

The population status of sulphur goatfish *Upeneus sulphureus* in the Iraqi marine waters, northwest Arabian Gulf

A.R.M. Mohamed* and A.K. Resen

Department of Fisheries and Marine Resources, Agriculture College, Basrah University, Iraq

* e-mail: abdul19532001@yahoo.com

Abstract - The status of the sulphur goatfish *Upeneus sulphureus* Cuvier, 1829 population in the Iraqi marine waters, north-west of the Arabian Gulf was assessed using FiSAT program from March 2007 to September 2008. A total of 7574 specimens of *U. sulphureus* were collected by trawl net, their lengths ranged from 5 to 17cm. Length-weight relationship was $W = 0.0621 L^{3.0125}$. The growth parameters estimated were $L_{\infty} = 18.85\text{cm}$ and $K = 0.72$. The growth performance index (ϕ) of the species was computed as 2.36. Total mortality rate (Z) was computed as 2.43, natural mortality rate (M) was 1.85, fishing mortality rate (F) was 0.58 and the exploitation ratio was 0.32. The values of F and E of *U. sulphureus* obtained in the present study were lower than those recorded for the same species in the previous studies, whereas the population of the species exposed to higher natural mortality rate. The results indicated that the present levels of E and F were lower than those of the maximum (Y/R)'.

Introduction

Goatfishes of the family Mullidae are predominantly benthivores which live in marine and brackish water habitats above sandy or muddy bottoms as well as along coral reefs, represented in the Arabian Gulf by six genera, *Mullus*, *Upeneus*, *Parupeneus*, *Mulloidichthys*, *Upenichthys* and *Pseudupeneus*, and seven species (Kuronuma and Abe, 1986) and in the West-Indian Ocean by twenty two species (Kumaran and Randall, 1984). However, the genus *Upeneus* is represented by seventy-one nominal species and another 18 were subsequently reclassified in the Indo-West Pacific region (Randall and Kulbicki, 2006). The goatfish catch reported from the West-Indian Ocean exceeded 6 500 t in 1980, of which more than 5 500 t corresponded to species of *Upeneus* (Kumaran and Randall, 1984). The catch rate of the *Upeneus* species ranged from 0.82 to 70.2 kg/hr, with a mean value of 25.9 kg/hr and formed 7.4% of the total catch in the Iraqi marine waters during 1989-1990 (Mohamed, 1993).

The sulphur goatfish *Upeneus sulphureus* Cuvier, 1829, locally known as Sultan Ibrahim, is a demersal, oceanodromous, usually in schools and inhabits a depth of 10-90m, and is widely distributed in coastal waters, entering estuaries throughout the Indo-West Pacific from the Arabian Gulf and eastern coast of Africa to southeast Asia, southern Japan through East China Sea, eastward to Fiji Islands and southward to Queensland (Kumaran and Randall, 1984; Kuronuma and Abe, 1986; Randall and Kulbicki, 2006). The diet of this species is mainly composed of small shrimps, crabs and fishes (Mohamed and Saleh, 2000).

The biology and dynamics of *U. sulphureus* have been studied in various regions of the world and reported by Dwiponggo (1984), Banon *et al.* (1986), Boraey and Soliman (1987), Budihardjo (1988), El-Gammal *et al.* (1994), Reuben *et al.* (1994), Wantiez (1998) and Ikejima *et al.* (2006). Several studies of this species have been undertaken in the Iraqi marine waters (Mohamed, 1993; Ali *et al.*, 1993; Ali, 1999; Mohamed and Saleh, 2000; Mohamed *et al.*, 2004; Mohamed and Mutlak, 2006; Hussain *et al.*, 2007; Mohamed *et al.*, 2007; 2008).

More than one attempt was conducted on the assessment of *U. sulphureus* stock in the northern Arabian Gulf during 1996-2000 (Ali, 1999; Mohamed and Saleh, 2000; Mohamed *et al.*, 2008). The present study aimed at estimating the basic parameters required for assessing the status of *U. sulphureus* during 2007-2008 from the Iraqi marine waters, northern Arabian Gulf and compared with the status of this species during the last decade, to detect the changes in the population characteristics.

Materials and Methods

Fish Samples:

The present study was carried out in the Iraqi marine waters, a part of the NW Arabian Gulf between latitudes $48^{\circ} 48'$ to $48^{\circ} 50'$ E and altitudes $29^{\circ} 45'$ to $29^{\circ} 48'$ N (Fig.1). The ecological properties of the Iraqi marine waters differ from the rest of the Gulf, due to fresh water effluent from the Shatt Al-Arab River.

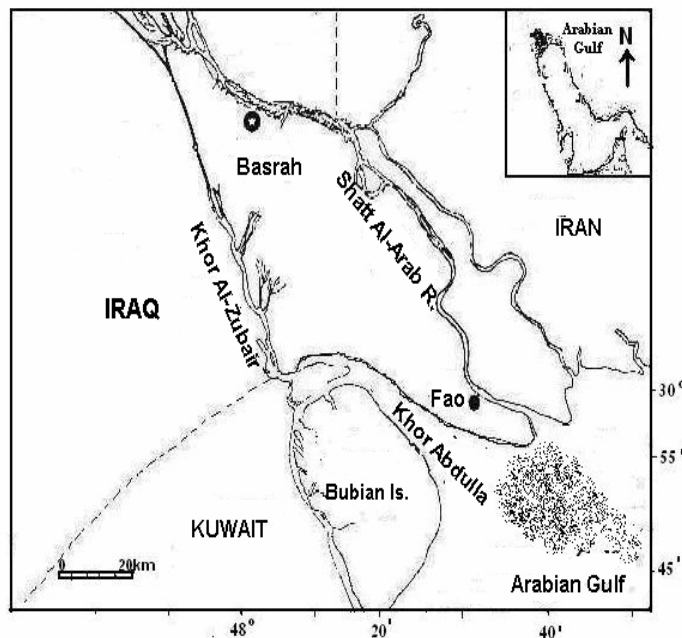


Fig. 1: Map of the Iraqi marine waters, northwest Arabian Gulf, showing the sampling area (shaded).

Fishes were collected on monthly basis from March 2007 to September 2008, by a commercial small trawler "Rahman Lanch" 16m length, 3.5m width, with inboard engine, 150hp, operating a trawl net (16m head rope, 18m ground rope and stretched mesh 2.5cm in the wings and 1.5cm in the cod-end) from a winch system towed by a wire of 75-100m. The samples were collected for 4-6 consecutive fishing days with an average of 5-6 hauls per day and 1.5-2.0 hours for each. Each trawl catch was weighed, and individuals were counted and measured by total length (TL) to the nearest mm. Species identification was based on Kumaran and Randall (1984) and Kuronuma and Abe (1986).

Data analysis:

A total of 7574 *U. sulphureus* constituted the database for stock analysis. Monthly length-frequency data were analyzed using the FiSAT program (Gayanilo *et al.*, 1996), version 2005. Fishes were measured to study the length frequency distribution, size intervals of 1.0 cm measured. The total length to the nearest millimeter and total weight to the nearest 0.1g were taken for each individual of *U. sulphureus*. The relation between the total length (L) and total weight (W) was computed according to the FiSAT program using the formula; $W = a L^b$, where a and b are constants whose values were estimated by the least square method. Age was determined by Bhattacharya (1967) method which depends on the analysis of length frequencies, the back-calculated lengths were applied according to Gulland and Holt (1959) plot incorporated in FiSAT software package to estimate the von Bertalanffy growth parameters (L_{∞} and K). The growth performance index (ϕ) was computed according to the formula of Pauly and Munro (1984) as: $\phi = \text{Log } K + 2\text{Log } L_{\infty}$. The length converted catch curve (Pauly, 1984) was applied to estimate the total mortality coefficient (Z). The coefficient of natural mortality (M) was estimated as exponential of (M) calculated by the empirical Pauly's equation (Pauly, 1980), where the annual water temperature of the study area (T) entered was 24.4 °C. The fishing mortality coefficient (F) was calculated as: $F = Z - M$. The exploitation rate (E) was calculated using the formula of Gulland (1970) as: $E = F/Z$. The recruitment pattern was estimated by projecting the length frequency data backward on to the time axis. Relative yield per recruit (Y/R)' and relative biomass per recruit (B/R)' were estimated using the model of Beverton and Holt (1957) as modified by Pauly and Soriano (1996) and incorporated in the FiSAT software. The data of probability of capture file M/K values were used to estimate both (E_{max}), which represent the optimum exploitation that may maximize the yield per recruitment and ($E_{0.5}$) the exploitation level at which the biomass is reduced to 50% of the unexploited stock.

Results

The total length frequencies of 7574 *U. sulphureus* ranging from 5 to 17 cm TL were analyzed (Fig. 2). The major peak was at a length of 12cm and formed 25.1 % of the species catch. Length and weight measurements of 7574 specimens were used to describe the length-weight relationship of *U. sulphureus*. Their total lengths varied between 5.0 and 17 cm, while the total weights ranged between 8 and 130.5 g. The obtained equation was as follow: $W = 0.0621 L^{3.0125}$ with a

regression coefficient $r^2 = 0.94$. No statistical significant difference was found between this and value 3 ($P > 0.05$), which means an isometric growth pattern was occurred.

The growth parameters estimates obtained by Gulland and Holt plot are $L_{\infty} = 18.31$ cm and $K = 0.68$ (Fig. 3), and used in the progressive calculations. Whereas, the values obtained by Faben's method ($L_{\infty} = 18.85$ cm and $K = 0.72$) were used to described the annual growth. *U. sulphureus* attained lengths of 10.5, 14.4 and 16.0cm at the end of (1–3) years, respectively. It can be concluded that most of the growth increment is taken place by this species at the first two years of its life span. The growth performance index (ϕ) of *U. sulphureus* was computed as 2.36.

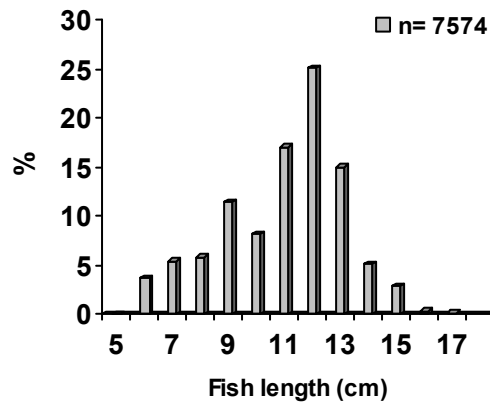


Fig. 2. Length–frequency distribution of *U. sulphureus* at the north-west Arabian Gulf during 2007-2008

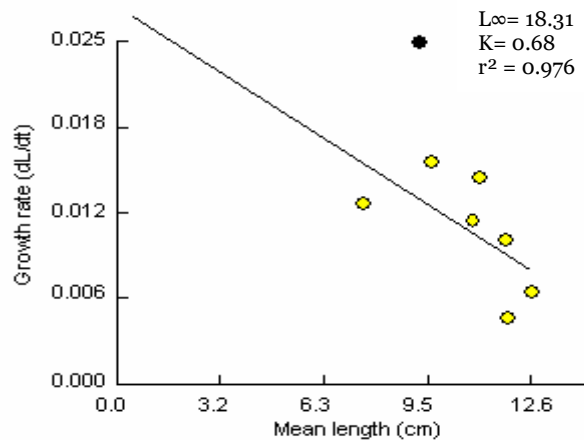


Fig. 3. Growth parameters estimates of *U. sulphureus* at the north-west Arabian Gulf during 2007-2008

The results obtained from figure (4) indicate that the total mortality coefficient "Z" was estimated as 2.43 year⁻¹. The value of natural mortality coefficient "M" was estimated as 1.85 year⁻¹, while fishing mortality coefficient "F" was estimated as 0.58 year⁻¹. Exploitation rate "E" of the species was computed to be 0.32.

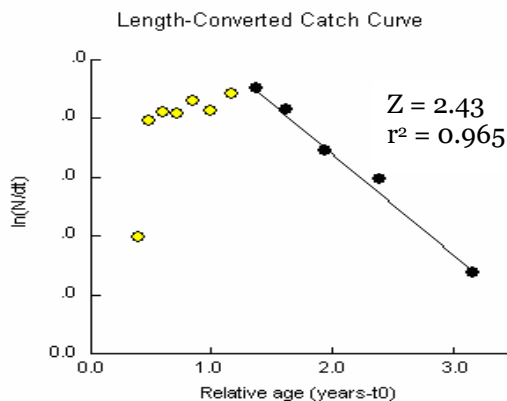


Fig. 4. Length converted catch curve of *U. sulphureus* at the north-west Arabian Gulf during 2007-2008

Annual recruitment of *U. sulphureus* appears to occur in two pulses (Fig. 5). The modes were of unequal strength pulses, the minor contributed about 37.9% of the total recruits with a peak in April and the major formed 62.1% with a peak in October. The relative yield per recruit (Y/R)' and relative biomass per recruit (B/R)' of *U. sulphureus* in the study area were calculated (Fig. 6).

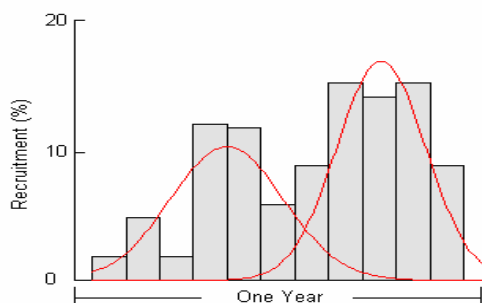


Fig. 5. Recruitment pattern of *U. sulphureus* at the north-west Arabian Gulf during 2007-2008

The maximum (Y/R)' was obtained at $E_{max} = 0.5$ as the exploitation rate increases beyond this value, relative yield per recruit decreases. The exploitation level which will result in a reduction of the unexploited biomass by 50% ($E_{0.5}$) was equaled 0.42. The results indicated that the present levels of E and F were lower than those which give the maximum (Y/R)'.

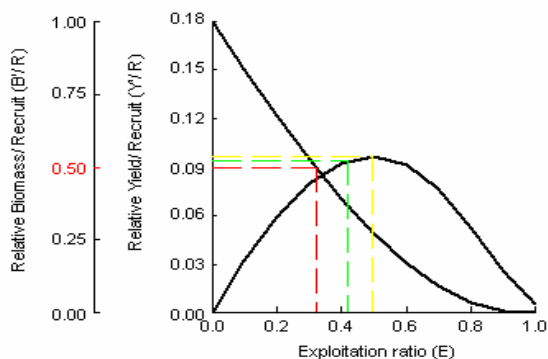


Fig. 6. Relative yield per recruit and Relative biomass per recruit of *U. sulphureus* at the north-West Arabian Gulf during 2007-2008

Discussion

The contribution of the goatfish's species of the total catch in the Iraqi marine waters increased from 7.4% during 1989-1990 (Mohamed, 1993) to 14.6% during 1999-2000 (Mohamed and Mutlak, 2006). *U. sulphureus* alone formed 13.6% of the total catch during 1999-2000 and the highest catch rates were recorded in summer and autumn (Mohamed and Mutlak, 2006). The seasonal pattern of the total catch of fish, in which the lowest value recorded during winter and the highest value during summer, has been previously stated for the Iraqi marine fisheries (Mohamed, 1993; Ali *et al.*, 1998). However, Al-Kholly and Soloviov (1978) referred to the migration of most fish species toward the deeper waters of the Gulf during the cold season.

The parameter estimates of *U. sulphureus* obtained in the present study were compared with the status of this species recorded in the previous studies (Table 1). The values of size range and the constant (b) of length-weight relationship of *U. sulphureus* occurring in the study area are like those reported by other authors in the region (Ali, 1999; Mohamed and Saleh, 2000; Mohamed *et al.*, 2008), this is due to similar condition factors. The von Bertalanffy growth model was used to describe the theoretical growth of *U. sulphureus* ($K = 0.72$ and $L_{\infty} = 18.85\text{cm}$) the values indicated that intermediate growth rate and longevity compared with other studies on the same species (Table 1). A method of validating growth parameters involves the comparison of growth performance index (Φ) in terms of growth in length with other estimates obtained for the same or a closely similar species (Gayani and Pauly, 1997). The growth performance index of *U. sulphureus* obtained in the present study falls within the values mentioned in FishBase for the same species in other areas. These controversies data from various regions may be due to different environmental conditions.

The values of fishing mortality and exploitation rates of *U. sulphureus* obtained in the present study are lower than those recorded for the same species in the previous studies (Table 1). Gulland (1970) suggested that the optimum exploitation rate is about 0.5, so the low value of the present

Table 1. Comparison of population parameters of the sulphur goatfish from different areas.

Region	Fish length (cmTL)	Length-weight relationship		L ∞ (cm)	K	ϕ	Z	F	M	E	Sources	
		a	b									
Peninsular east coast, Malaysia	-	-	-	-	19.40	0.560	2.32	-	-	-	-	FishBase
Sarawak Sarawak, Malaysia	-	-	-	-	22.0	0.650	2.50	-	-	-	-	FishBase
Samar Sea, Philippines	-	-	-	-	19.50	1.200	2.66	-	-	-	-	FishBase
Burias Pass, Philippines	-	-	-	-	23.5 FL	1.300	2.86	-	-	-	-	FishBase
Java Sea, Indonesia	-	-	-	-	19.9	0.875	-	-	-	-	-	FishBase
Northwest Arabian Gulf	5.7 – 18.6	0.0013	2.964	19.6	19.6	0.725	-	-	-	-	-	Mohamed and Saleh (2000)
=	4.0 - 16.0	0.0036	2.9494	17.45	17.45	0.86	-	3.31	1.68	1.63	0.49	Ali, 1999
=	5.0 – 18.0	0.0686	3.132	19.0	19.0	0.53	-	2.17	1.22	0.95	0.46	Mohamed et al (2008)
=	5.0 – 17.0	0.0621	3.0125	18.85	18.85	0.72	2.37	2.43	0.58	1.85	0.32	Present study

exploitation rate indicates that the stock of *U. sulphureus* is underexploited. Also, the results indicated that the present levels of E and F were lower than those giving the maximum (Y/R)'.

The value of natural mortality rate to growth coefficient (M/K) of *U. sulphureus* in the present study was 2.57. Beverton and Holt (1957) mentioned that the value of M/K is ranging from 1.5 to 2.5 and the ideal value of this equivalent is 2.0 and any excess of this value exposed the vulnerability of fish to considerable natural mortality before it reach the stage of aging. There are several factors respond for the natural mortality in fishes (Dulcic *et al.*, 2000; Silvano and Begossi, 2001), one of them can be attributed to oil pollution, Resen (2007) found that the levels of oil hydrocarbons in the tissues and gonads of marine fishes in the region were higher during the period of 2004-2005 compared to previous decades.

The bimodal recruitment pattern obtained in the present study was coincided with the previous work of Ali (1999). Mohamed *et al.* (2004) reported that *U. sulphureus* has a spawning period extending from June to the end of July. The bimodal recruitment pattern was also shown by other species occupying the northwest Arabian Gulf (Hussain and Abdullah, 1977; Mohamed and Ali, 1993; Ali *et al.*, 2000; Mohamed *et al.*, 2008). Such modals indicate the biological importance of the region for early stages of many species successfully utilizing this region as a nursery ground.

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حالة مجتمع اسماك سلطان إبراهيم *Upeneus sulphureus* في المياه البحرية العراقية، شمال غرب الخليج العربي

عبد الرزاق محمود محمد و امجد كاظم رسن
قسم الأسماك والثروة البحرية، كلية الزراعة، جامعة البصرة، العراق

المستخلص قيم مجتمع اسماك سلطان إبراهيم *Upeneus sulphureus* في المياه البحرية العراقية، شمال غرب الخليج العربي، خلال الفترة من آذار 2007 إلى أيلول 2008 باستخدام برنامج FiSAT. جمع 7574 نموذجاً من الأسماك بواسطة شبكة الجر، تراوحت أطوال الاسماك بين 5- 17 سم. كانت علاقة الطول الكلي بالوزن الكلي للأسماك ($W = 0.0621 L^{3.0125}$). بلغت قيم مقاييس النمو $L_{\infty} = 42.4$ سم و $K = 0.53$. بلغ دليل كفاءة النمو (θ) للنوع 2.27. كانت معدلات النفوق الكلي (Z) 2.43 والطبيعي (M) 1.85 والصيد (F) 0.58 والاستغلال (E) 0.32. أظهرت الدراسة انخفاض قيم نفوق الصيد والاستغلال وارتفاع قيمة النفوق الطبيعي لأسماك سلطان إبراهيم في الدراسة الحالية مقارنة بالقيم المسجلة للنوع في المياه العراقية.