Fisheries status of the bogue *Boops boops* (Linnaeus, 1758) in Algerian East Coast (Western Mediterranean Sea)

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**ABSTRACT**

This study is the first that deals with the stock status of the bogue *Boops boops* (Linnaeus, 1758) in the Eastern Algerian coast (Western Mediterranean). It aims is to estimate the important parameters needed to evaluate the dynamics of the stock of this species which is economically important resource in Algeria. The FiSAT II software has been used for data analysis. The total length and weight of the fishes sampled ranged from 10.1 to 30.9 cm and from 13.47 to 268.15 g, respectively. The longevity has been estimated at 5 years. The parameters of von Bertalanffy growth curve were \( L_\infty = 32.03 \text{ cm}, \ K = 0.28 \text{ yr}^{-1}, \ t_0 = -1.13 \text{ years} \) and \( \varphi' = 2.45 \). The length-weight relationships was described by parameters \( a = 0.016 \) and \( b = 2.815 \), reflecting a trend towards negative allometric growth. The total mortality (Z), natural (M) and fishing (F) mortalities were 1.03, 0.37 and 0.66 yr\(^{-1}\), respectively. The current exploitation rate (E) of the species was 0.64. The relative yield per recruit analysis (Y’/R) from the Beverton-Holt showed that the current level of exploitation is significantly higher than E\(_{\text{max}}\) and E\(_{0.5}\) (0.54 and 0.32 respectively), indicating that the population is overexploited and suffers from fishing pressure. For sustainable management of this resource, the current exploitation rate should be reduced by 50%.

**INTRODUCTION**

The bogue, *Boops boops* (Linnaeus, 1758) is a marine species, gregarious of the sparidae family. Demersal to semi-pelagic, it is widespread in the Mediterranean and East Atlantic (FAO, 2019). On the Algerian coasts, it is one of the most common sparidae (Djabali *et al.*, 1993; Derbal and Kara, 2001) Fished essentially with pelagic trawl and purse seine with slide, the bogue is often caught in association with other pelagic species, it thus occupies the 4th place after sardine (59%), round sardinella (22%) and saurel (7%), and thus represents 3% of the catch, according to General Directorate for Fisheries and Aquaculture (DGPA, 2018). Between 2010 and 2017, Algerian average annual fish production was estimated at 100,000 tons, mainly pelagic fish, which accounted for 80% of catches (DGPA, 2018).

In 2017, Algeria participated in the FAO's CopeMed II project; Mediterranean Fisheries Cooperation Project; whose main purpose was to strengthen scientific...
collaboration between the countries of the Western Mediterranean for sustainable fisheries management (CopeMed II, 2017). This project came after several alarm signals, drawn by different organizations, notably the FAO which following the study made on the state of the world's fisheries which had reported that in 2015, the Mediterranean with the Black Sea had displayed, the highest percentage (62.2%) of unsustainable stocks (FAO, 2018). In many parts of the Atlantic and Mediterranean, several studies have already been undertaken on the ecology and biology of this species (Valle et al., 2003; Mendes et al., 2004; Khemiri et al., 2005; Charif et al., 2008; Ghailen et al., 2010; Kara and Bayhan, 2015; Layachi et al., 2015), few works on their fisheries except Allam (2003) and Monteiro et al. (2006).

In Algeria, few studies have been done on B. boops, among them, we quote Derbal and Kara (2008) on the diet; Ramdane et al. (2013) on parasitology; Kherraz et al. (2016) on age and growth and Amira et al. (2019) on reproduction, data on the exploitation of stocks remain rare with the exception of the works of Benina et al. (2014) at the Algerian center. Given these findings and due the lack of data on the assessment of fisheries, we believe it is important to undertake a study on the population dynamics of B. boops in the eastern zone of the Algerian littoral. This study aims to estimate the biological and demographic parameters necessary for future development and sustainable management plans for this species.

**MATERIALS AND METHODS**

**Study area and sample collection**

This study focused on the Northeast coast of Algeria (Fig. 1) between Cap Takouch 37°04’04”N – 07° 83’03”E and Ain B’Har 36°56’45”N – 8°36’57”E.

Samples of a total of 1434 individuals of both sexes were collected monthly during commercial landings in the three fishing ports of Chetaibi, Annaba and El Kala between January and December 2018. For each specimen, the total length “TL” was measured to the nearest 0.1 cm while total weight “TW” was recorded to the nearest 0.01 g.

![Fig. 1: A map of the Northeast coast of Algeria showing the three sampling locations](image)

**Age and growth**

Bhattacharya’s method (1967) fitted in FiSAT II was used to split the age groups from the length frequency data (Gayanilo et al., 1995).

The description of fish growth was done by the von Bertalanffy linear growth equation (VBGF): \( TL = L_\infty [1 - e^{-k(t-t_0)}] \), requires the use of three parameters. The asymptotic length \( (L_\infty) \) that would be reached at infinite theoretical age; the growth
coefficient (K) characterizing the speed with which the fish grows towards its asymptotic size and the theoretical age \((t_0)\) for which the length is zero. \(L\infty\) and K were estimated using ELEFAN-I (Pauly and David, 1981) module incorporated into the FiSAT software, where a K scan routine was conducted to assess a reliable estimate of the K value. As for, it was obtained from Pauly’s equation (1979): 
\[
\log_{10}(t_0) = -0.3922 - 0.2752 \times \log_{10} L\infty - 1.0381 \times \log_{10} K
\]

The reliability of these growth parameters was tested by the equation of Pauly and Munro (1984): 
\[
\phi' = \log_{10} K + 2 \log_{10} L\infty
\]

Length weight relationship

Length weight relationship was evaluated using the equation of Ricker (1973): 
\[
TW = a TL^b
\]

Where a is constant and b is the slope, these two parameters are estimated by the least square method.

Mortality and Exploitation Rates

Total mortality coefficient (Z) was estimated by using the length converted catch curve (Pauly, 1984). Natural mortality coefficient (M) was estimated by two methods; the equation of Pauly (1980):
\[
\log_{10} M = -0.0066 \times 0.279 \times \log_{10} L\infty + 0.6543 \times \log_{10} K + 0.4634 \times \log_{10} T
\]
Where T is mean annual temperature, estimated in study area at 18 °C (Ouali et al., 2018) and the equation of Djabali et al. (1994):
\[
\log_{10} M = 0.0278 - 0.1172 \times \log_{10} L\infty + 0.5092 \times \log_{10} K
\]
(based on growth parameters and mortality of 56 Mediterranean fish stocks, k and \(L\infty\) are the constants of the von Bertalanffy equation). Fishing mortality coefficient “F” was estimated using the relationship of Pauly (1980): 
\[
F = Z - M
\]
The exploitation rate (E) was obtained by the relationship of Gulland (1971): 
\[
E = F / Z = F / (F + M)
\]
The stock is in equilibrium when \(E = 0.5\), it is under-exploited when \(E < 0.5\) and is overexploited when \(E > 0.5\) (Gulland, 1971 in Pauly, 1985).

Length at first capture \((L_{c50})\)

The ascending left side of the length converted catch curve incorporated in FiSAT II tool is used to estimate the probability at first capture \(L_{c50}\) (Pauly, 1984).

Virtual Population Analysis (VPA)

The length-structured Virtual Population Analysis (VPA) was carried based on previously produced information \((L\infty, K, t_0, M, F, a \text{ and } b)\) and cohort analysis in accordance with the FAO FiSAT-II program (Gayanilo et al., 2005).

Relative yield per recruit \((Y'/R)\) and relative biomass per recruit \((B'/R)\)

The relative yield-per-recruit \((Y'/R)\) and relative biomass-per-recruit \((B'/R)\) were estimated by using the knife-edge method of Beverton and Holt (1966) as modified by Pauly and Soriano (1986) and incorporated in FiSAT software.

From the analysis, the maximum allowable limit of exploitation \((E_{\text{max}})\) giving maximum relative yield-per-recruit \((MSY = \text{Maximum Sustainable Yield})\), \(E_{0.1}\), the exploitation rate at which the marginal increase in relative yield-per-recruit, is 10% of its virgin stock and \(E_{0.5}\), the exploitation rate corresponding to 50% of the unexploited relative biomass per- recruit \((B'/R)\) (TRP=target reference point), have been calculated. Also yield contours which characterize yield isopleth were plotted to identify the impact on yield based on changes in exploitation rate \((E_{\text{max}})\) and critical length ratio \((L_{c50}/L\infty)\).
RESULTS

Age and growth

The method of Bhattacharya (1967), allowed us to cinded the sample of *B. boops* of both sexes into 5 cohorts grouped around the lengths of 14.42; 17.43; 20.58; 24.51 and 29.38 cm (Table 1).

The ages 1 and 2 were most present in the catches with 37.48 and 41.42 % respectively. The minimum catch has been observed in individuals of 5 years (0.86 %).

<table>
<thead>
<tr>
<th>Species</th>
<th>Ages (years)</th>
<th>Mean total lengths (cm)</th>
<th>Effective N</th>
<th>%</th>
<th>Separation Index</th>
<th>Growth rates</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>B. boops</em></td>
<td>1</td>
<td>14.42</td>
<td>650</td>
<td>37.48</td>
<td>n.a.</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>17.43</td>
<td>720</td>
<td>41.42</td>
<td>2.72</td>
<td>3.01</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>20.58</td>
<td>319</td>
<td>18.40</td>
<td>2.92</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>24.51</td>
<td>30</td>
<td>1.73</td>
<td>2.43</td>
<td>3.93</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>29.38</td>
<td>15</td>
<td>0.86</td>
<td>3.25</td>
<td>4.87</td>
</tr>
</tbody>
</table>

Notes: N = number of fish; n.a = not affiched.

The Asymptotic length (L∞), the growth coefficient (K) and theoretical age at length 0 (t₀) were 32.03 cm, 0.28 yr⁻¹ and-0.58 respectively (Fig. 2). So, the Von Bertanlaffy equation was $L_t=32.03 (1-e^{-0.28 (t+0.58)})$ with a growth performance index of $\phi' =2.46$.

![Fig. 2: ELEFAN I K-scan routine FiSAT II output for *B. boops* from the Algerian east coast.](image)

Length weight relationship

The total length measurements of *B. boops* ranged from 10.1 to 30.9 cm and the total weight varied from 13.47 to 268.15 g. Consequently the length-weight equation was $W = 0.0016 L^{2.815}$ ($R^2=0.928$).

The value of b reflected the negative allometric growth (Fig. 3).
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Mortality and Exploitation Rates

Total mortality coefficient (Z) was estimated at 1.03 yr\(^{-1}\), the natural mortality (M) was estimated at 0.62 yr\(^{-1}\), according to the empirical model of Pauly (1980), while that calculated by the equation of Djabali *et al.* (1994) was estimated at 0.37 yr\(^{-1}\). The fishing mortality (F) estimated at 0.66 yr\(^{-1}\), was obtained using the Z value and the M estimate obtained from the Djabali *et al.* (1994). The current exploitation rate (E) was estimated at 0.64 (Fig. 4).

Length at first capture (L\(_{<50}\))

The probability of capture gives estimates of L\(_{25\%}\), L\(_{50\%}\) and L\(_{75\%}\) at 9.71; 10.74 and 11.49 cm respectively. Therefore, the length at first capture (L\(_{<50}\)) was estimated at 10.74 cm for *B. boops* (Fig. 5).
Virtual population analysis (VPA)
VPA results revealed that fishing mortality affects all size classes of *B. boops* and that the majority of this species were caught between 13 and 18 cm, with a peak fishing mortality (F) of 1.32 yr\(^{-1}\) observed at mid-length 17.5 cm (Fig. 6). The terminal fishing mortality was 1.38 per year.

Fig. 6: Length-structured Virtual Population Analysis VPA of *B. boops* from the Algerian east coast.

Relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R)
Estimates of the relative yield-per-recruit (Y'/R) and relative biomass-per-recruit (B'/R) using the Knife-edge option (Fig. 7) were E\(_{0.1}\) = 0.46, E\(_{0.5}\) = 0.32 and E\(_{\text{max}}\) = 0.54. The results indicate that the E\(_{0.5}\) (TRP), and E\(_{\text{max}}\) (MSY) values are below the current exploitation rate (0.64).

For the yield isopleths, they place the *B. boops* fishery in quadrant D (Pauly and Soriano, 1986), based on the interception of L\(_c\) (L\(_{50}\) / L\(_{\infty}\) = 0.335) and E (0.64) (Fig. 8).

Fig. 7: Relative yield per recruit and biomass per recruit: E\(_{0.5}\) (red), E\(_{0.1}\) (green) and E\(_{\text{max}}\) (yellow).

Fig. 8: Yield Isopleth diagram of *B. boops* from the Algerian east coast.
DISCUSSION

The knowledge of age and growth is a fundamental aspect necessary for the establishment of fisheries management policy (Cailliet et al., 2006). In this study, the total length of *B. boops* caught in the Algerian east coast ranged from 10.1 to 30.9 cm and the maximum lifespan was 5 years with a quantitative dominance of ages 1 and 2. The size range of our specimens differs from the results obtained by other studies (Table 2), as for their life span (5 years), which is consistent with those obtained by Allam (2003); Benina (2015) and Kara and Bayhan (2015), close to those of El-Hawee and al. (2007), El-Oukda (2008) and differs from those of Khemiri et al. (2005) and Monteiro et al. (2006) (Table 2). The difference in the results obtained would probably be due to the sampling protocol used by each author, the study method as well as the sample size (Bariche, 2005).

Table 2: The growth parameters of *B. boops* in different geographical areas.

<table>
<thead>
<tr>
<th>Areas</th>
<th>Size limits (cm)</th>
<th>T&lt;sub&gt;max&lt;/sub&gt; (y)</th>
<th>Method</th>
<th>L&lt;sub&gt;c&lt;/sub&gt; (cm)</th>
<th>K (1/yr)</th>
<th>t&lt;sub&gt;50&lt;/sub&gt; (y)</th>
<th>φ'</th>
<th>Sex</th>
<th>a</th>
<th>b</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aegean Sea (Turkey)</td>
<td>11.3-27.9</td>
<td>5</td>
<td>O</td>
<td>30.79</td>
<td>0.23</td>
<td>-0.900</td>
<td>2.37</td>
<td>F</td>
<td>0.050</td>
<td>3.23(+)</td>
<td>Kara and Bayhan (2015)</td>
</tr>
<tr>
<td>Middle Aegean (Turkey)</td>
<td>11 - 23.8</td>
<td>-</td>
<td>-</td>
<td>29.58</td>
<td>0.26</td>
<td>-1.142</td>
<td>2.37</td>
<td>C</td>
<td>0.050</td>
<td>3.25(+)</td>
<td>Soykan et al. (2015)</td>
</tr>
<tr>
<td>Algarve (southern Portugal)</td>
<td>7.4-30.5</td>
<td>11 O</td>
<td>-</td>
<td>28.06</td>
<td>0.22</td>
<td>-1.420</td>
<td>2.24</td>
<td>C</td>
<td>0.0009</td>
<td>3.01(+)</td>
<td>Monteiro et al. (2006)</td>
</tr>
<tr>
<td>Nazaret to St Andrei (Portugal)</td>
<td>16.6-34.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>C</td>
<td>0.0074</td>
<td>3.084(+)</td>
<td>Mendes et al. (2004)</td>
</tr>
<tr>
<td>East coast of Spain (corsica)</td>
<td>9.7-16.7 (SL)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>C</td>
<td>0.0161</td>
<td>2.812(-)</td>
<td>Valle et al. (2003)</td>
</tr>
<tr>
<td>Alexandria (Egypt)</td>
<td>10.5-22.4</td>
<td>5 S</td>
<td>-</td>
<td>31.70</td>
<td>0.15</td>
<td>-1.780</td>
<td>2.19</td>
<td>C</td>
<td>-2.1548</td>
<td>3.103(+)</td>
<td>Allam (2003)</td>
</tr>
<tr>
<td>Saloum Bay (Egypt)</td>
<td>7-24</td>
<td>6 S</td>
<td>S</td>
<td>31.90</td>
<td>0.15</td>
<td>-1.131</td>
<td>2.18</td>
<td>C</td>
<td>-</td>
<td>-</td>
<td>El-Hawee and al. (2007)</td>
</tr>
<tr>
<td>Alexandri (Egypt)</td>
<td>9.59-17.07</td>
<td>4 O</td>
<td>B</td>
<td>30.11</td>
<td>0.15</td>
<td>-1.508</td>
<td>2.14</td>
<td>C</td>
<td>-</td>
<td>-</td>
<td>El-Oukda (2008)</td>
</tr>
<tr>
<td>Morocco (Mediterranean)</td>
<td>6-28</td>
<td>-</td>
<td>-</td>
<td>30.00</td>
<td>0.41</td>
<td>-0.300</td>
<td>2.54</td>
<td>C</td>
<td>-0.0067</td>
<td>2.906(+)</td>
<td>Layachi et al. (2015)</td>
</tr>
<tr>
<td>North Tunisia</td>
<td>6.1-26 (FL)</td>
<td>9 O</td>
<td>-</td>
<td>28.67</td>
<td>0.20</td>
<td>-1.410</td>
<td>2.22</td>
<td>C</td>
<td>-</td>
<td>-</td>
<td>Khemiri et al. (2005)</td>
</tr>
<tr>
<td>East Tunisia</td>
<td>26.70</td>
<td>22 O</td>
<td>-</td>
<td>24.30</td>
<td>0.23</td>
<td>-1.650</td>
<td>2.13</td>
<td>C</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>South Tunisia</td>
<td>23.50</td>
<td>21 O</td>
<td>-</td>
<td>26.70</td>
<td>0.22</td>
<td>-1.430</td>
<td>2.20</td>
<td>C</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gulf of Tunis (Tunisia)</td>
<td>12-26</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>C</td>
<td>0.0070</td>
<td>3.060(+)</td>
<td>Charif et al. (2008)</td>
</tr>
<tr>
<td>Gulf of Gabes (Tunisia)</td>
<td>12.6 - 22.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>C</td>
<td>0.0102</td>
<td>3.034(+)</td>
<td>Ghailen et al. (2010)</td>
</tr>
<tr>
<td>East of Algeria (Bejaia)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>27.50</td>
<td>0.28</td>
<td>-1.200</td>
<td>2.32</td>
<td>F</td>
<td>0.0150</td>
<td>2.776(-)</td>
<td>Ramdane et al. (2013)</td>
</tr>
<tr>
<td>Algerian Center</td>
<td>9-29</td>
<td>5 B</td>
<td>-</td>
<td>27.00</td>
<td>0.24</td>
<td>-1.530</td>
<td>2.24</td>
<td>M</td>
<td>0.0130</td>
<td>2.816(-)</td>
<td>Benina et al. (2014)</td>
</tr>
<tr>
<td>Western Algeria</td>
<td>11.2- 32.3</td>
<td>-</td>
<td>-</td>
<td>34.13</td>
<td>0.26</td>
<td>-1.500</td>
<td>2.48</td>
<td>F</td>
<td>0.0120</td>
<td>2.889(+)</td>
<td>Kherraz et al. (2016)</td>
</tr>
<tr>
<td>Eastern of Algeria</td>
<td>10.1 - 30.9</td>
<td>5 B</td>
<td>-</td>
<td>26.78</td>
<td>0.38</td>
<td>-0.750</td>
<td>2.43</td>
<td>M</td>
<td>0.0130</td>
<td>2.863(+)</td>
<td>Present study</td>
</tr>
</tbody>
</table>

Notes: O – Otoliths; B – Bhattacharya; S – Scales; T<sub>max</sub> – maximum recorded age (y); M – male; F – female; C – total population; (+) positive allometry; (-) negative allometry; (=) isometric allometry.

However Allam (2003); Benina (2015) and Kara and Bayhan (2015), those authors used Bhattacharya method, Scales and Otoliths respectively with sample sizes equal to 1372; 421 and 932 individuals respectively were different, and had found ages similar to ours. This similarity may be related to the geographical location of the study areas (Mediterranean Sea) and the fact that they undergo almost the same climatic conditions (Dulvy et al., 2008). The quantitative dominance of ages 1 and 2 indicates that overexploitation of the species can be observed, Kara and Bayhan (2015) explains the presence in our capture of this range of size by the non-selectivity
of the fishing gear used, effectively our samples are fished essentially by pelagic trawl and purse seine, these techniques are not very selective and they are capable of catching all sizes of fish.

The von Bertalanffy growth parameters ($L_\infty$, $K$ and $t_0$), basic input data in various models used to manage exploited fish stocks, were 32.03 cm; 0.28 yr$^{-1}$ and 0.58 respectively. These values were relatively different from other researchers' estimates (Table 2). The likely reasons for these differences could be the difference between the maximum lengths observed in the catches (Table 2) or the sampling methods and the techniques used in the calculations by the different authors at different times and localities. Thus, the variability of growth would be related to geographical distribution (Overholtz, 2002; Andersen and Brander, 2009), changes in environmental conditions (Perry et al., 2005; Cheung et al., 2009), climatic effects and fishing effort (Perry et al., 2005; Dulvy et al., 2008).

The growth performance index estimate ($\psi' = 2.46$) showed agreement with the results of Benina et al. (2014) and Kherraz et al. (2016) (Table 2). However, this value has slight differences with those obtained by other authors in the Mediterranean and Atlantic (Table 2). Rahman et al. (2016) estimate that the growth performance of species tends to change with the environment but also with the number of species sampled, as well as the size of the largest individual.

The length-weight relationship for $B. boops$ in the eastern Algerian coast, showed a negative allometric growth ($b = 2.815$). Table 2 shows, on the one hand, a concordance between the results of the present study and those found in Algeria. And on the other hand a divergence with the other results found in the Mediterranean and Atlantic. Regional disparity in results may be due to environmental and biological conditions such as seasons, feeding behavior, competition, maturity, sex, and age (Sparre et al., 1989; Mommsen, 1998).

The coefficients of total mortality ($Z$); natural mortality ($M$) according to Djabali et al. (1994) and $B. Boops$ fishing mortality ($F$) of this study were estimated at 1.03; 0.37 and 0.66 year$^{-1}$ respectively. The current exploitation rate ($E$) was estimated at 0.64.

According to pauly (1980), the natural mortality is related to the $K$ growth parameter and correlated with the average annual temperature of the fish habitat ($T^\circ$), this equation can lead to errors (Sparre and Venema, 1996) because, if during the year, the ambient water heats, the natural mortality rises and vice versa. Hence the choice of the method of Djabali et al. (1994), that considers not the temperature of the environment and is better adapted to the study of Mediterranean fishes.

Based on our results, it is evident that fishing mortality ($F = 0.66$) is higher than natural mortality ($M = 0.37$), suggesting a level of exploitation ($E$) greater than 0.5, the first indicator factor of overfishing. Our results are in harmony with those obtained by all the authors who worked on $B. boops$ mortality (Table 3). The bogues are therefore more vulnerable to fishing gear than naturally victims of the sea.

Table 3: Various mortality and Exploitation rates estimated for $B. boops$ from different locations.

<table>
<thead>
<tr>
<th>Areas</th>
<th>Sex</th>
<th>Z (y$^{-1}$)</th>
<th>M (y$^{-1}$)</th>
<th>F (y$^{-1}$)</th>
<th>E</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle Aegean (Turkey)</td>
<td>C</td>
<td>1.173</td>
<td>0.148</td>
<td>1.025</td>
<td>0.874</td>
<td>Soykan et al. (2015)</td>
</tr>
<tr>
<td>Algarve (southern Portugal)</td>
<td>C</td>
<td>1.04</td>
<td>0.33</td>
<td>0.71</td>
<td>0.68</td>
<td>Monteiro et al. (2006)</td>
</tr>
<tr>
<td>Alexandria (Egypt)</td>
<td>C</td>
<td>1.283</td>
<td>0.458</td>
<td>0.824</td>
<td>0.464</td>
<td>Allam (2003)</td>
</tr>
<tr>
<td>Algerian Center</td>
<td>C</td>
<td>1.02</td>
<td>0.36</td>
<td>0.66</td>
<td>0.65</td>
<td>Benina et al. (2014)</td>
</tr>
<tr>
<td>East of Algeria</td>
<td>C</td>
<td>1.03</td>
<td>0.37</td>
<td>0.66</td>
<td>0.64</td>
<td>Present study</td>
</tr>
</tbody>
</table>

C− total population.
The estimate of length at the first capture ($L_{c50} = 10.74$ cm) was found to be below the minimum landing size of 15 cm (MPRH, 2012).

This observation could be linked to the mesh size of the fishing gear used for the catch of $B. boops$ and seems to confirm the explanation given by Kara and Bayhan in 2015 concerning the non-selectivity of the latter (trawls and seines).

The $L_{c50}$ of the present study is smaller than that determined in the Egyptian sector of the Mediterranean by Allam in 2003 ($L_{c50} = 14.15$ cm), and in southern Portugal (southern Portugal) in the Atlantic by Monteiro et al. in 2006 ($L_{c50} = 19$ cm). The discrepancy in estimates would be related to environmental factors and long-term fishing pressure (Tsikliras and Anthonopoulou, 2006).

The results of the VPA have shown that small fish are exposed to high exploitation; the greatest fishing effort is exerted on size ranges between 13 and 18 cm. This situation prevents the stock from benefiting from a good renewal by recruitment and thus, can induce very large decreases in biomass, by changing demographic structures (Gascuel, 2008).

The relative yield per recruit ($Y'/R$) and the relative biomass per recruit ($B'/R$), determined according to $L_{c50}/L\infty$ (0.335) and $M/K$ (1.321), revealed exploitation ratios ($E_{0.1} = 0.48$); ($E_{0.5} = 0.32$) and ($E_{\text{max}} = 0.54$) lower than the current exploitation rate ($E = 0.64$). This corroborates the earlier assertion that the $B. boops$ stock in this study is overfished.

The interception of $L_{c50}/L\infty$ and the current exploitation rate of yield isopleths places the $B. boops$ fishery in quadrant D, which means that in terms of relative yield per recruit, the catch of the bogue in the waters of the eastern Algerian coast touch small fish at a high level of fishing effort (Pauly and Soriano, 1986).

As a result, the implementation of rational management measures to avoid a possible collapse is necessary. Increasing the mesh size and reducing the fishing effort from 0.64 to 0.32 (50%) would make it possible to conserve and regulate this fishery in a sustainable manner.

**REFERENCES**


البحيرة الرقعتية في الساحل الشرقي الجزائري (Linnaeaus, 1758) Boops Boops (غريب البحر الأبيض المتوسط)

هذه الدراسة هي الأولى التي تتناول تقييم مخزون سمكة الجزء الشرقي من الساحل الجزائري (غرب البحر الأبيض المتوسط). يهدف إلى تقدير العوامل الهامة اللازمة لتقنيات طوقيات مخزون هذا النوع من الأسماك ذات الأهمية الاقتصادية في الجزائر. تم استخدام برنامج FISAT II لتحليل البيانات. تراوح الطول والوزن الكلي للأسماك التي تم أخذ عينات منها من 10.1 إلى 30.9 سم ومن 12.4 إلى 28.15 غرام على التوالي. وقد تم تقدير مدى العمر 5 سنوات. كانت معدلات منحنى النمو L∞ = 32.03 سم لK = 0.28 سنة.

المتوسط 1.13 = 2.45 وϕ = 0.016 = a و b = 2.815 ضغط مثل RM و RM = 0.016 = a و b = 2.815 = 0.37 و RM = 0.016 = a و b = 2.815

كم يعكس الاتجاه نحو نمو النبات过度 السبلي. وكان معدل النمو الكلي (Z) و معدل الفوائد الصيد (F) و معدل الاستغلال الحالي (E) = 0.07 سنة. و RM = 0.016 = a و b = 2.815 = 0.37 و RM = 0.016 = a و b = 2.815

أظهر تحليل العائد النسبي (Y'/R) من Bevorton-Holt أعبأ من ضبط الصيد. من أجل الإدارة المستدامة لصادم الأسماك هذه، ينبغي تخفيض معدل الاستغلال الحالي بنسبة 50 %.