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Population ecology parameters and biomass of golden grey mullet (*Liza aurata*) in Iranian waters of the Caspian Sea

Hasan Fazli[a,*], Davod Ghaninejad[b], Ali Asghar Janbaz[a], Reza Daryanabard[a]

[a] *The Caspian Sea Ecology Research Center, Sari, Iran*
[b] *Inland Water Fisheries Research Center, Anzali, Iran*

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ABSTRACT

This paper examines the changes in the population ecology parameters and biomass of golden grey mullet (*Liza aurata*) in Iranian waters of the Caspian Sea from 1991 to 2005. For most years during this 14-year period, we estimated the age structure of the catch, length–weight relationship, von Bertalanffy growth parameters, condition factor, natural and fishing mortality and biomass. Growth parameters were estimated as $L_\infty = 62.7$ cm, $K = 0.15$ year^{-1}, $t_0 = -0.23$ year^{-1}. The instantaneous coefficient of natural mortality was estimated as 0.350 year^{-1} and the instantaneous coefficient of fishing mortality varied during the 14-year period between 0.111 to 0.539 year^{-1}. Biomass estimates of golden grey mullet, from the biomass-based cohort analysis were increased from 13,527 mt in 1991–1992 to 23,992 mt in 2002–2003. In 2004–2005, it was estimated to be 23,658 mt. We concluded that at the present time, the stock of golden grey mullet is not being over-fished.

1. Introduction

About three millions juveniles of Black Sea grey mullet (*Mugil cephalus*, *Liza aurata* and *L. saliens*) were successfully introduced from Black Sea into the Caspian Sea in 1930 and 1934 (Anon, 1958; Konovalov, 1959; Oren, 1981; Kosarev and Yablonskaya, 1994; Zablotski, 1966), but only the two last species have successfully acclimated, adapted and propagated in the Caspian Sea. During the first years of their acclimatization the numbers of mullet increased rapidly with good growth rates. This appeared in the catches which by the middle of the 1950s reached up to 3000 tons for the USSR and Iran. By this time these fishes had reached their maximum numbers in their new habitat, after which time the growth rate began to fall and the life cycle became shorter. In the second half of the 1960s the mullet population reached dynamic equilibrium with the potential of the nutrition base, and these species became quite naturalized in the Caspian Sea. Nowadays they provide one of the principal fishing resources, especially in the southern Caspian Sea.

Mullet feed on periphyton, detritus and small invertebrates. Large quantities of soil may also be found in the intestines of the fish. The golden grey, like other species of mullet, is euryhaline (from freshwater to 38‰ and eurythermic (from 3 to 35 °C) (Amini, 1989).

Golden grey mullet in the Caspian Sea spend spring in the north and autumn in the south (Probatov and Tereshchenko, 1951; Tereshchenko, 1950). Males Caspian Sea mullet will be adult at the age of 3 and the female at the age of 4 (Tereshchenko, 1950). The rate of maturation in female mullet is very rapid, i.e. from stage 2 of sexual maturity till stage 4 takes only 1.5–2 months.

Previous studies on the population characteristics of the golden mullet stock in the Iranian waters of the Caspian Sea were limited to the biological characteristics and population dynamic (Ghadirnejad, 1996; Fazli, 1998). However, quantitative assessments are necessary for effective utilization and management of the stock. Despite the economic and ecological importance of the golden grey mullet as one of the major commercial and forage species in the Caspian Sea, no adequate information about sex, age, growth and mortality of golden grey mullet in the Caspian Sea has been published. Such information is especially important because of the ecological changes that are occurring in the sea at the present time. Further, an invasive jellyfish (Ctenophora, *Mnemiopsis leidyi*), that appeared in 1999 (Ivanov et al., 2000), affects all components of the ecosystem, and specially had negative affects on two pelagic species (anchovy, *Clupeonella engrauliformis* and bigeye kilka, *C. grimmi*, and no affect on one pelagic species (common kilka, *C. cultriventris*) (Fazli, 2007; Karpyuk et al., 2004). The objective of the present study is to fill the information gaps on the population biology, consider the biomass of golden grey mullet during 1991–2005

* Corresponding author at: The Caspian Sea Ecology Research Center, P.O. Box 961, Khazar-abad, Sari, Mazandaran, Iran. Tel.: +98 151 346 2512; fax: +98 151 346 2495.
E-mail addresses: hn_fazli@yahoo.com, fazlihasan@gmail.com (H. Fazli).

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(pre-invasive; 1991–1999 and post-invasive; 2000–2004) and provide a basis for improved and effective management of golden grey mullet fisheries in the Iranian waters.

2. Materials and methods

Sampling areas were located in the fishing regions. There are 151 fishing cooperatives along Iranian coastal zone. The samples were collected during the fishing season (from early October to the middle of April), during 1991–2005.

The mullet examined in this study were caught by using beach seines. Field sampling was conducted by staff of the Caspian Sea Ecology Research Center, Inland water Fisheries Research Center and Golestan Fisheries Research Center/IFRO from 1991 (October) to 2005 (April). The fork length was measured to the nearest 0.5 cm and total weight to the nearest 25 g.

Scales were collected from the middle of the body behind the pectoral fins above the hypothetical lateral line and preserved in the envelopes for future treatment. The scales from this body area are uniform and well readable. The scales were washed, placed in small covered Petri dishes with tap water. Following this, the organic layers were removed by rubbing and washing the scales between the fingers in tap water (Fig. 1). A total of 3502 *L. aurata* specimens were sampled in weekly intervals during 2002–2004, from commercial catches. Age compositions of catch were derived from the length composition data and age-length keys.

The relation of weight to length was calculated applying the exponential regression as the following equation:

$$W = a \times L^b$$

where W is the total weight (g) and L, the fork length (mm), and a and b are parameters to be estimated (Ricker, 1975). The condition factor (CF) was calculated as the following equation (Bagenal, 1978):

$$\mathrm{CF} = \frac{W}{L^b} \times 100$$

where W is the total weight (g).

The Bertalanffy growth curve (1938) was fitted to the observed length at age data for the resulting age-length key using a non-linear estimation method the following:

$$L_t = L_\infty(1 - \mathrm{e}^{-K(t-t_0)})$$

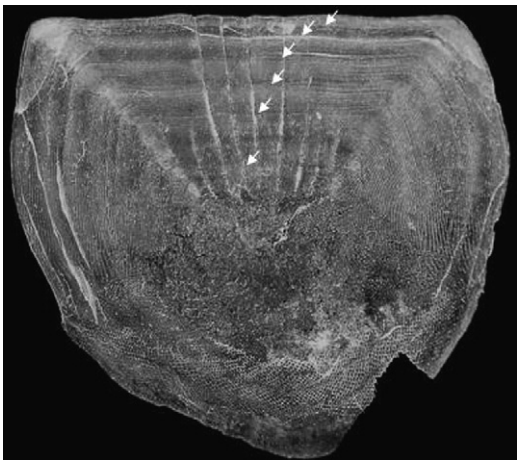

Fig. 1. Photo of *Liza auarata* scale sampled in the Caspian Sea (35.3 cm fork length and 455 g weight). Arrows indicate annulis.

Table 1
Mean fork lengths (cm) of golden grey mullet sampled in Iranian region of the Caspian Sea during the years 1991–2005

Year	Fork length (cm)			Weight (g)		
	N	Mean ± S.D.	Min.–Max.	*N*	Mean ± S.D.	Min.–Max
1991–1992	7,869	31.4 ± 5.56	18.0–57.0	4,680	386.9 ± 255.3	100–2300
1992–1993	4,540	31.4 ± 5.61	21.0–57.0	4,518	376.7 ± 230.6	100–2000
1993–1994	4,120	31.5 ± 5.82	18.0–57.0	4,099	400.5 ± 254.9	70–1800
1994–1995	1,274	29.6 ± 5.62	18.0–61.0	1,264	330.9 ± 234.5	58–2100
1995–1996	1,781	33.2 ± 6.31	19.0–58.0	1,735	444.7 ± 293.9	65–1750
1996–1997	1,676	32.8 ± 6.72	21.0–56.5	1,667	441.2 ± 299.1	100–1800
1997–1998	950	32.9 ± 6.59	18.0–56.0	949	453.6 ± 319.6	50–2400
1998–1999	3,657	34.2 ± 6.86	18.5–58.0	3,641	484.1 ± 311.3	50–2300
1999–2000	2,592	34.0 ± 7.65	18.0–58.5	1,209	450.3 ± 350.0	50–2250
2000–2001	2,618	33.5 ± 7.06	19.5–59.0	2,604	465.9 ± 323.4	88–2200
2001–2002	2,334	31.9 ± 6.71	20.5–58.0	2,334	402.9 ± 288.6	100–2150
2002–2003	2,644	33.0 ± 6.57	21.0–58.5	2,631	435.4 ± 277.6	100–2500
2003–2004	2,362	32.3 ± 6.08	18.0–56.5	2,338	417.4 ± 262.7	80–2000
2004–2005	1,150	33.3 ± 6.03	20.3–56.0	1,150	452.5 ± 288.8	130–1980
Total	38,417	32.3 ± 6.38	18.0–61.0	33,669	418.6 ± 277.4	50–2500