ORIGINAL ARTICLES

Population Dynamics and Assessment of *Barbus Gyrpus* (Heckel, 1843) and *Barbus Barbulus* (Heckel, 1847) in Karoon River

1Seyedahmadreza Hashemi, 2Abdosahb mortezavi, 3Mohammadtaghi Kashi

1-3South of Iran aquaculture fishery research center, Ahwaz, P.O Box 61645/8663.

ABSTRACT

The Population Dynamics and status of Shirbot (*Barbus gyrpus*) and Berzem labpan(*Barbus barbulus*) in the Karoon river were investigated to derive information required for their management. During this study from 2006 to 2008 more than 2000 specimens *B. gyrpus* and *B. barbulus* were measured. Mean±S.D Length Values for this species were 37.94±8.18 and 43.62±10.27 respectively and maximum and minimum total length were 20-76cm and 20-94cm respectively. Mean ±S.D weight Values for this species were 873.2±1092.45 gr and 778.59±725.97 gr respectively and maximum and minimum weight were 52- 11170gr and 52- 4675 gr respectively. Growth and mortality parameters were calculated for *B. gyrpus* and *B. barbulus* as below, \( L_4 \): 86.64, 132.9 and \( K \): 0.27, 0.17 and \( t_0 \): -0.46, -0.66, M: 0.5, 0.33, F: 1.22, 1.04, Z: 1.78, 2.72, E: 0.71, 0.76 respectively. Relative yield per recruitment \( (Y'/R) \):0.037,0.021 relative biomass per recruitment, \( (B'/R) \):0.29,0.25, exploitation ratio maximum sustainable yield, \( E_{max} \): 0.44,0.42; precautionary average target (\( F_{opt}=0.25,0.16 \) year\(^{-1} \)) and limit (\( F_{limit}=0.33,0.21 \) year\(^{-1} \)) biological reference points for *B. gyrpus* and *B. barbulus* stock respectively was calculated. According to exploitation coefficient *B. gyrpus* and *B. barbulus* stocks is over fishing and decreases exploitation coefficient proposed.

Key words: *Barbus gyrpus*, *Barbus barbulus*, population dynamic, Karoon river.

Introduction

Overall purpose of fisheries science is to provide decision-markers with advice on the relative merits of alternative management. Demography rates are fundamental to fisheries stock assessment and estimated of potential yield (King, 2007). In tropical waters; lack of distinct seasonality has made such analyses more difficult (Spare and Venema, 1998).

Order Cypriniformes with six families, 321 genera and some 3268 species (Nelson, 2006) is one of the most widespread and large (specious) orders of fishes all over the world. Thus cyprinids are, as well, a major element in Iran's ichthyofauna, found in all its major drainage basins. The genus Barbus (Cyprinidae, Barbinae), being a member of this group, is a polyphyletic taxon in southwest Asia where one monophyletic clad comprising of six species is reported from the Levant, the Arabian Peninsula, the Tigris-Euphrates basin and neighboring drainages in western Iran (Krupp, 1985).

The barbels, genus *Barbus*, are found in Europe, Southwest Asia and Africa and comprise about 800 species (Coad, 2006). According to Coad (1995), Abdoli (2000) more than 17 species of Barbus have been reported from different basins of Iran. Shirbot (*Barbus gyrpus*) and Berzemlabpan (*Barbus barbulus*) belong to the order Cypriniformes, the family Cyprinidae, and the genus Barbus. This species is found in the Tigris-Euphrates basin (Berg, 1949; Marammazi, 1994; Abdoli, 2000). Shirbot and Berzemlabpan species mainly found in running water of streams and rivers although some may inhabit ponds, springs and lakes and have migrations for spawning (Coad, 2006). The Karoon River is one of the longest rivers (850 km) in the Iran (Khuzestan Province) and this river cover a spread area of Khuzestan Province(Marammazi, 1994).

Corresponding Author: Seyedahmadreza Hashemi, South of Iran aquaculture fishery research center, Ahwaz, P.O Box 61645/866.
Ph: +989177055568
E-mail: Seyedahmad83@yahoo.com,
Shirbot and Berzemlabpan are regarded as valuable and are often fished in Karoon River and were caught on drift gill net with different mesh size.

Different aspects of biological work of *B. gyrpus* have been done by different authors (Marammazi, 1994; Nikpey et al., 2000) but no work has been done on population dynamics of this species in Iran. Unfortunately, no references from other studies are available regarding *B. barbulus*.

In this context, the aim of the present study was twofold: (i) to estimate its growth and mortality parameters via length frequency methods (ii) to determine the exploration pattern of the population of *B. gyrpus* and *B. Barbulus* in the Karoon river. Results will greatly contribute to elaborating management programmes for this economically important fish species of the region under study.

**Material and methods**

Length-frequency data of *B. gyrpus* and *B. barbulus* were collected monthly from the catches from landing at five station: Gotvand, Shoshtar, Molasani, Ahwaz, Dakhoin (table1): from April 2006 to March 2008 (Fig.1). Fish sampling was carried out by using 12.5m long gill nets, with meshes of 20, 40, 50, 60, 70, 76, and 140 mm (stretched). Nets were anchored at each of the sampling stations at sunset and they were removed at sunrise on the following day, remaining 12 h in water. Total length (TL, mm) and total weight (W,g) were measured for each fish. Parameters of the length weight relationship were obtained by fitting the power function $W = a \times L^b$ to length and weight data where: $W$ is the total wet weight, $a$ is a constant determined empirically, $L$ is the fork length and $b$ is close to 3.0 for species with isometric growth. The data were then pooled monthly from different landing sites and subsequently grouped into classes of four centimeter intervals. The data were analysis using FiSAT II (FAO-ICLARM Stock Assessment Tools) as explained in details by Gayanilo Jr. et al. (1996).

Growth was calculated by fitting the von Bertalanffy growth function to length frequency data. The von Bertalanffy growth equation is defined as follows (Sparre and Venema, 1998): $L_t = L_\infty - (L_\infty - L_0) \times e^{-K(t - t_0)}$

Where $L_t$ is length at time $t$, $L_\infty$ the asymptotic length, $K$ the growth coefficient and $t_0$ is the hypothetical time at which length is equal to zero.

The $t_0$ value estimated using the empirical equation (Pauly, 1979).

$$\log_{10}(-t_0) = -0.3922 - 0.2752 \log_{10}L_\infty - 1.038 \log_{10}K$$

The fitting of the best growth curve was based on the ELEFAN I programm (Pauly and David 1981), which allows the fitted curve through the maximum number of peaks of the length-frequency distribution. With the help of the best growth curve, growth constant ($K$) and asymptotic length ($L_\infty$) were estimated.

The growth performance index $\Phi'$ (Gayanilo and Pauly, 1997) was calculated in order to provide a basis for the comparison of growth characteristics in terms of length:

$$\Phi' = \Phi - \frac{2}{3} \log_{10}(a),$$

Where $\Phi = \log_{10}(k) + 0.67 \log_{10}(W_\infty)$ and $W_\infty = a \times L_\infty^3$.

The constant, $a$, was derived from length-weight relationships and $k$ and $L_\infty$ were obtained from the von Bertalanffy growth function. The annual instantaneous rate of total mortality ($Z$) was obtained using length converted catch curves adapted to incorporate seasonal growth patterns (Gayanilo and Pauly, 1997). Pooled length frequency samples were converted into relative age frequency distributions using parameters of the von Bertalanffy growth function. The annual instantaneous rate of natural mortality ($M$) was estimated using the empirical equation derived by Pauly’s empirical relationship (Pauly,1980).

$$\log_{10}M = 0.0066 - 0.279 \log_{10}L_\infty + 0.6543 \log_{10}K + 0.4634 \log_{10}T$$

Where $L_\infty$ is expressed in cm and $T$, the mean annual environmental water temperature in °C. Here it is 25°C.

Fishing mortality ($F$) was obtained by subtracting $M$ from $Z$ and exploitation rate ($E$) was obtained from $F/Z$.

Pauly and Soriano (1986) was used to predict the effects of increasing the existing mean size at first capture ($L_{50}$) to that at which yield per recruit would be maximized ($L_{max}$).

Relative yield per recruit ($Y/R$) and relative biomass per recruit ($B/R$) values as a function of $E$ were determined from the estimated growth parameters and probability of capture by length (Pauly and Soriano, 1986). Evaluations of resource status were made using estimates of exploitation rates associated with: a marginal increase of relative yield per recruit which is 0.1 of its value at $E = 0$ ($E_{0.1}$), a reduction in the stock to 50% of its unexploited size ($E_{0.5}$), maximum sustainable yield ($E_{max}$), maximum sustainable yield ($E_{max}$) and by comparing estimates of the fishing mortality rate with target ($F_{opt}$) and limit ($F_{limit}$) biological reference points (BRPs), which were defined as $F_{opt}=0.5M$ and $F_{limit} = 2/3M$, following Patterson (1992).
Fig 1: The map of Iran and Situation of Karoon river (stations) in Khuzestan province (South West of Iran).

Table 1: Five stations in Karoon river.

<table>
<thead>
<tr>
<th>Station</th>
<th>Longitudes E</th>
<th>Latitudes N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gotvand</td>
<td>48°50</td>
<td>32°12</td>
</tr>
<tr>
<td>Shoshtar</td>
<td>48°46</td>
<td>31°58</td>
</tr>
<tr>
<td>Molasani</td>
<td>48°52</td>
<td>31°29</td>
</tr>
<tr>
<td>Ahvaz</td>
<td>48°51</td>
<td>31°22</td>
</tr>
<tr>
<td>Darkhoin</td>
<td>48°25</td>
<td>30°45</td>
</tr>
</tbody>
</table>

Results:

Length Frequency Distribution:

The total length of 2077 fish in the size range 20 to 39 cm for *B. gyrpus* and 812 fish for *B. barbulus* in the size range 20 to 94 cm using a meter scale (1±mm) were measured. Length frequency percentage groups of *B. gyrpus* and *B. barbulus* during period from April 2006 to March 2008 is presented in Fig 2. Mean length value and sample number of *Barbus gyrpus* and *Barbus barbulus* in table2. Sample number in five stations: Gotvand, Shoshtar, Molasani, Ahwaz, Dakhoin for *Barbus gyrpus* 76, 120, 356, 163, 289 specimens and for *Barbus barbulus* in this stations 29, 469, 138, 63, 112 specimens were respectively.

Table 2: Average values (±S.D.) of size corresponding of *Barbus gyrpus* and *Barbus barbulus* from the Karoon River.

<table>
<thead>
<tr>
<th>Month</th>
<th>N</th>
<th>Mean TL ± S.D (cm)</th>
<th>Min.-max</th>
<th>N</th>
<th>Mean TL ± S.D (cm)</th>
<th>Min.-max</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>90</td>
<td>4.32±43.06</td>
<td>30-50</td>
<td>99</td>
<td>7.41±96.40</td>
<td>23-67</td>
</tr>
<tr>
<td>May</td>
<td>200</td>
<td>4.39±38.38</td>
<td>30-58</td>
<td>58</td>
<td>4.21±44.80</td>
<td>26-75</td>
</tr>
<tr>
<td>June</td>
<td>123</td>
<td>4.56±42.19</td>
<td>20-51</td>
<td>45</td>
<td>3.70±38.72</td>
<td>15-71</td>
</tr>
<tr>
<td>July</td>
<td>142</td>
<td>4.60±40.56</td>
<td>27-55</td>
<td>47</td>
<td>4.67±39.12</td>
<td>23-55</td>
</tr>
<tr>
<td>August</td>
<td>218</td>
<td>4.57±40.60</td>
<td>22-52</td>
<td>41</td>
<td>10.36±42.96</td>
<td>29-62</td>
</tr>
<tr>
<td>September</td>
<td>173</td>
<td>3.08±33.05</td>
<td>20-58</td>
<td>32</td>
<td>4.52±41.90</td>
<td>20-66</td>
</tr>
<tr>
<td>October</td>
<td>341</td>
<td>3.10±36.53</td>
<td>22-76</td>
<td>52</td>
<td>4.04±43.46</td>
<td>23-58</td>
</tr>
<tr>
<td>November</td>
<td>299</td>
<td>3.59±38.08</td>
<td>23-51</td>
<td>73</td>
<td>4.29±47.99</td>
<td>23-82</td>
</tr>
<tr>
<td>December</td>
<td>246</td>
<td>2.54±40.63</td>
<td>28-60</td>
<td>93</td>
<td>4.22±43.13</td>
<td>20-74</td>
</tr>
<tr>
<td>January</td>
<td>74</td>
<td>10.06±36.54</td>
<td>16-60</td>
<td>85</td>
<td>10.69±45.08</td>
<td>25-83</td>
</tr>
<tr>
<td>February</td>
<td>97</td>
<td>2.36±29.54</td>
<td>16-42</td>
<td>101</td>
<td>2.20±43.20</td>
<td>20-94</td>
</tr>
<tr>
<td>March</td>
<td>74</td>
<td>3.66±31.51</td>
<td>15-45</td>
<td>86</td>
<td>4.62±44.61</td>
<td>22-66</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>8.18±37.94</td>
<td>-</td>
<td></td>
<td>10.27±43.62</td>
<td>-</td>
</tr>
</tbody>
</table>
Fig 2: Percentage frequency of length *Barbus gyrpus* (A) and *Barbus barbulus* (B) in Karoon river of Iran during 2006-08.

**Length–weight Relationship:**

Major and minor range weight fishery supporting in the 52-11170 with average values (±S.D.) of 873.2±109.45 gr for *B. gyrpus* and 52-4675 with average values (±S.D.) of 78.59±725.97 gr for *B. barbulus*.

The linear regression analysis of the length–weight data allowed the estimation of the constants, a and b of the length–weight relationship represented by the equation $W = 0.0192 FL^{2.8349}$ with a regression coefficient ($R^2 = 0.85$, n=410) for *B. gyrpus* and equation $W = 0.0081 FL^{3.0627}$ with a regression coefficient ($R^2 = 0.95$, n=401) for *B. barbulus* (Fig 3).
Growth Studies:

As the study has allowed the estimation of several pairs of growth constant values, a mean value was sought by trying the Response Surface Analysis routine. The best fit given by method, \( L_4 = 86.64 \) cm and \( K = 0.27 \) for \( B. \) gyrpus and \( L_4 = 132.9 \) cm and \( K = 0.17 \) for \( B. \) barbulus, is used in all the future analysis involved in this study (Fig 4). The value of \( t_0 \) as \(-0.46, -0.66 \) and \( ' \) from the growth parameters as \( 3.31, 3.48 \) was estimated for \( B. \) gyrpus and \( B. \) barbulus respectively.

Mortality Estimate and Relatively Yield, Relative Biomass per Recruit:

The total mortality (\( Z \)), fishing mortality (\( F \)), natural mortality (\( M \)) and exploitation rate (\( E \)) (Fig 5), relative yield per recruit (\( Y'/R \)), relative biomass per recruit (\( B'/R \)) (table 3), exploitation ratio (\( E \)), exploitation ratio maximum sustainable yield (\( E_{\text{max}} \)), the exploitation rate at 0.1(\( E_{0.1} \)) and the exploitation rate at which the stock would be reduced to 50% of the unexploited level (\( E_{0.5} \)) for \( B. \) gyrpus and \( B. \) barbulus were estimate as follows (Fig 6).
The sizes at which yield per recruit would be maximized, 22.5 cm (LF) for *B. gyrpus* and 29.68 cm (LF) for *B. barbulus*, were considerably greater than the existing mean sizes at first capture (15.59 and 21.31 cm) (LF), respectively.

Fish were recruited to the fishery at a mean size of L_50_. The yield per recruit function predicted that an increase in the size at first capture to that which would maximize yield per recruit would be associated with a substantial increase in yield at the current level of exploitation, despite the high level of fishing mortality. The fishing mortality rate of *B. gyrpus* and *B. barbulus* was greater than both the precautionary target and limit biological reference points.

Fig. 5: FISAT graphic output of the catch curve analysis for *Barbus gyrpus*(A) and *Barbus barbulus*(B).

**Table 3:** Estimate mortality and yield of *Barbus gyrpus* and *Barbus barbulus* in Karoon River.

<table>
<thead>
<tr>
<th>Species</th>
<th>Z</th>
<th>F present</th>
<th>M</th>
<th>E present</th>
<th>Y'/R</th>
<th>B'/R</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Barbus gyrpus</em></td>
<td>1.72</td>
<td>1.22</td>
<td>0.5</td>
<td>0.71</td>
<td>0.037</td>
<td>0.29</td>
</tr>
<tr>
<td><em>Barbus barbulus</em></td>
<td>1.37</td>
<td>1.04</td>
<td>0.33</td>
<td>0.76</td>
<td>0.021</td>
<td>0.25</td>
</tr>
</tbody>
</table>

**Table 4:** Biological reference points of *Barbus gyrpus* and *Barbus barbulus* derived from the yield per recruit model (E_{10} and E_{max}) at the existing size at first capture (L_{50}) and relative biomass per recruit at precautionary reference points (F_{opt} and F_{limit}).

<table>
<thead>
<tr>
<th>Species</th>
<th>E_{50}</th>
<th>E_{10}</th>
<th>E_{max}</th>
<th>F_{opt}</th>
<th>F_{limit}</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Barbus gyrpus</em></td>
<td>0.28</td>
<td>0.37</td>
<td>0.44</td>
<td>0.25</td>
<td>0.33</td>
</tr>
<tr>
<td><em>Barbus barbulus</em></td>
<td>0.26</td>
<td>0.35</td>
<td>0.42</td>
<td>0.16</td>
<td>0.21</td>
</tr>
</tbody>
</table>
Fig. 6: Relative yield and biomass per recruit curves (descending lines) for Barbus gyrpus(A) and Barbus barbulus(B) showing the existing exploitation rate (E), the exploitation rate at 0.1(E 0.1) and the exploitation rate at which the stock would be reduced to 50% of the unexploited level (E 0.5). Curves show the effect of increasing the existing mean size at first capture (L50) to the size, which would maximize yield per recruit (Lmax).

Discussion:

This study has established key population parameters of two common representatives of the B. gyrpus and B. barbulus, which are exploited in the Karoon River. Furthermore, it demonstrates the utility of using a combination of size frequency for assessing the status of this species and providing information required for resource management purposes.

The b parameter values in the weight-length model, W= a L^b are close to 3 for B. gyrpus and B. barbulus, indicating isometric growth (King, 2007). The value of b from other studies for B. gyrpus b=2.88 in Habbaniya lake, b= 2.95 in tharthar lake and for B. barbulus b=2.88 in Habbaniya lake, b= 3.02 in tharthar lake were estimated in the Iraq country (Szypula et al., 2001).

The reasons for the variation of b in the different regions are said to be due to seasonal fluctuations in environmental parameters, physiological conditions of the fish at the time of collection, sex, gonad development and nutritive conditions in the environment of fish (Biswa, 1993). Mayrat (1970) has suggested that the parameter b is characteristic of each species and generally does not change significantly throughout the year. The length–weight relationship is a practical index of the condition of fish, and may vary over the year according several exogenous and endogenous factors such as food availability, feeding rate, health, sex, gonad development, spawning period and preservation techniques (Bagenal and Tesch, 1978).

Szypula et al.,(2001) estimated infinity length and growth coefficient of B. gyrpus 134 cm and 0.094 y⁻¹ in tharthar lake; 215 cm and 0.039 y⁻¹ in Habbaniya lake. In the present study L₄ and K of B. gyrpus were 87.66cm and 0.27y⁻¹ which indicated lower infinity length and upper growth coefficient.
Unfortunately, no references from other studies for \( L_{\infty} \) and \( K \) are available regarding \( B. \) barbulus. Eskandary, et al. (1997) estimated \( L_{\infty} \) and \( K \) of \( B. \) Xanthonopterus 115 cm and 0.13 \( y^{-1} \) (for male) and 126 cm and 0.14 \( y^{-1} \) (for female) in Dez damlake. Different \( L_{\infty} \) and \( K \) might be associated with sampling error or variation in fishing intensity or environmental conditions. \( L_{\infty} \) and \( K \) amounts have reverse correlation and with decrement \( L_{\infty} \), amount of \( K \) increases and vise versa (Sparre and Venema, 1998).

Age at zero length \( (t_0) \) were calculated as -0.46 and -0.66 for \( B. \) gyrpus and \( B. \) barbulus respectively. The value of \( t_0 \) for \( B. \) gyrpus \( t_0= -1.15 \) in Habhaniya lake in the Iraq country and \( t_0=-0.48 \) in tharthar lake in the Iraq country were estimated (Szypula et al., 2001). With negative \( t_0 \) values, juveniles grew more quickly than the predicted growth curve for adults, and with positive \( t_0 \) values, juveniles grew more slowly (King, 2007).

Values of \( t_0 \) for \( B. \) gyrpus available from other studies have ranged from 2.23 in tharthar lake to 3.26 in Habhaniya lake has been obtained for this species in the Iraq country (Szypula et al., 2001). The estimate obtained in our study (3.31) compares with the upper of other studies.

A method of validating growth parameters involves the comparison of growth performance indices (\( \Phi \)) in terms of growth in length with other estimates obtained for the same or a similar species (Gayanilo and Pauly, 1997). Reliable estimate of \( M \) can only be obtained for an unexploited stock (Al-Hosni and Siddeek, 1999). Errors in estimates of the natural mortality rates (\( M \)) from the empirically derived formula of Pauly (1980) may have occurred as the relationship has tended to overestimate \( M \), especially for slow growing species (Russ et al., 1998).

Gulland (1970) suggested that in an optimally exploited stock, fishing mortality should be about equal to natural mortality, resulting in an exploitation rate over of 0.5/yr.

The specified precautionary target \( (F_{opt}=0.5.M) \) and limit \( (F_{limit}=2/3.M) \) values are considered to be more appropriate biological reference points in light of the constraints of the yield-per-recruit model.

The length converted catch curve method used for estimating the annual instantaneous rate of total mortality (\( Z \)) is based on the assumption that all of the relative age groups used in the analyses were equally vulnerable to the fishing gear and equally abundant at recruitment (Gayanilo and Pauly, 1997).

\( B. \) gyrpus and \( B. \) barbulus is a low-growing species with a low rate of natural mortality. Life history characteristics can be used to classify the vulnerability of a species to fishing pressure and the level of productivity within a population (Musick, 1999). The growth and mortality, estimates derived here suggest that \( B. \) gyrpus and \( B. \) barbulus has a high resilience to exploitation.

Whilst the yield curve at the existing size at first capture is tenable, the prediction suggests that maximum yields would be achieved at high levels of exploitation where the remaining biomass may not be capable of sustaining recruitment.

At the existing exploitation rate and size at first capture \( B. \) gyrpus and \( B. \) barbulus is being growth overfished, where the fishing mortality is in excess of that which is required to maximize the yield per recruit. An increase in the mean size at first capture to that which would maximize yield per recruit was predicted to increase yields and the standing stock biomass by an order of magnitude. Furthermore, because of the increase in sustainable yields at this mean size at first capture, the stock would not be growth overfished at the existing rate of fishing mortality.

This result clearly indicates growth over fishing for both species and, in combination with the results of the yield-per-recruit analyses, demonstrates that effort reductions are also required in the fishery because target reference points cannot be achieved by modification of the gear-selectivity characteristics alone.

However, the existing exploitation rate for \( B. \) gyrpus (0.71) and \( B. \) barbulus (0.76) were greater than that which would maximize yield per recruit, the results indicate that growth over fishing is also occurring for this species. The relative biomass per recruit of \( B. \) gyrpus and \( B. \) barbulus at the estimated fishing mortality rates was particularly low at less than 30% of unexploited levels. If the critical spawning stock biomass is between 20% and 50% of the unexploited levels, as suggested by King (2007), recruitment over fishing is likely to be occurring for both species. Because the size at first capture was smaller than the size at which yield per recruit would be maximized (44.4 cm \( L_{\infty} \)) for \( B. \) gyrpus and \( B. \) barbulus, an increase in the mesh size for the trap fishery should be considered by management authorities especially given the high rate of juvenile retention for this species.

Conclusions:

Considering \( E.Y'Y/R.B'/R, F_{opt} \) and \( F_{limit} \) values it can be concluded that: catch rate and fishing mortality are more than maximum sustainable yield and must be decreased. Any increase in the existing fishing level/exploitation will most likely result in a reduction in the yield per recruit and there by hamper the optimum level.
It is necessary to immediately impose fishing regulation on the stock and this can be done by gradually increasing the mesh size of the gears or by restricting fishing for certain seasons or declaring fish sanctuaries in certain areas, especially in spawning areas.

Acknowledgments

We thank Dr. Maramazi, the manager of the South of Iran aquaculture fishery research center, Ahwaz. We are also very grateful the experts of the South of Iran aquaculture fishery research center, Ahwaz for helping the project work.

Reference


