and fishing mortalities were estimated 2.58, 0.76 and 1.82 (1/year) respectively. The reliability of the natural mortality estimates made by Pauly's formula for schooling pelagic fish such as Kawakawa is questionable. The M value estimated by the said formula for schooling fish has shown significant deviations (Pauly, 1980). The data set for estimating Z by the length converted catch curve method should satisfy the primary assumption that the stock was is in equilibrium (Al-Hosni and Siddeek, 1999).In a declining stock, this assumption may have been violated because of a declining trend in recruitment tends to under estimate Z by roughly the some percentage of decline (Al-Hosni and Siddeek, 1999).

Exploitation rate in this study were 0.7. Patterson (1992) observed that the fishing rate satisfying Gulland's optimal E level of 0.5 tended to reduce pelagic fish stock abundance, and hence, the former author suggested that E should be maintained at 0.4 for optimal exploitation of those stocks. Accordingly our estimation, the north Persian Gulf and Oman Sea *E.affinis* stock appeared to have been highly exploited during the study period. Different estimates of mortality and exploitation rate of *E.affinis* available from Indian Ocean countries is presented in table 5.

Table 5.Summary of mortalities and exploitation rate of *E.affinis* (Indian Ocean)

Area	M(1/year)	F(1/year)	Z(1/year)	E	Author
India	0.98	4.90	5.85	0.8	Pillai *et al*.,2002
India	1.16	-	2.24	-	Khan,2004
India	0.93	0.75	1.68	0.36	Rohit *et al*.,2012
Iran	0.65	1.72	2.37	0.65	TaghaviMotlagh *et al*.,2010
Sri Lanka	0.44	1.45	1.89	0.24	Dayaratne & Silva,1991
India	0.94	0.75	1.69	0.36	Ghosh *et al*.,2010
Iran	0.76	1.82	2.58	0.7	Present study

Our study showed that *E.affinis* has highest recruitment in two months. Tropical species are known to have recruitment through all the year (Sparre and Venema, 1992). Recruitment of pelagic fishes fluctuated widely in response to both fishing and environmental effects.

CONCLUSIONS:

It is necessary to immediately impose fishing regulation on the *E.affinis* stock and this can be done by gradually increasing the mesh size of the gill nets or by restricting fishing for certain seasons or declaring fish sanctuaries in certain areas, especially in spawning grounds. Further studies on *E.affinis* should be conducted in collaboration with countries bordering at least in the Persian Gulf and Oman Sea.

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