Asian Journal of Applied Sciences (ISSN: 2321 – 089)
Volume 04 – Issue 03, June 2016

Stock Assessment of Four Fish Species in the East Hammar Marsh, Iraq

Abdul-Razak M Mohamed[1*], Sadik A. Hussein[1] and Falah M. Mutlak[2]

[1]Department of Fisheries, College of Agriculture
Basrah University, Iraq

[2]Marine Science Centre
University of Basrah, Iraq

[*]*Corresponding author's email: abdul19532001 [AT] yahoo.com*

ABSTRACT-- ***Stock assessment of Planiliza abu, Carassius auratus, Tenualosa ilisha and Carasobarbus luteus in the Esat Hammar marsh, Iraq were assessed using FiSAT II software. Samples were collected from three sites: Harer, Salal and Burkah by five types of fishing gears from January 2009 to May 2010. P. abu and C. auratus were the most abundant numerically represented by 14.8% and 13.1% of the total catch, respectively, while T. ilisha and C. luteus comprised 6.1% and 2.2%, respectively.*** **The *growth and mortality parameters* L_∞, K, *Z, M and F were 24.6 cm, 0.44, 3.27, 1.03 and 2.24 for P. abu, 42.3 cm, 0.27, 1.87, 1.87 and 1.22 for C. auratus, 57.1 cm, 0.33, 1.55, 0.68 and 0.87 for T. ilisha and 37.9 cm, 0.27, 1.59, 0.67 and 0.92 for C. luteus, respectively. The exploitation rate (E) estimates were 0.68, 0.65, 0.56 and 0.58 for P. abu, C. auratus, T. ilisha and C. luteus, respectively. The results revealed that all species were overexploited. Moreover these values exceeded the maximum allowable limit based on the yield-per-recruit calculation (E_{max}) for all species. It is necessary to enforce immediate fishing regulation measures on the fish stock in the investigated location and this can be assessed by activating the national law of fishing, exploiting and protecting aquatic resources.***

Keywords-- Growth, mortality, exploitation, East Hammar marsh, Iraq

---

1. INTRODUCTION

The southern marshes in Iraq of a wider wetland in southwest Asia, covering an area of more than 15,000 km^2 and is characterized by a lid vegetarian dense and therefore constitute a natural shelters for many of the special birds, fish, buffalo and other aquatic life [1]. These marshes were encountered various issues during the last three decades amongst them construction of new hydrological projects in upper parts of the Euphrates and Tigris Rivers and drainage activities in the 1990s desiccating the southern marshlands [2].Since mid-2003, great efforts were made to restore the marshlands.

There is no published information on the species composition, fish ecology, and fisheries of the marshes before their draining, but some biological aspects of some freshwater fishes were investigated [3-7].

The fish assemblage of East Hammar marsh differs from that of other Iraqi marshes by the regular occurrence of marine and diadromous fish species, in addition to pure freshwater species both native and alien. According to a recent study, the fish assemblage of East Hammar marsh consists of 39 species belonging to 19 families, 11 of them were native, nine alien and 19 marine species [8].

After inundation the marsh in April 2003, published research papers dealt mostly with the fish species composition, like [9-11], but unfortunately few studies were detected dealing with the fish stock assessment [12, 13].

The objective of the present work is to determine growth, mortality, exploitation and yield per recruit of three freshwater species (*Planiliza (Liza) abu, Carassius auratus* and *Carasobarbus luteus*) and one diadromous species (*Tenualosa ilisha*) in the Esat Hammar marsh following six years of inundation.

2. MATERIALS AND METHODS

East Hammar marsh is an extensive area of wetlands. It is located at the upper corner formed by the meeting of the Euphrates and Shat Al-Arab Rivers and extends west to the oilfields of West Qurna. The Shatt Al-Arab flows southwards along the eastern edge of the marsh. After inundation in April 2003, the marsh received water mainly from the Shatt Al-Arab River. Therefore, it is tidal marsh affected by semidiurnal tide from Arabian Gulf. Almost entire marsh was covered by tall reed-beds of *Phragmites australis* and *Typha domingensis*, in addition to *Ceratophyllum demersum*, *Nagas* sp., *Potamageton pectinatus, P. perfiolatus, Meriophylum sipctum*, *Salvinia natans* and *Vallisiniria spirlais* [14].

The fish stocks were sampled from three selected sites in the East Hammar (Fig. 1); Harer site (E 47° 41′ 37.5″: N 30° 35′ 17.6″), Salal site (E 47° 39′ 19.7″: N 30° 38′ 17.2″) and Burkah site (E 47° 36′ 44.8″: E 30° 41′ 11.5″). Fish were collected on a monthly basis during January 2009 to May 2010 using different types of fishing gears: seine net (120m long with 25 and 100 mm mesh sizes), trammel net (150 m long with 30 and 40 mm mesh sizes), fixed and drifted gill nets (50 to 100 m long with 25 to100 mm mesh sizes), cast nets (6 to 9 m diameter with 25 and 40 mm mesh sizes) and electro-fishing by generator engines (provides 300-400V and 10A).

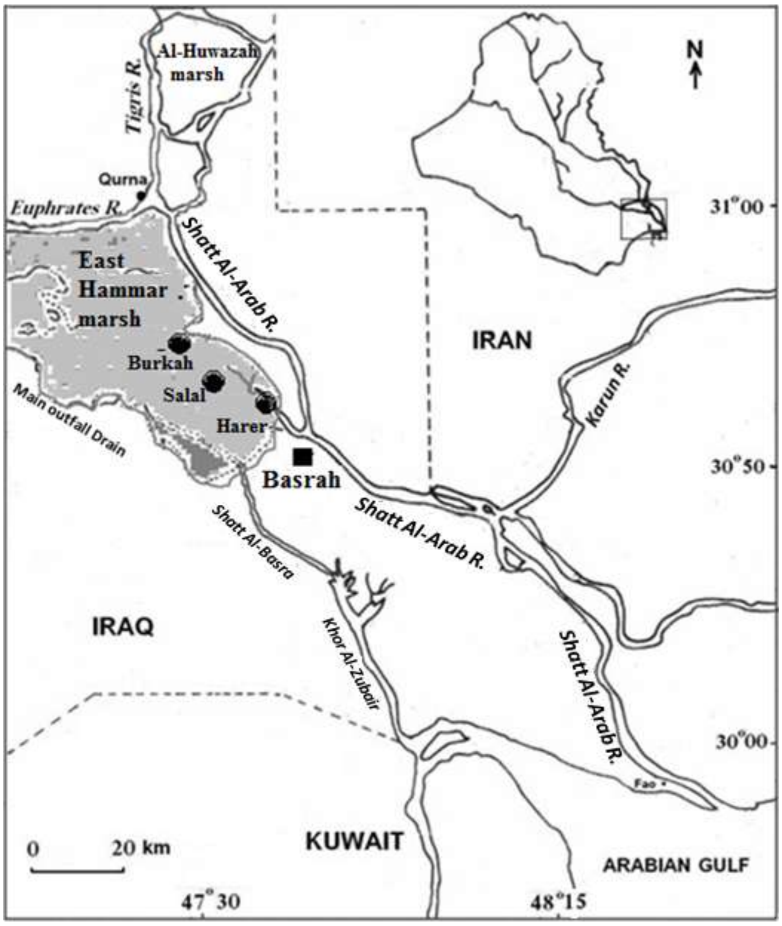

Figure (1): Map of southern of Iraq, showing the location of sampling area

Total length (TL, mm) was measured to the largest possible number of fish in the field. Total lengths of fish collected by various fishing gears were combined. The combination of fishing gears used would minimize bias attributable to gear selectivity [15]. Subsamples were collected for each species for length-weight relationships.

The length-frequency data for each species were pooled monthly from different sampling sites and subsequently grouped with one cm class intervals for analysis. The data were analysis using FiSAT II (FAO-ICLARM Stock Assessment Tools) as explained in details by [16]. Bhattacharya's method was used to identify different cohorts in the catch and to estimate the mean length for each cohort. Means were then involved in the estimation of the growth parameters (L_∞ and K) using Fabens method integrated in FiSAT software package. The total mortality rate (Z) was estimated by length-converted catch curve [17]. The natural mortality rate (M) was calculated by using Pauly's empirical formula [18], where the mean habitat temperature was 24.3 °C. The fishing mortality rate (*F*) was then calculated by the difference between (*Z*) and (*M*) and the rate of exploitation (*E*) was calculated by the quotient between fishing and total mortality: $E = F/Z$ [17]. One year recruitment pattern was obtained by projecting the length frequency data backward on to the time axis as described in the FiSAT routine. Relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) were estimated using the model of Beverton and Holt [19] as modified by Pauly and Soriano [20] and incorporated in the FiSAT software.

3. RESULTS

3.1 Relative abundance

A total of 47 fish species belonging to 35 genera and 20 families were collected from the marsh, including 24 freshwater and 23 marine species. *P. abu* and *C. auratus* were the most abundant numerically represented by 14.8% and 13.1% of the total catch, respectively, while *T. ilisha and C. luteus* comprised 6.1% and 2.2%, respectively.

3.2 Length frequency distributions

A total of 56430 fish specimens (distributed as 23131 *P. abu*, 20331 *C. auratus,* 9533 *T. ilisha* and 3435 *C. luteus*) were involved in this study. The overall length frequency distributions of the study fish species in the marsh are illustrated in Figure 2. The lengths of *P. abu* ranged from 1.4 to 21.3 cm, and the most dominant length groups observed were those of 6.0 to 13cm representing 85.8% of the total number. Sizes of *C. auratus* ranged from 2.3 to 34.5 cm, and the length groups (11.0 to 21.0 cm) were prevailing formed 74.4%. Lengths of *T. ilisha* from 2.3 to 47.7 cm were represented in the samples, and the dominant length groups were 8.0 to 11 cm. The length range of *C. luteus* includes sizes from 7.1 to 31.7 cm, with fish of 11-19 cm dominating the catch forming 78.5% of the species catch.

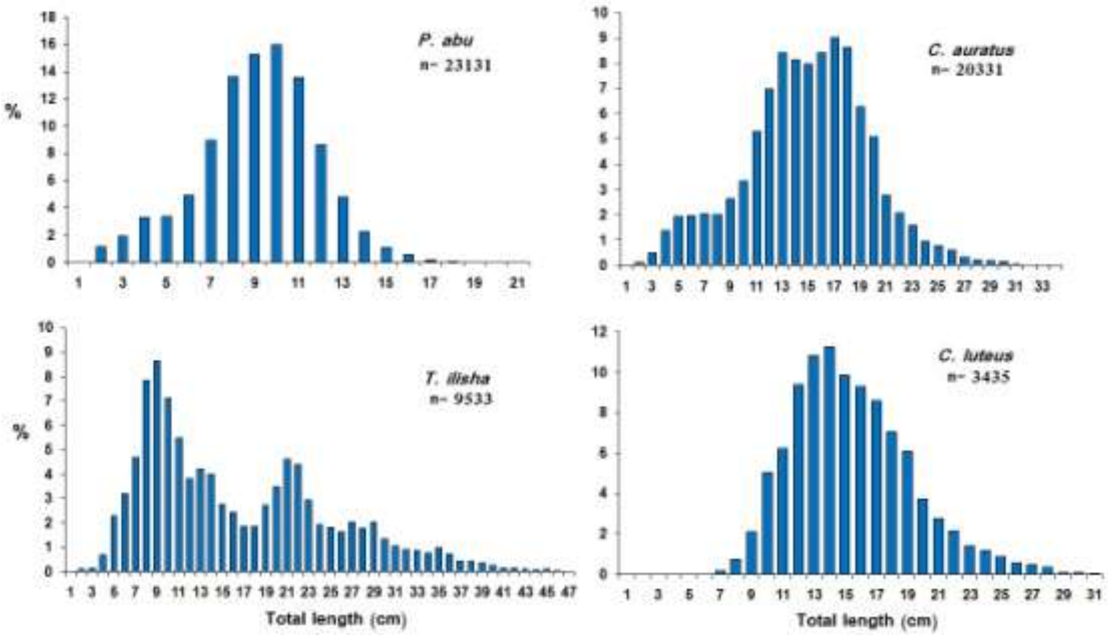

Figure (2): The overall length frequency distributions of the study fish species in the marsh

3.3 Growth

The length–weight relationships of the studied species were:

$W = 0.0143 * L^{2.934}$	$r^2 = 0.992$	n = 709	*P. abu*
$W = 0.0135 * L^{3.085}$	$r^2 = 0.993$	n = 583	*C. auratus*
$W = 0.0082 * L^{3.006}$	$r^2 = 0.987$	n = 1468	*T. ilisha*
$W = 0.0075 * L^{3.225}$	$r^2 = 0.977$	n = 596	*C. luteus*

The analysis of length frequency data by Bhattacharya's method gave an estimate of the asymptotic growth ($L\infty$) values of 24.6, 42.3, 57.1 and 37.9 cm for *P. abu*, *C. auratus*, *T. ilisha* and *C. luteus*, respectively. The annual growth coefficient (*K*) was 0.44, 0.27, 0.33 and 0.27 for *P. abu*, *C. auratus, T. ilisha* and *C. luteus*, respectively.

3.4 Mortality

The length-converted catch curves (Fig. 3) estimated the instantaneous rate of total mortality (Z) as 3.27 for *P. abu*, 1.87 for C. *auratus*, 1.55 for *T. ilisha* and 1.59 for *C. luteus*.The values of the instantaneous natural mortality coefficient for *P. abu*, *C. auratus*, *T. ilisha* and *C. luteus* were 1.03, 1.87, 0.68 and 0.67, respectively. From these results, the fishing mortality coefficient of *P. abu*, *C. auratus*, *T. ilisha* and *C. luteus* in the marsh were computed to be 2.24, 1.22, 0.87 and 0.92, respectively. Therefore, the values of the exploitation rate of *P. abu*, *C. auratus, T. ilisha* and *C. luteus* were 0.68, 0.65, 0.56 and 0.58, respectively.

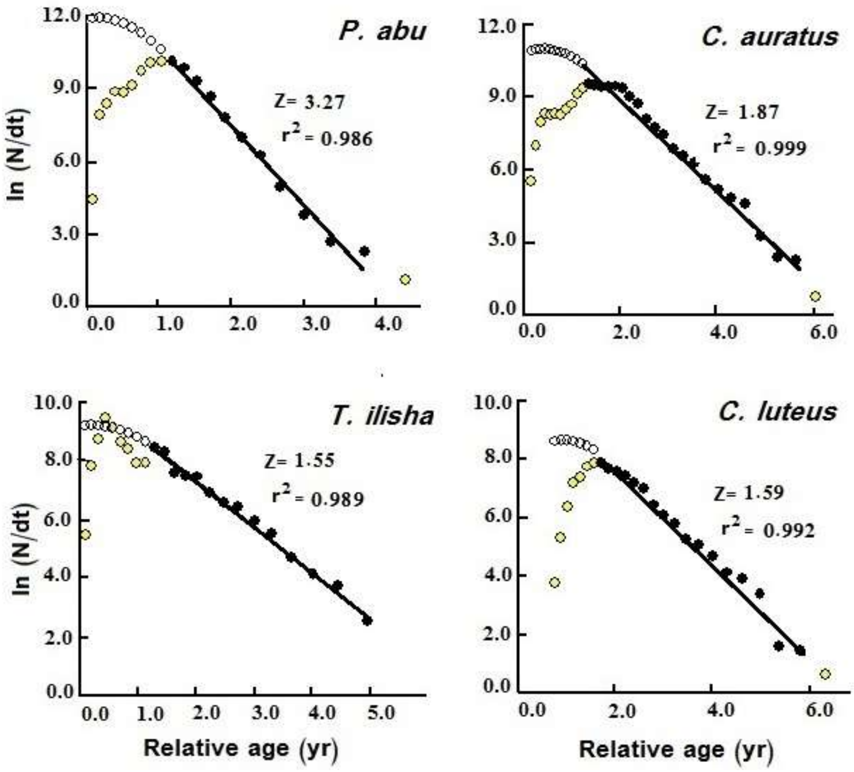

Figure (3): Length converted catch curves of the study fish species in the marsh

3.5 Recruitment patterns

Figure 4 shows the recruitment patterns of the four species in the marsh. The recruitment of *P. abu* was of bimodal pattern . The modes were of unequal strength pulses, the minor contributed 25.3% of the total recruits with a peak in March and the major formed 74.7% with a peak in August. The recruitment of *C. auratus* was noticed in April to September forming 90.7% with a peak in June. The bimodal recruitment pattern of *T. ilisha* was of unequal strength pulses. The major was comprised 56.2% of the recruited numbers with a peak in April; however, the second was constituted 43.8% and occurred during June-August. *C. luteus* was recruited twice a year in the marsh. The first, the major, was constituted 65.3% of the recruitment its peak occurred in May, while the second, the minor, formed 34.7% with a peak in August.

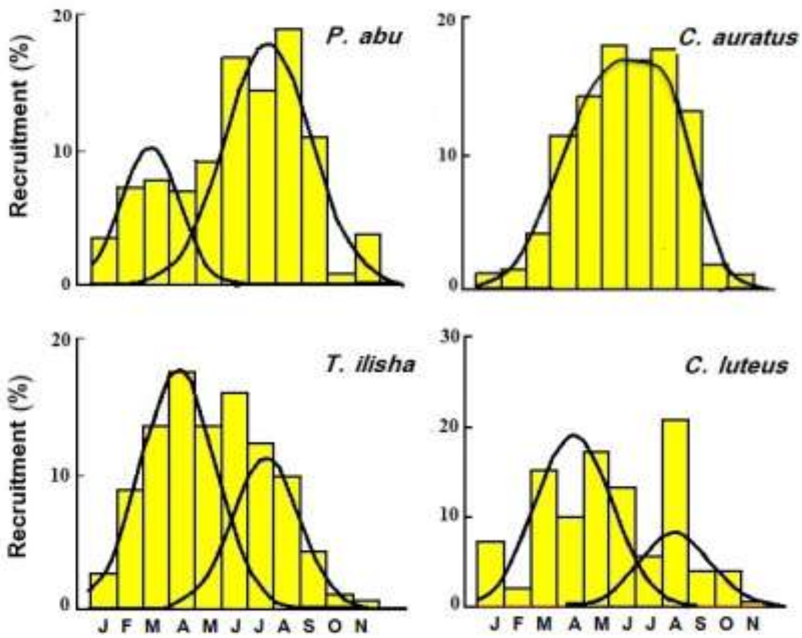

Figure (4): Recruitment patterns of the study fish species in the marsh

3.6 Yield-per-recruit and biomass-per-recruit

The Beverton-Holt relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) estimated using selective ogive procedure of FiSAT for all studied species are given in Fig. 5. The analysis produced values of E_{max} = 0.54, $E_{0.1}$ = 0.40 and $E_{0.5}$ = 0.30 for *P. abu*; E_{max} = 0.42, $E_{0.1}$ = 0.4, and $E_{0.5}$ = 0.27 for *C. auratus*; E_{max} = 0.52, $E_{0.1}$ = 0.41, and $E_{0.5}$ = 0.30 for *T. Ilisha* and E_{max} = 0.54, $E_{0.1}$ = 0.45 and $E_{0.5}$ = 0.30 for *C. luteus*.

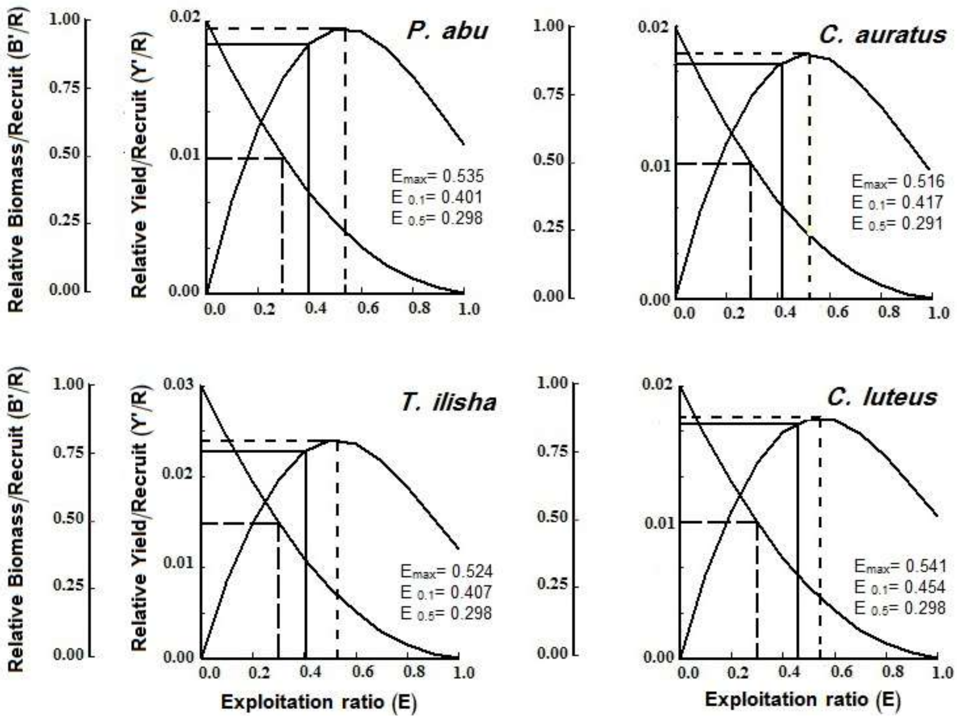

Figure (5): Relative yield per recruit and biomass per recruit curves of the study fish species in the marsh

4. DISCUSSION

Results revealed that *P. abu* and *C. auratus* were the most abundant species in the East Hammar, similar to the situation in the marsh and other southern marshes after inundation [10, 21, 22]. However, Mohamed, *et al.* [8] mentioned that the fish assemblage in the East Hammar marsh during 2012 -2013 was dominated by aliened species of which *C.*

auratus comprised 22.1% followed by *Poecillius latipinna* (14.3%), while, *P. abu* and *Coptodon zilli* (a new exotic species) formed 13.4% and 5.1%, respectively. They suggested that these changes in the structure of fish assemblage in the marsh may be due to the decline in discharge rates of the Shatt Al-Arab River [23], heavy rains and the discharge of drainage water from the Main Outfall Drain (MOD) canal to the marsh during this period. Welcomme [24] stated that fish populations in rivers, lakes and reservoirs vary widely in abundance from year to year, and these variations are in response to fluctuations in precipitation and flood strength.

The length ranges of *P. abu*, *C. auratus* and *C. luteus* in the present study were almost similar to those recorded for these species in the southern marshes after inundation [21, 12, 25], except *T. ilisha*. The length range of *T. ilisha* was wider than those reported previously in East Hammar marsh after inundation in 2003. Mohamed, *et al*. [11] found that the length range of this species in the marsh ranged from 3 to 13 cm, and a length of 6 cm dominated the catch during 2005-2006 and the species exploited the marsh for nursery and feeding activities. The spawning migrations of the species to Shatt Al-Arab River and other rivers in south Iran have been documented by several authors viz. Al-Noor [26], Al-Hassan [27] and Roomiani and Jamili [28]. During the last years the structure of fish assemblage of the marsh has been altered due to impact of marine waters progress from Arabian Gulf as a result of the low waters flow into the Shatt Al-Arab River from the Tigris and Euphrates Rivers [8], and the diversion of the Karun River, away from the Shatt Al-Arab River [29] pushing adult individuals of *T. ilisha* and other marine species to enter east Hammar marsh for spawning, after it has been exploited by the species for nursery and feeding activities [30].

The asymptotic length ($L\infty$) obtained in this study for *P. abu* was comparable to those in other Iraqi waters (23.8cm in Tharthar Lake [31] and 23.2cm in East Hammar marsh [13], although is lower than the value (24.6cm) recorded for the species in Atatürk Lake, Turkey [32]. The value of $L\infty$ of *C. auratus* was better than that recorded for the species in the same marsh (32.6cm) during 2005-2006 [12] and similar to that recorded for the species (43.0cm) in Trasimeno Lake, Italia [33]. $L\infty$ of *T. ilisha* in the study marsh was slightly lower than those recorded for the species in the Iraqi marine waters (60.5cm [34] and 61.5cm [35], and better than those recorded in the Iranian waters (43.3cm [36] and 42.7cm [37] and Indian waters (47.8cm [38]. The value $L\infty$ of *C. luteus* in the present study was better than that recorded for the species in the same marsh before drainage activities in the 1990s, 32.8cm [5] and similar to that recorded for the species in Al-Huwazah marsh, 37.0cm [25]. It has been reported that there must be some differences between growth characteristics among localities as a result of diversity and availability of dietary items, hydrographical and climatic conditions [39, 40].

The study revealed that the stocks of all the four species were overexploited and the values of the exploitation rate of all species were exceeded the optimum exploitation level. If the value of exploitation rate (E) would have been more than 0.50 then it could be concluded that the fish is overexploited from the particular area during this period [41]. The results of exploitation rate obtained in the present study for *P. abu* and *C. auratus* are quite higher than the earlier reported values for *P. abu*, E= 0.58 [13] and *C. auratus*, E= 0.33[12] in East Hammar marsh during 2005-2006. Also, information about status of *T. ilisha* stock in Iraqi marine waters indicated that the stock was overexploited, E= 0.67 [35]. Also, the stock of *T. ilisha* in Iranian waters suffered from heavy exploitation, E= 0.72 [37]. However, Mohamed [25] recorded higher value of E= 0.65 for *C. luteus* in Al-Huwazah marsh, Iraq during 2005-2006.

The overexploitation of all four species are also supported with the obtained relative yield-per-recruit (Y'/R) and relative biomass-per recruit (B'/R) values. Both estimates indicated that the present level of exploitation rate (E) for all species higher than the maximum allowable limit based on the yield-per-recruit calculation (E_{max}).

The comparatively high values of exploitation rate of these species in this marsh may be attributed to several factors including illegal fishing gears, use of explosives, poisons and long-term use of illegal small-meshed nets [42], moreover the substantial reduction in water quality and quantity, and effective absence of the flood pulses that sustained wetland ecosystems in the lower Tigris-Euphrates basin [43].

However, it is urgent to enforce immediate fish regulations in the East Hammar marsh and this can be achieved by activating the national law of fishing, exploiting and protecting aquatic resources, in particular preventing illegal fishing methods, restricting fishing for certain seasons including declaring fish sanctuaries in certain areas, especially in spawning sits.

5. CONCLUSION

This study revealed that the overexploitation of all four species were overexploited and higher than the maximum allowable limit based on the yield-per-recruit calculation (E_{max}). Therefore, it is urgent to enforce immediate fish regulations in the East Hammar marsh.

6. REFERENCES

[1] Partow, H. 2001. *The Mesopotamian Marshlands: Demise of an ecosystem. Nairobi (Kenya): Division of early warning and assessment*, United Nation for Environmental Programs: UNEP publication UNEP/DEWA/, 103p.

[2] Richardson, C. J. and N. A. Hussain. 2006. Restoring the Garden of Eden: An ecological assessment of the marshes of Iraq. *BioScience* 56 (6): 477-489.

[3] Barak, N.A.A. and Mohamed, A.R.M. 1982. Food habits of cyprinid fish *Barbus luteus* (Heckel) from Garma Marsh. *Iraqi J. Mar. Sci.*, 1: 59-66.

[4] Barak, N.A.A. and Mohamed, A.R.M. 1983. Biological study of the cyprinid fish *Barbus luteus* (Heckel) in Garma Marshes. *JBS.*, 14(2): 63-70.

[5] Al-Mukhtar, M.A. 1982. *Biological studies on two fresh water species Barbus luteus (Heckel) and Aspius vorax (Heckel) in Al-Hammar marsh, Basrah*. MSc. thesis, Basrah University, Iraq. 203p.

[6] Mohamed, A.R.M. and Barak, N.A.E. 1988. Growth and condition of cypyinid fish, *Barbus sharpeyi* Gunther in Al-Hammar marsh, Basrah, Iraq. *Basrah J. Agric. Sci.*, 2: 17-22.

[7] Mohamed, A. R. M., and Ali, T.S. 1994. *The biological importance of Iraqi marshes in fish growth*. Pages 205-215 in N. A. Hussain, editor. Ahwar of Iraq environmental approach. MSC Publ. (18), 1994, 299 pp.

[8] Mohamed A.R.M., Al-Saboonchi, A. A. and Fadia, K. R. 2014. Variability of fish assemblage structure in the East Hammar marsh, southern Iraq. *JKAU: Mar. Sci.*, 25(2): 161-184.

[9] Al-Shamary, A.C. 2008. *Ecological assessment for South-East Al-Hammar marsh, north of Basrah*. M.Sc. thesis, Basrah University, Iraq. 121p.

[10] Hussain, N.A., Mohamed, A.R.M., Al-Noor, S.S, Mutlak, F.M., Abed, I. M. and Coad, B.W. 2009. Structure and ecological indices of fish assemblages in the recently restored Al-Hammar Marsh, Southern Iraq. *Bio Risk*, 3: 173-186.

[11] Mohamed, A.R.M., Hussain, N.A., Al-Noor, S.S., Coad, B.W. and Mutlak, F.M. 2009. Status of diadromous fish species in the restored East Hammar Marsh in Southern Iraq. *J. Amer. Fish. Soc*., 69: 577-588.

[12] Al-Noor, S.S. 2010. Population status of gold fish *Carassius auratus* in restored East Hammar Marsh, Southern Iraq. *JKAU: Mar. Sci.*, 21(1): 65-83.

[13] Mohamed, A. R. M. 2014. Stock assessment of freshwater mullet, *Liza abu* populations in the three restored southern marshes, Iraq. *Croatian J. Fish*., 72:48–54.

[14] Al-Abbawy, D.A.H. and Al-Mayah, A.A. 2010. Ecological survey of aquatic macrophytes in restored marshes of southern Iraq during 2006 and 2007. *Marsh Bulletin*. 5: 177-196.

[15] Lucena, F.M. and O'Brien, C. M. 2001. Effects of gear selectivity and different calculation methods on estimating growth parameters of bluefish, *Pomatomus saltatrix* (Pisces: Pomatomidae), from southern Brazil. *Fish. Bull.* 99: 432–442.

[16] Gayanilo, F.C., Sparre, P. and Pauly, D. 2005. *FAO-ICLARM Stock Assessment Tools II (FiSAT II). User's guide.FAO Computerized Information Series (Fisheries*). No. 8, Revised version, FAO, Rome, 168pp.

[17] Pauly, D. 1984. *Fish population dynamics in tropical waters: a manual for use with programmable calculators*. ICLARM stud. Rev., (8): 325p.

[18] Pauly, D. 1980. On the inter-relationships between natural mortality, growth performance and mean environmental temperature in 175 fish stock. *J. Cons.*, 39 (3): 175-192.

[19] Beverton, R. J. H. and Holt, S. J. 1966. *Manual of methods for fish stock assessment*. Part II. Tables of yield function. FAO Fish. Tech. Pap., 38 ver. 1, 67 p.

[20] Pauly, D. and Soriano, M.L. 1986. *Some practical extensions to Beverton and Holt's relative yield-per-recruit model*. In: First Asian Fisheries Forum, Asian Fisheries Society (eds. Maclean, J.L.; Dizon, L.B. and Hosillos, L.V.), pp. 149-495. Manila, Philippines.

[21] Mohamed, A.R.M., Hussain, N.A., Al-Noor, S.S., Coad, B.W., Mutlak, F.M., Al-Sudani, I. M., Mojer, A. M. and Toman, A. J. 2008. Species composition, ecological indices and trophic pyramid of fish assemblage of the restored Al-Hawizeh Marsh, Southern Iraq. *Ecohydrology & Hydrobiology*, 8 (2-4): 375-384.

[22] Mohamed, A. R. M., Hussain, N.A., Al-Noor, S.S. and Mutlak, F. M. 2012. Ecological and biological aspects of fish assemblage in the Chybayish marsh, Southern Iraq. *Ecohydrology & Hydrobiology*, 12(1): 65-74.

[23] Al-Mahmood, H. K. H, Hassan, W. F., Alhello, A.Z.A., Hammood, A. I. and Muhson, N. K. 2015. Impact of low discharge and drought of the water quality of the Shatt Al Arab and Al-Basrah Rivers (south of Iraq). *J. Int. Acad. Res. Multidisciplinary*. 3(1): 285-296.

[24] Welcomme, R. L. 2001. *Inland fisheries: ecology and management*. Food and Agriculture Organization and Fishing News Books, Blackwell Science Ltd. 358p.

[25] Mohamed, A. R. M. 2014. The status of himri fish, *Barbus luteus* (Heckel) population in the Al-Huwazah marsh, south Iraq. *J. Zankoy Sulaimani*-Part A, 16: 303-314.

[26] Al-Noor, S. S. 1998. *The reproductive biology of Tenualosa ilisha in Shatt Al-Arab and Iraqi marine waters.* Ph.D thesis, Basrah University, Iraq. 164p.

[27] Al-Hassan, L.A.L. 1999. Shad of the Shatt Al-Arab River in Iraq. *Shad J.* 4(2): 1-4.

[28] Roomiani, L. and Jamili, S. 2011. Population dynamics and stock assessment of Hilsa Shad, *Tenualosa ilisha* in Iran (Khuzestan Province). *J. Fish. Aquat. Sci*. 6: 151-160.

[29] Hameed, H.A. and Aljorany, Y.S. 2011. Investigation on nutrient behavi-or along Shatt Al-Arab River, Basrah, Iraq. *J. Appl. Sci. Res*., 7(8): 1340-1345.

[30] Mutlak, F. M. 2012. *Stock assessment of some fish species in east Hammar marsh*. Ph.D. thesis, Basrah University. 193p.

[31] Shawardi, A. A. 2006. *Ecology and biology of Carassius carassius (L.1758) and Liza abu (Heckel, 1843) in Tharthar lake*. Ph.D thesis: Al-Mustansiria University, Iraq. 142p.

[32] Doğu, Z., Şahinoz, E., Faruk Aral, F. and Şevik, R. 2013. The growth characteristics of *Liza (Mugil) abu* (Heckel, 1843) in Atatürk Dam Lake. *African J. Agri. Res*., 8(34): 4434-4440.

[33] Lorenzoni, M., Ghetti, L., Pedicillo, G. and Carosi, A. 2010. Analysis of the biological features of the goldfish Carassius auratus auratus in Lake Trasimeno (Umbria, Italy) with a view to drawing up plans for population control. *Folia Zool.*, 59 (2): 142-156.

[34] Mohamed, A.R.M., Ali, T.S. and Hussain, N.A. 2001. Stock assessment of hilsa shad *Tenualosa ilisha* in the Iraqi marine waters, Northwest Arabian Gulf. *Marina Mesopotamica*, 16 (1): 1-9.

[35] Mohamed A.R.M. and Qasim, A. M. H. 2014. Stock assessment and management of hilsa shad,*Tenualosa ilisha* in Iraqi marine waters, northwest Arabian Gulf. *Int. J. Fish. Aquat. Stud*. 1(5): 1-7.

[36] Hashemi, S.A.R., Mohammadi, G. and Eskandary, G. 2010. Population dynamics and stock assessment of hilsa shad, (*Tenualosa ilisha* Hamilton-Buchanan, 1822) in coastal waters of Iran (Northwest of Persian Gulf). *Aust. J. Basic Appl. Sci*., 4(12): 5780-5786.

[37] Dutta, S.D., Maity, S., Chanda, A. and Hazra, S. 2012. Population structure, mortality rate and exploitation rate of Hilsa Shad (*Tenualosa ilisha*) in West Bengal Coast of Northern Bay of Bengal, India. *World J. Fish Mar. Sci.* 4 (1): 54-59.

[38] Nikolsky, G.V. 1963. *The ecology of fishes*. Acad. Pres., London and New York, 352 pp.

[39] Bartulovic, V., Glamuzina, B., Conides, A., Dulcic, J., Lucic, D., Njire, J. and Kozul, V. 2004. Age, growth, mortality and sex ratio of sand smelt, *Atherina boyeri*, Risso, 1810 (Pisces: Atherinidae) in the estuary of the Mala Neretva River (Middle-Eastern Adriatic, Croatia). *J. Appl. Ichthyol*., 20: 427-430.

[40] Gulland, J. A. 1970. *The fish resources of the ocean*. FAO Fisheries Technical Paper, No. 97, FAO, Rome, 425 pp.

[41] Jawad, L. A. 2006. Fishing gear and methods of the lower Mesopotamian plain with reference to fisheries management. *Marina Mesopotamica*, 1(1): 1-39.

[42] Garstecki, T. and Amr, Z. 2011. *Biodiversity and Ecosystem Management in the Iraqi Marshland. Screening Study on Potential World Heritage Nomination*. IUCN, Amman, Jordan. 191p.