

## Catch composition and fishing trend of kilka in Iranian part of the Caspian Sea

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**Abstract:** Population structure of three kilka fishes (*Clupeonella* spp.), particularly anchovy kilka (*C. engrauliformis*), in Iranian waters of the Caspian Sea was surveyed in 2003. A total of 3230 biweekly samples were collected from commercially landed kilka at 3 stations in Mazandaran and Guilan provinces. Catch and effort statistics were obtained from the relevant organization. Results showed a great decline in the commercial kilka catch from 95000 tons in 1999 to 15497 tons in 2003. The contribution of anchovy kilka to the total kilka fishery also showed a decline from 71% in 1999 to 52.5% in 2003, while common kilka (*C. cultriventris*) increased from 13.7% in 1999 to 48.9% in 2003. Fork length range of anchovy kilka showed an increase from  $89.2 \pm 12$  mm in 1999 to  $100.4 \pm 4.9$  mm in 2003. The age composition of anchovy ranged between 1<sup>+</sup> to 7<sup>+</sup> years and the dominant group was 5<sup>+</sup> years old (age group of 4<sup>+</sup> and 5<sup>+</sup> comprised 84.6% of population). The K value and  $L_{\infty}$  calculated 0.598/year and 110.13 mm respectively. Natural, fishing and total mortality coefficient was estimated 0.69, 0.31 and 1 per year respectively. The results showed a sex ratio of F: M= 68.2: 31.8.

**Keywords:** *Clupeonella engrauliformis*, Catch, Growth coefficient, Age, length, Caspian Sea, Iran

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## Introduction

The three zooplanktivore species of kilka (sprats), viz *Clupeonella engrauliformis* (anchovy kilka), *C. grimmi* (bigeye kilka) and *C. cultriventris* (common kilka) are the most abundant fishes in the Caspian Sea. Distribution of these schooling fishes is related to water currents and feeding regimes in the southern and middle part of the Caspian Sea (Melnikov, 2000). Kilka fishes are caught using light with cove nets. These fishes are commercially important and play a significant role from economic point of view as well as being a crucial part of the food chain as seals, birds and predatory fishes feed on kilka (Kazanchev, 1992). Anchovy kilka and bigeye kilka are regarded as indigenous to the Caspian Sea, but common kilka has its origin in the Black Sea and Sea of Azov (Melnikov, 2000). Among these species, anchovy kilka had always constituted the most prominent share of the kilka catches along the Iranian coasts until 2003 (Sayyad Bourani, 2003), but this contribution has been changing drastically since then.

Mass spawning of anchovy kilka takes place primarily in the south-eastern part of the Caspian Sea (Yermelchov *et al.* 1995), in the surface water layers (20-25m) of the circulating current zone (Askerov *et al.*, 2003). According to Prikhodko (1961), anchovy kilka migrates twice a year; one is in spring (from the south to the central part for feeding) and another one in autumn (from the central to the southern part for wintering); this abounds the Iranian coastal region with this species during autumn and winter. The largest concentrations occur at depth of 40 to 100m, although the vertical distribution of this species varies in different seasons, 75-100m in winter and 10-75m in spring and summer (Razavi Sayyad, 1999).

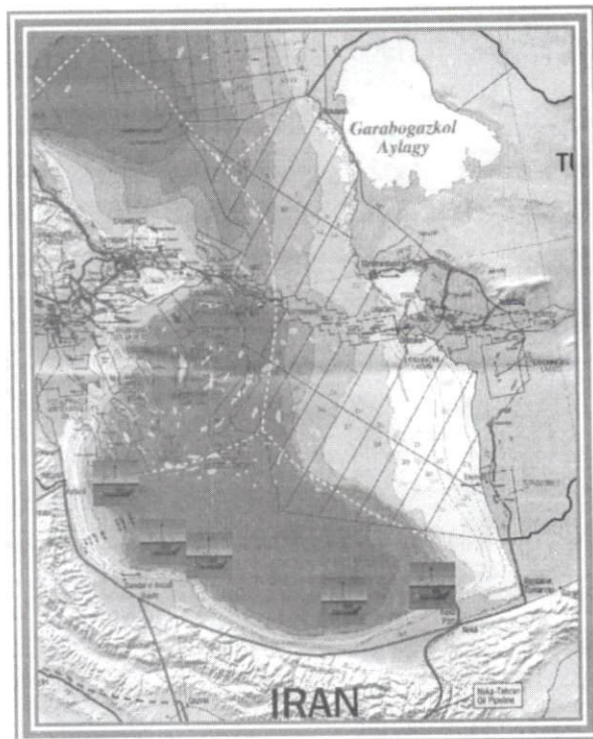
The catch of anchovy kilka from the Caspian Sea by the ex-Soviet Union was 220 to 310 thousand tons during the period 1974-1979 (Yermelchov *et al.*, 1995). The catch of this species along the Iranian coasts had always constituted the most prominent share-generally above 70%- of the total kilka catches until 2003 (Sayyad Bourani, 2003), but this contribution has been changing drastically since then. For example, it peaked to about 67.4 thousand tons in 1999, which contributed about 71% of the total kilka fishery, but declined to about 7.8 thousand tons with a 50.5%

contribution to the total kilka fishing in 2003 (Fazli *et al.*, 2007). This change could be attributed to several adverse ecological circumstances, including the invasion of the comb-jelly, *Mnemiopsis leidyi*, as the most serious recent event (Ivanov *et al.*, 2001).

The purpose of this study is to survey catch composition and fishing trend of kilka fishes, particularly anchovy kilka, in the new environmental circumstances along the Iranian coasts of the Caspian Sea.

### Material and methods

This research was conducted by biweekly random collection of a total of 3230 samples from commercially caught kilka from the Iranian coastal regions of the Caspian Sea, which were landed at 3 stations of Babolsar, Amīrabad (Mazandaran province) and Bandare Anzali (Guilan province) (Fig. 1).



Available: ([http://www.lib.utexas.edu/maps/middle\\_east\\_and\\_asia/caspian\\_sea\\_s\\_rel01.jpg](http://www.lib.utexas.edu/maps/middle_east_and_asia/caspian_sea_s_rel01.jpg))

**Figure 1: Landing places of kilka in Iranian part of the Caspian Sea**

In the lab, the three species of kilka were identified and separated, and then biological parameters were studied. For biological studies, parameters like length, weight, sexuality, and maturation were studied. Length was measured using a measuring board and recorded to the nearest mm fork length. Whole wet weight was measured using an electronic balance and recorded to the nearest gram. Age groups determined by otolith. *Sagittal otoliths* were extracted and were put in the solution of glycerin and ethanol for 24 hours and were viewed in mineral oil against a black background under reflected light through a stereomicroscope. The otoliths were aged through the read area from the posterior end on the proximal surface. Complete annuli (one translucent and one opaque zone) were counted from the nucleus to the outer edge (Chilton and Beamish, 1982).

The parameter values of the Von Bertalanffy growth function (Sparre & Venema, 1992), fit to size at age data (males and females combined) using Fisat computer package. The function for growth in length is given by:

$$L_t = L_\infty [1 - e^{-k(t-t_0)}]$$

Where  $L_t$  is the length at age  $t$ ,  $L_\infty$  is the asymptotic length,  $k$  is a growth coefficient and  $t_0$  is the age at which fish would have had length zero if they always grow according to the above equation.

Total mortality ( $Z$ ) and natural mortality ( $M$ ) calculated by catch curve and Pauly's empirical formula, respectively (Pauly, 1980):

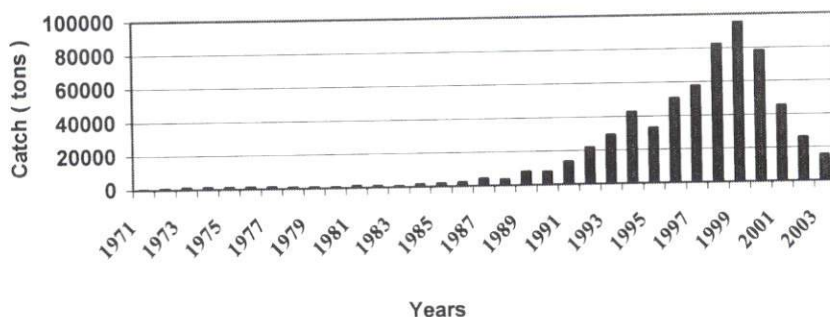
$M = 0.8 \exp(0/279 - 0/0152 - \ln L_\infty / 0/6543 + \ln k / 0/463 + \ln T)$ , where  $T$  is the annual mean temperature ( $^{\circ}\text{C}$ ) of the water in which the stock lives. Fishing mortality calculated as  $F = Z - M$  (Sparre & Venema, 1992).

Catch data (catch and fishing effort statistics) were gained from the Catch and Harbor Deputy of the Shilat Organization. CPUE was calculated as catch of one vessel per night in tons.

## Results

Historical catch of kilka (all species) in the Iranian coastal waters of the Caspian Sea is shown in Fig. 2 and Table 1. The CPUE of the kilka decreased from 5.5 tons in 1991 to 1.16 tons in 2003 (Table 2).

The commercial catch of kilka (all species combined) in the Iranian part of the Caspian Sea showed increasing trend from 1991 and reached to 95 thousand tons in 1999, and a decreasing trend since then by figures of 40.4%, 65.7%, 80.1% and 83.7% in 2000, 2001, 2002 and 2003, respectively (Fig. 2). The catch of anchovy kilka in 2003 was 7.8 thousand tones, while this amount was 67.5 thousand tones in 1999 (Table 1). Anchovy kilka constituted the main catch of kilka fishes and every change in the stock of this species had a large effect on kilka landings.



**Figure 2: Total amount of kilka catch (all species) in the Iranian coastal waters of the Caspian Sea**

**Table 1: The catch (tons) of kilka fishes during period 1999-2003 in the Iranian part of the Caspian Sea**

| Species | <i>C. engrauliformis</i> | <i>C. cultriventris</i> | <i>C. grimmi</i> | Total catch |
|---------|--------------------------|-------------------------|------------------|-------------|
| Year    |                          |                         |                  |             |
| 1999    | 67450                    | 13015                   | 14535            | 95000       |
| 2000    | 57486                    | 10686                   | 9828             | 78000       |
| 2001    | 37590                    | 4789                    | 2801             | 45180       |
| 2002    | 18070                    | 7904                    | 26               | 26000       |
| 2003    | 7826                     | 7578                    | 93               | 15497       |

**Table 2: The changes of CPUE (tons/vessel- night) in Iranian part of the Caspian Sea**

| Year          | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| CPUE          | 5.5  | 4.89 | 5.23 | 4.49 | 3.4  | 3.48 | 3.63 | 3.9  | 4.4  | 3.1  | 1.57 | 1.1  | 1.16 |
| catch/vessel  |      |      |      |      |      |      |      |      |      |      |      |      |      |
| /night (tons) |      |      |      |      |      |      |      |      |      |      |      |      |      |

This research showed the catch composition of kilka species changed during the period of 1998 to 2003. The catch composition of anchovy kilka showed a gradual decline from 72.8% in 1998 to 50.5% in 2003, while common kilka had an increasing trend from 5.5% in 1998 reached to 48.9% in 2003 (Table 3).

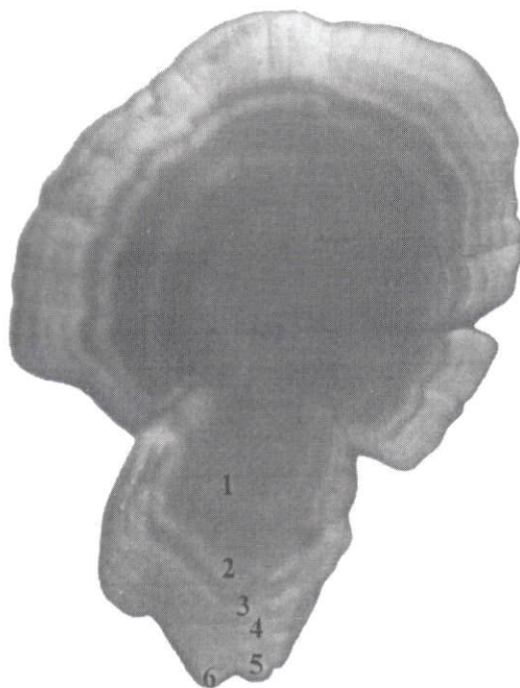
**Table 3: Catch composition (%) of kilka fishes in Iranian part of the Caspian Sea**

| Year  | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|------|------|------|------|------|------|
| <b>Species</b>                                |      |      |      |      |      |      |
| Anchovy kilka<br>( <i>C. engrauliformis</i> ) | 72.8 | 71   | 73.7 | 83.2 | 69.5 | 50.5 |
| Common kilka<br>( <i>C. cultriventris</i> )   | 5.5  | 13.7 | 13.7 | 10.6 | 30.4 | 48.9 |
| Big eye kilka<br>( <i>C. grimmi</i> )         | 21.7 | 15.3 | 12.6 | 6.2  | 0.1  | 0.6  |

The age composition of anchovy kilka ranged between 1-6 years and the dominant group was 5<sup>+</sup> years old. Age group of 4<sup>+</sup> and 5<sup>+</sup> composed 84.6% of the population (Table 4). There was just one specimen which aged 7<sup>+</sup>.

**Table 4: Mean fork length at age (mm) and age composition (%) of anchovy kilka, *C. engrauliformis* in the Iranian part of the Caspian Sea (2003)**

| Age                   | 1 <sup>+</sup> | 2 <sup>+</sup> | 3 <sup>+</sup> | 4 <sup>+</sup> | 5 <sup>+</sup> | 6 <sup>+</sup> |
|-----------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Mean fork length (mm) | 77.68          | 95.3           | 99.3           | 102.98         | 106.79         | 110.32         |
| Age composition (%)   | 0.005          | 0.44           | 5.84           | 32.5           | 52.1           | 9.1            |

**Fig 3: Age determination of anchovy kilka by otolith (6 years old)**

The fork length range of anchovy kilka (N=3230) was measured between 70 to 120 mm in the Iranian coastal region in 2003, showing a decrease in comparison with the earlier years (Table 5).

Mean length and weight of this species increased in 2003 (100.4 mm and 7 g) in comparison with 1998 (93.3mm and 5.6g) due to its decreasing recruitment.

According to this survey, sex ratio was (F:M): 68.2: 31.8. The Bertalanffy growth coefficients  $K$ ,  $L_{\infty}$  and  $t_0$  were calculated 0.598/year, 110.13 mm and  $-1.08$ /year, respectively. Total mortality coefficient based on catch curve was determined 1/year. Natural and fishing mortality coefficient was 0.69/year and 0.31/year, respectively.

**Table 5: Length and weight range of *C. engrauliformis* in 1998-2003  
(Iranian coastal waters)**

| Year                   | 1998     | 1999      | 2000     | 2001      | 2002      | 2003       |
|------------------------|----------|-----------|----------|-----------|-----------|------------|
| <b>Parameters</b>      |          |           |          |           |           |            |
| Fork length range (mm) | 40-130   | 45-125    | 55-120   | 60-120    | 60-125    | 70-120     |
| Mean fork length (mm)  | 93.3±14  | 89.2±12.6 | 87.3±6.8 | 93.1±5.48 | 98.3±5.73 | 100.4±4.89 |
| Weight range (g)       | 0.4-14.5 | 0.4-12.7  | 0.8-9.4  | 1.3-11.7  | 1.9-11.6  | 3.2-10.9   |
| Mean weight (g)        | 5.6±2.3  | 4.9±1.8   | 4.4±0.8  | 5.5±0.8   | 6.4±0.97  | 7±0.8      |
| Number                 | 3979     | 7448      | 9957     | 12657     | 7594      | 3230       |



## Discussion

Results showed that the catch and CPUE of kilka (especially anchovy kilka) had a decreasing trend during the recent years (Fig. 2; Table 2). This decreasing trend is seen in all other Caspian Sea neighboring countries. The total catches of 4 countries (except Iran) around the Caspian Sea in 2001 decreased by 59% from the earlier year (Parafkandeh, 2002). In the Iranian part of the Caspian Sea, the catch composition of common kilka increased from 5.5% in 1998 to 48.9% in 2003, but anchovy kilka composition reduced from 80-85% to 50.5% (Table 3). In addition, during the last years, common kilka was seen only in warm seasons, but in 2002 and 2003, this species was caught in the cold seasons, too. Results showed the length and age groups of anchovy kilka were limited and mean length increased in 2002-2003 in comparison with 1998 (Table 4 and 5). This issue suggests the poor recruitment of this species.

Reduction in catch, CPUE and limitation of length size groups indicate the obvious incoming damage to kilka stocks. The main reason for decrease in the catch could be attributed to the entry of the uninvited guest, *Mnemiopsis leidyi*, to the Caspian Sea that has successfully flourished in the southern part of the Caspian Sea (Ivanov, *et al.*, 2001). *M. leidyi* is a food competitor to kilka fishes and feed on the eggs and larvae as well (Fazli & Roohi, 2002; Esmaeily Sari *et al.*, 2001). Kideys and Romanova (2001) also reported that *M. leidyi* was a food competitor to anchovy (*Engraulis encrasicolus ponticus*) population in the Black Sea, and also eats their eggs and larvae (4 to 5%), which caused reduction of anchovy during period 1988-1990.

On the other hand, the first period of embryonic development of kilka fishes, especially anchovy kilka, is undergone in surface layers and various pollutions like oil has negative effects on embryonic development (Yermelchov *et al.*, 1995). The sewage of the major Russian industries concentrated around the Volga River drain into the Caspian Sea and also oil wells in Azerbaijan and Ghazaghestan's water cause oil pollutions in the Caspian Sea (Parafkandeh, 2002).

Results showed the catch of anchovy kilka had greatly reduced during period 1999-2003, but the common kilka had a lower fluctuation (Table 1). Bigeye kilka had the greatest reduction in 2002-2003 (Table 1 and 3), possibly due to migration of this species to the deeper layers.

The results also showed that the age composition of anchovy ranged 1-7 years and the dominant group was 5<sup>+</sup> years (age group of 4<sup>+</sup> and 5<sup>+</sup> composed 84.6% of population; Table 4). According to Fazli (2007), the age groups of anchovy kilka ranged from 1 to 7 years and during the years 2001-2003, age 3 was the largest of all age groups in composition with 57.7%, 55.3% and 52.1%, respectively.

During the years 1998-2003 (present study), the fork length and weight of anchovy kilka ranged from 40 to 130mm and from 0.4 to 14.5g (Table 5), which shows a decrease from the fork length range of 40 to 140mm and weight range of 0.4 to 18.4g recorded during the years 1995-2004 (Fazli, 2007).

Before 2001, relative frequency of the youngest age groups (0<sup>+</sup> and 1<sup>+</sup>) was noticeable and the age group has been expanded and according to Fazli *et al.* (2007), the age groups of 0<sup>+</sup> and 1<sup>+</sup> comprised high percentage in the catch during period 1997-2000.

The growth of anchovy kilka during the first and second year of life was faster and after the third year, the growth rate became smoother (Table 4), which corresponds with the results of Kazanchev (1992). The Bertalanffy growth coefficients  $K$ ,  $L_{\infty}$  and  $t_0$  were calculated 0.598/year, 110.13 mm and -1.08/year respectively. According to Fazli (2007), the estimated value of  $L_{\infty}$  and  $K$  were 148 mm and 0.238, respectively.

According to this survey, sex ratio (F: M) of anchovy kilka was found 68.2:31.8, which is in accordance with Fazli's (2007) results that the female was dominant in the population of this species. The Caspian Sea biodiversity database reports that the ratio of males and females anchovy kilka in the population is invariant, close to 1:1 with a slight predominance of males in spring (53.3%) (Besharat & Khatib, 1993).

Our study showed that the natural ( $M$ ), fishing and total mortality ( $Z$ ) of anchovy kilka were 0.69, 0.31 and 1/year, respectively. According to Fazli (2007),  $M$  and  $Z$  were calculated to be 0.473/year and 1.75/year.

In conclusion, analysis of the data confirms that kilka stocks structure in the Caspian Sea has been changing recently and the biggest change has been to anchovy kilka population. All the biological parameters surveyed in this study confirm that anchovy kilka population is not in a sufficient good condition and it is necessary to take urgent measures to combat the spread of the ctenophore, which seems to have seriously jeopardized the survival of juvenile anchovy kilka.

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