



Mortality of red mullet *Mullus barbatus barbatus* (Linnaeus., 1758) in Western Algerian coasts

Hebbar Chafika^{1,2*}, Boutiba Zitouni¹

¹Laboratory of Environmental Monitoring Network, Department of Biology, Faculty of Natural Sciences and Life, University of Oran, Algeria

²Institute of Maintenance and Industrial Safety, IMSI, University Of Oran, Algeria

Article published on January 12, 2015

Key words: Demersal, Mortality, *Mullus barbatus barbatus*, Oran's coast, Stock.

Abstract

Red mullet *Mullus barbatus barbatus* (Linnaeus, 1758) is a demersal species. It is an important commercial fish in Mediterranean coasts of Algeria, as a target of trawl fishery. Annual landings of this species are approximately 17.3% of the total landings of demersal fishes species (DPRH, 2010). Of a total of 1679 specimens, 1150 females and 529 males were captured in 2009; The range of the length is between 83 to 277 mm. Fishing of red mullet occurs at depth of 0-50 m on sandy bottoms. The catch is comprised on 5 cohorts, but the average sizes of our fish sample, that are the most exploited, are aged between 0-5 years. The parameters of the Von Bertalanffy growth equation obtained for both sex were $L_{\infty} = 28.88\text{cm}$, $k = 0.59\text{ cm / year}$, and $t_0 = 0\text{ years}$. The size of the first capture is 11.2 cm. Total, natural and fishing Mortalities were respectively 1.34; 0.76 and 0.58 year⁻¹; while exploitation rate is about 0.43. It would be a preserved stock.

*Corresponding Author: Hebbar Chafika ✉ racha_hebbar@hotmail.fr

Introduction

The growth represents the positive aspect of the fish stock dynamic; the study of growth is focused primarily on the determination of length function of age. When we use growth parameters to describe mortality rate they are called “mortality rates” and reflect the number of disappearances per time unit. The easiest way to describe changes in number of fish in the analyzed stock is to determine no of “larve eclozate” in the same period of time in the same cohort. It is considered that mortality in a cohort, Z value, it is composed of mortality due to fishing (“F” fishing mortality) and that having natural causes (“M” natural mortality).

Fishing is a major link, intimately related the man overboard, based on impressions of a cultural dimension, emotional satisfaction and strict food requirements relations. It is a fundamental contribution to a food security and animal protein intake, employment and countries’ welfare in maritime domain. Fishing is an activity that contributes significantly to the welfare and prosperity of mankind. In addition, fishery products are part of the staple foods most traded in the world (FAO, 2012). Fish is the main source of protein (over 70%) for African populations (Vanga, 2011). Thus, many countries have experienced economic wealth through fishing as Mauritania, Morocco and Senegal (Boushaba, 2008).

In Algeria, fishing has not been the focus of interest but now is currently the subject of considerable attention, increasingly important to overall development strategy. In 2009, the maritime Algerian population, had realized a net increase of over 15% compared to 2008, wish has created of 8800 new direct and indirect jobs (MPRH, 2009).

The total landing of demersal fish has clearly evolved over time. In fact, it is noted that the production of these fish species, recorded a weight of 5855 tonnes in 1999; 7632,5 tonnes in 2006 and 5115 tonnes in 2007 (DPRH, 2010). This species is caught by

trawlers and a various other small scale fishing vessels with a range of gears practically in all Mediterranean areas. The fishery begins on age group 0, in many areas the small individuals (caught in summer and early autumn) reach higher prices. The catch is composed mainly of two species; *Mullus surmuletus* and *Mullus barbatus*.

The demersal species with high economical values are mainly caught and landed by the bottom trawl fishing fleet (Dimech and *al.*, 2008).

The Mullidae, an economic resource of the Mediterranean coasts, where they are heavily exploited (Bauchot, 1987) and characterized by the presence of two barbs in the lower jaws for foraging (Aguirre, 2000). They don't have a swim bladder (Fischer and *al.*, 1987).

Mullus barbatus barbatus (L., 1758) is a Mullidae, demersal species widely distributed along the coasts of Europe, Africa and Mediterranean Sea. It is the target of artisanal and trawls fisheries. This fish gregarious nature frequenting sandy bottoms, rocky and gravelly (Lombarte and Aguirre, 1997) is one of the favorite species for evaluation studies in the Mediterranean Coasts (CGPM, 2002).

Red mullet is the oldest known and appreciated fish. Despite the high commercial value (Suquet and Person-Le Ruyet, 2001; Gharbi and *al.*, 2004), biology and stock assessment of these of Mullidae species, are poorly known in Algeria, in general and in Oran’s coast in particular.

In the Algerian coast, only two studies have been conducted on the biology (including growth) of this species (Lalami, 1979; Djabali and *al.*, 1990) and one study on the identification and ecology of crustacean ectoparasites of fish Teleost in the eastern coast of Algeria (Ramdane, 2010). Despite no studies have been performed on mortality and exploitation of this species. The main aims purpose of the present work, is to provide the first information on the deaths: Total, natural and

fishing *Mullus barbatus barbatus* and to give the state of the stock in the western coast of Algeria (Oran's coast). The data of this study will contribute to the management of this demersal species and serve as a reference for other studies.

Materials and methods

Area Sampling

The selected biological material collected from the trawler auction landings of Oran's port (Fig. 1). Oran (North Western of Algeria) is located at the bottom of an open north and west dominated directly by the mountain of Aïdour (Murdjajo), with a height of 375 m, and by the tea Moulay Abdelkader al-Jilani (Moul el Meida). The town is spread out on either side of the ravine of the river Rhi now covered.

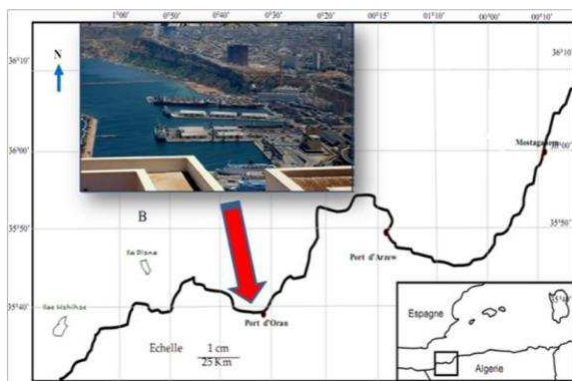


Fig. 1. Geographical Position of Oran's Coast (Hebbar and *al.*, 2012).

The geographical position of the port of Oran (longitude west 2°58'53"- North Latitude 35°42'58") is located midway between the limits of Morocco and the province of Algiers. It is a combo port established between the beaches between the Lamoune tip to the west and the White Cap to the east. This port's dock is 6km longer with drafts ranging from 7 to 12m. It is an important fishing freight-transit port (PDAU, 1995).

Sampling and Collection of Data

A total of 1679 individuals of both sexes were collected monthly at the port fishing of Oran from January to December 2009. The fish individuals measured between 83 and 277 mm, divided into 20 length classes with a 10 mm. The total length selected

(Lt) was measured to the nearest mm (the only one recognized by fishermen and legislation). The total weight (Wt) varying between 6.43 g and 206.21 g randomly. The total body weight (Wt) and eviscerated body weight were measured at 0.01 g. Sex was identified macroscopically.

In the dynamics of a stock, the growing is the positive aspect, while the disappearance process is the negative one. In order to maintain the fish stock at the desired level, the mortality control through fishing is needed. The growing was described with the help of a model and some parameters, the same data being used for mortality.

The mortality of these species is the result of the combined action of natural mortality (disease, predation, old age ...) and fishing mortality. Thus, total mortality rate is $Z = F + M$.

There are some methods for estimating mortality, and these are:

1-Total Mortality (Z)

Total mortality is the total number of missing persons in a given time interval that may be one day, month, or year. To evaluate this mortality, there exist several methods based on following parameters:

- Abundance of one or several age classes
- Marking
- Analysis CPUE-effort relations
- Analysis size frequency of the catch. It is enjoyed by our data available on the red mullet of Oran's coast.

Total mortality was determined by these following three methods:

- Powell-Wetherall Method which, from size frequency, estimates a value of asymptomatic length L_{∞} and Z , expressed by the equation: $Z / K = b / (1-b)$.
- Beverton and Holt Method, expressed by the equation $Z = K (L_{\infty} - L_m) / (L_m - L_c)$

Where :

K and L_{∞} : Parameters of the Von Bertalanffy equation;

L_m : Mean length of the sample;

L_c : Size at first capture and the smallest size that is well-represented in the sample or the smallest limit classes (Cadima, 2002).

-Method of curve linearized capture.

2 - Natural Mortality (M)

Natural mortality includes all factors of death from natural origin, such as old age, illness, stress and lack of food. Pauly (1980) shows that mortality differs according to the size of fish. Those small have a higher than those of large natural mortality.

The estimate of natural mortality (M) is obtained by three equations:

-Method Taylor (1959) given by: $M = 2.996 K / (2.996 + K)$

-Method Pauly (1980) given by the following form:
 $\log M = -0.0066 - 0.279 \log(L_{\infty}) + 0.6543 \log(K) + 0.4634 \log(T^{\circ})$

-And the method Djabali and al. (1993) expressed by
 $\log_{10} M = -0.0278 - 0.1172 + 0.5092 \log_{10} L_{\infty} \log_{10} K$

3 - Fishing Mortality

It is derived from the relationship $Z = M + F$, where $F = Z - M$.

4 - Rate of Exploitation

What is the ratio of dead individuals fishing on the number of dead individuals from various causes? The stock is in equilibrium when E is close to 0.5.

Pauly (1985) defines the usage rate (E) as: $E = F / (F + M) = F/Z$.

In 1989, Barry and Tegner enunciated the general rules:

If $Z / K < 1$: Population has a tendency to mortality;

If $Z / K \approx 2$: Population slightly used;

If $Z / K > 2$: Population overexploited.

Results and discussion

Age Analysis by Bhattacharya Method

The application of the method of Bhattacharya (1967) by FISAT II (Gayanilo and al., 2005) allowed us to get five cohorts gather around lengths of 11.84; 15.47; 19.92; 20.85 and 26.25 cm. The most important mode of catch is situated between 16 and 20 cm. The modes and less than 10 cm beyond 26 cm are very negligible (Fig.2).

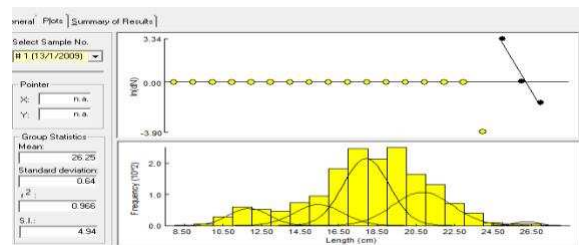


Fig. 2. Decomposition of Frequency Distribution of Sizes of *Mullus barbatus* in cohorts by Bhattacharya Method (Gayanilo and al., 2005).

For both sexes, age 2 (46.84%) is dominant, followed by age 3 (27.89%) and age 1 (23.09%). Ages 4 (1.96%) and 5 (0.23%) adults are poorly represented in the catch.

Probability of Capture

The logistic curves (Fig. 3) are characterized by three distinctive points L_{25} , L_{50} and L_{75} .

L_{25} : total length (9.60 cm) at which 25% of the fish will be vulnerable to the fishing gear;

L_{50} : total length (10.73 cm) at which 50% of the fish will be vulnerable to the fishing gear;

L_{75} : total length (11.85 cm) at which 75% of the fish will be vulnerable to the fishing gear.

These results of capture depending on the lengths are generally bad for the studied species which are caught at sizes too small that have not reached sexual maturity. According Hebbbar and al. (2012), the size at

first maturity is 14.5 cm for females and 13.6 cm for male's sex of Oran's coast.

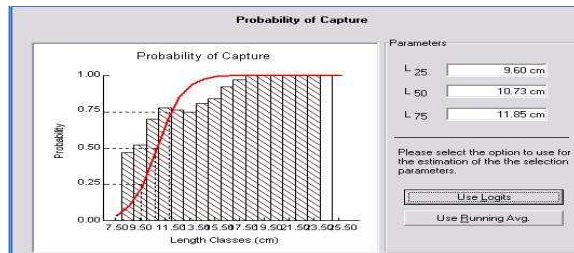
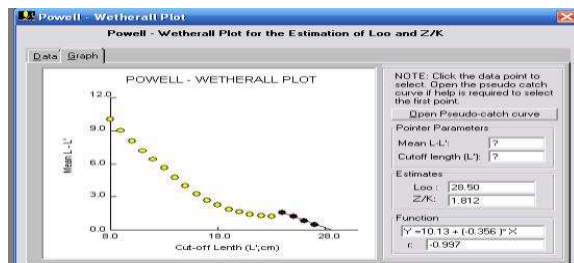


Fig. 3. Probability of Capture Of *Mullus barbatus* (Gayanilo and *al.*, 2005).

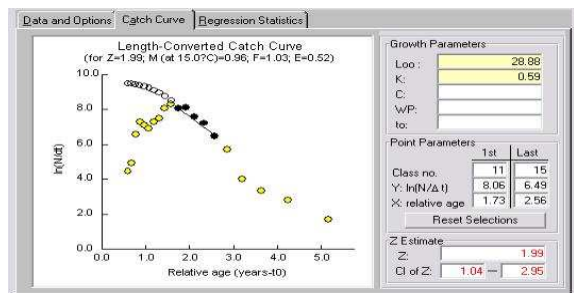
Analysis of Mortalities

Using the FISAT II software (Gayanilo and *al.*, 2005), the values of total mortality (Z) are respectively estimated from the linearized catch curve and the Powell Wetherall (Fig. 4 and 5). Furthermore, using the approximate method of Beverton and Holt (1957) ($K = 0.59 \text{ yr}^{-1}$, $L_{\infty} = 28.88 \text{ cm}$, $L_m = 17.91 \text{ cm}$, $L_c = 11.20 \text{ cm}$), the instantaneous coefficient of total mortality (Z) was estimated at 0.965 year^{-1} .



• : Points included in the calculation of the regression
 ○ : Points not included

Fig. 4. Determination of Z from the Powell-Wetherall Method.



• : Points included in the calculation of the regression
 ○ : Points not included

Fig. 5. Determination of Z by Curve Linearized Capture.

The relationship $Z/K = 1.812$ (both sex) ratio is less than 2; confirming that the stock of *M. barbatus* of Oran coastline is preserved.

Altogether, the values of the instantaneous coefficient of total mortality (Z), for any sex confused, obtained by the different methods are averagely close. The average value is esteemed to be 1.34 year^{-1} . The obtained average value of Z depends on the method used, the points included in the calculation of the regression (Hemida, 2005) and mainly on the quality of the sample.

From the growth parameters defined above and an average temperature of 15°C , the value M estimated by the equation of Pauly (1980) is 0.96 year^{-1} . Method of Taylor (1959) gives a coefficient of natural mortality of 0.59 year^{-1} . Method Djabali and *al.* (1993) gives a coefficient of natural mortality of 0.73 year^{-1} . The average value of natural mortality is estimated to be 0.76 yr^{-1} ; it seems to be in standards as specified (Copace, FAO, 1994) as the lower limit conventional of natural mortality (M) is 0.5 and the superior limit is 1.

The coefficient of fishing mortality (F) is estimated at 0.58 year^{-1} from the values of Z and M, calculated above; it is generally less than that of natural mortality (Table. 1). The reduction in fishing mortality can only lead to increased spawning biomass, which is recommended. The biomass of the spawning stock is the capital of the entire population, one that will produce qualified interests of future generations. Booth (2000) shows that fishing mortality is significantly and spatially correlated with fishing effort.

In general, more K is great, more natural mortality (M) is high.

Natural mortality is also linked to the size and weight asymptotics (L_{∞} , W_{∞}) (Roff, 1984).

Other studies suggest that natural mortality (M) is correlated with reproduction. Fish species arriving early maturity have high mortality (Rikhter and Efanov, 1976). It's the same idea that Gunderson and Dygert (1968) connect natural mortality (M) at the gonadosomatic index (GSI).

Other studies suggest that natural mortality (M) is correlated with reproduction. Fish species arriving early maturity have high mortality (Rikhter and Efanov, 1976). It's the same idea that Gunderson and Dygert (1968) connect natural mortality (M) at the gonadosomatic index (GSI).

Table 1. Summary of Results of Instantaneous Mortality Rates of *M. barbatus*.

<i>Mullus barbatus</i>		Both Sex
Total mortality Z (year - 1)	Powell-Wetherall	1.07
	Linearized catch curve	1.99
	Beverton & Holt	0.96
	Z average used	1.34
	Taylor (1959)	0.59
Natural mortality M (year-1)	Djabali and al., (1993)	0.73
	Pauly (1980)	0.96
	M average used	0.76
Mortality by fishing F (year -1)		0.58
Rate of Exploitation E		0.43

In contrast, older stages (4 and 5 years) show a low sensitivity to changes in natural mortality (M). This could be because older fish undergo fishing mortality

(F) higher than natural mortality (Hilborn and Walter, 1992).

Estimates of various instantaneous coefficients of total, natural and fishing mortalities differ from an author in the other one and from a region to another. These differences may be due to the divergence of the methods used for their determination; the high values of K and L_{∞} that can also influence directly the natural and total mortalities by increasing them; and temperature of the water where caught demersal species was.

The method of Taylor (1959) and Pauly (1980) assume that more a species has rapid growth, more its rate natural mortality is high.

The same species can present different rates from natural mortality in various areas depending on the density of predators and/or competitors whose abundance is moreover influenced by fishing activities (Sparre and Venema, 1996).

Results of earlier studies concerning mortality rates of *Mullus barbatus* in different localities are represented in Table 2. In this study, the average exploitation rate (E =0.48) indicated that red Mullet in Oran's coasts is under exploited.

Table 2. Various Mortality Coefficients in Different Zones.

Autors (year)	Zone	Sex	Z	M	F	E
Arneri and Jukic (1986)	Adriatic Sea	Confused	1.64			
Papaconstantinou and al.(1986)	Golf Patraikos	Confused	0.709			
	Golf Korinthiakos		0.662			
Livadas (1988)	Chypre	Confused	0.694			
			1.278			
Vrantzas and al. (1992)	Saronikos Golf	Confused	1.88			
Slimani and Hamdi (2002)	Moroccan Mediterranean Sea	Confused		0.482		
Gharbi and al. (2004)	North and South of Tunisia	Confused		0.54		
Layachi and al. (2007)	Mediterranean coast of Nador	Confused	0.848			
Joksimović and al. (2008)	Adriatic Sea (tray of Montenegro)	Confused	0.749	0.342		
Aissat (2010)	Coast center of Algeria	Confused	1.29	0.46	0.83	0.64
Present Study	Oran's coast	Confused	1.34	0.76	0.58	0.43

The instantaneous coefficient of total mortality estimate is higher than that obtained in the Mediterranean coast of Nador (Morocco) and the tray

Montenegro (Layachi, 2007; Joksimović and al., 2008). In fact, it is much closer to that reported by

Livadas (1988) in Cyprus and Aissat (2010) of Algerian coastal centers (Table. 2).

The discrepancies between the mortality rates from different localities can probably be attributed to various factors such as different ecological conditions and intensive fishing activities between the localities and unequal precision of employed various methods (Joksimović and *al.*, 2009).

Fishing Mortality Analysis (F) by Virtual Population Analysis (VPA)

Fishing mortality (Fig. 6) is almost zero for sizes from 8 to 10 cm but remains low in all sizes between 11 and 15.5 cm and never exceeds the value of 0.359 yr⁻¹. However, this is of course linked to low harvest pressure by weight. Then, very large F values recorded are observed with two high and two peaks of 2.121 and 2 yr⁻¹, corresponding to size classes of 21.5 and 23.5 cm. The value of the average fishing mortality \bar{F} , estimated at 0.905 yr⁻¹, is still much higher than the total value of fishing mortality (Fg), which is 0.555 yr⁻¹. This is due to the fact that Fg links the total annual catch to the average number of individuals in the population.

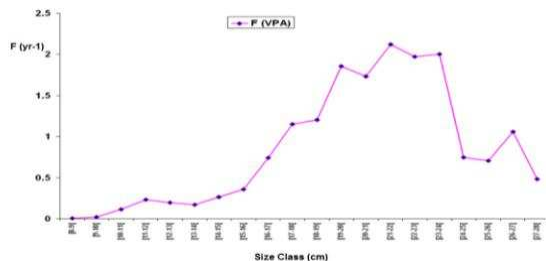


Fig. 6. Fishing Mortality (VPA) according to the size of *Mullus barbatus* Stock in Oran's Coasts.

The most vulnerable fish for fishing gear have sizes ranging from 16 to 24.9 cm. The majority of fish are caught in sizes between 15 and 28 cm if we refer to the curve of the fishing mortality (Fig. 6).

Considering that fishing mortality should be maintained below safety thresholds to ensure high long-term returns, while limiting the risk of stock collapse and

ensuring stability and increased sustainability of fisheries. Whereas preventive actions are required to address and control the levels of excessive fishing mortality while waiting for the development and the adoption of multiannual management plans for stocks and the fisheries involving.

Exploitation Rates

Exploitation rate $E = 0.48$ so close to 0.5, suggests that the stock of red mullet would be good. The relatively small value of E indicates underfishing of this stock during that period. However, these results are approximate in the absence of reliable statistics over several years (fishing effort, catch, ...) to directly calculate different rates. Gulland (1971) stated that suitable yield is optimized when $F = M$ (i.e., when E is more than 0.5), the stock is generally considered to be overfished. More recently, Pauly (1987) proposed a lower optimum F that equals 0.4 M.

Very high exploitation rates have been recorded in Italian waters (CGPM, 1995; Baino and *al.*, 1985; Abella and *al.*, 1999) except for Sardinia and other areas of the Tyrrhenian Sea; the species is overexploited, as in the Adriatic (Ungaro and *al.*, 1994) or Western Mediterranean (Martin and *al.*, 1999). The red mullet is fully exploited in southern Tunisian waters and in the Ionian Sea (Tursi and *al.*, 1995).

Conclusion

In 2009, landings of red mullet at the port of Oran are fluctuating, with a maximum in September and a minimum during the summer season. This maximum would be due, on one hand to new recruits (juveniles join the parental stock and therefore represent of this fact a large part of the catch), and on the other hand, to the turbidity ruling on funds and supports increased taken. By cons, declining catches in the summer is due to the withdrawal of the parents and the closure of the fishery during the biological period rest.

The estimated fishing mortality rates and exploitation rates were very average in the study area. Possible causes of the differences in life-history parameters

between these results to those of previous studies could be attributed to differences in environmental conditions and/or sampling strategy.

Estimation the growth rhythm constitutes in a basic parameter that comes to answer and to argument the recommendation to protect the stocks and to limit the length of the standard fishes at first catch. Analyzing the influence result of this restriction, doubled by the Y/R (production / recruitment) rule, we can obtain, in general lines, information over the dimensions of the stock and its exploitation level.

The present work has shown that the stock of red mullet : *M. barbatus* of Oran coastline is preserved (underexploited) and to test our estimates and assumptions made during this first works. It is necessary and will be interesting to pursue and to spread this study over several annual cycles.

Oran's coast can be at present considered as a refuge for *Mullus barbatus* and (probably) for other demersal species from which it is suggested a partial transfer of the fishing offshore (beyond 3 nautical miles). This measure will allow certainly an increase of the biomass, and improvement of recruitment levels and a growth of the productivity of the resource. This stock is considered within its safety limits.

The Scientists begin to measure the scale of the rarefaction of large-sized fish. Researchers whether biologists, oceanographers, ecologists and economists, lean on fishery resources. To listen and read to them allows understanding better phenomena with which the fishermen are confronted.

Finally, three actors of the fisheries to know the administration, scientists and professionals, must imperatively work, cooperate together their policies and strategies for a sustainable development methods and fishing gear, in order to preserve and manage fishery resources to be able to meet the needs present and future generations.

References

Abella AJ, Belluscio A, Bertrand J, Carbonara PL, Giordano D, Sbrana M, Zamboni A. 1999. Use of MEDITS trawls survey data and commercial fleet information for the assessment of some Mediterranean demersal resources. *Aquatic Living Resource*, **12 (3)**,155 - 166.

Aguirre H. 2000. Aspectos biológicos y ecológicos del salmonete de fango *Mullus barbatus* L., 1758 y el salmonete de roca *Mullus surmuletus* L., 1758 en el Mediterraneo Noroccidental. Tesis de Doctorado. Consejo Superior De Investigaciones Científicas (CSIC). Ciencias del Mar. Universidad Politécnica de Cataluña, 213 p.

Aissat F. 2010. Biologie et Exploitation du rouget barbet de vase dans les côtes centre algériennes. Mémoire de Magister. Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral (ENSSMAL). Algérie, 97p.

Baino R, Auteri, Serena F. 1985. Ground fish stocks in the Northern Tyrrhenian Sea management with Gulland-Fox production model. *FAO GFCM Report*, 336, Annexe (E) R. pp: 125-130.

Barry JP, Tegner MJ. 1989. Inferring demographic process from size frequency distribution: simple models indicate specific patterns of growth and mortality. *Fishery. Bulletin. US*, **88**, 13-19.

Bauchot ML. 1987. Poissons osseux. Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II., M. S. Fischer, M. L. Bauchot and M. Schneider, ed, Commission des Communautés Européennes and FAO, Rome.

Bertalanffy L Von. 1938. A quantitative theory of organic growth (inquiries on growth laws. II). *Human Biology*, **10(2)**, 182-213.

Beverton RJH, Holt SJ. 1957. On the dynamics of exploited fish populations. *Fish. Invest. Ser II. Min. Agi. Vol. XIX. London.* **19**, 533 pp.

Bhattacharya CG. 1967. A simple method of resolution of a distribution into Gaussian components. *Biometrics*, **23**, 115-135.

Booth AJ. 2000. Incorporating the spatial component of fisheries data into stock assessment models. *ICES Journal of Marine Science*, **57**, 858-865. doi:10.1006/jmsc.2000.0816.

- Boushaba A.** 2008. L'Algérie et le droit des pêches maritimes. Thèse de doctorat. Université Mentouri (Constantine). Algérie, 217p.
- Cadima EL.** 2002. Manuel d'évaluation des ressources halieutiques. FAO Document technique sur les pêches. Rome, **393**, 1-160.
- CGPM.** 1995. Report of the third technical consultation on stock assessment in the central Mediterranean (Tunis, 8-12 Nov 1994): 19 pp.
- CGPM.** 2002. Report of the twenty-seventh session. Rome 19 -22 November 2002. G.F.C.M. Report n° 27. Rome, F.A.O. 36p.
- Copace FAO.** 1994. Groupe de travail Adhoc sur les sardinelles et autres espèces de petits pélagiques côtiers de la zone Nord du COPACE /PACE Séries 91/58, Rome, 1-13.
- Dimech M, Camilleri M, Hiddink JG, Kaiser, MJ, Ragonese S, Schembri PJ.** 2008. Differences in demersal community structure and biomass size spectra within and outside the Maltese Fishery Management Zone (FMZ). *Scientia. Marina.*, **72**, 669-682.
- DPRH.** 2010. Direction de Pêche et de Recherches Halieutiques, Oran. Algérie.
- Djabali F, Boudraa S, Bouhdid A, Bousbia H, Bouchelaghem EH, Brahmi B, Dob M, Derdiche O, Djekrir F, Kadri L, Mammasse M, Stambouli A, Tehami B.** 1990. Travaux réalisés sur les stocks pélagiques et démersaux de la région de Béni-saf. Food and Agriculture Organization Fish report, **447**, 160–165.
- Djabali F, Mehailia A, Koudil M, Brahimi B.** 1993. Assessment of equation for predicting natural mortality in Méditerranéan teleost. NAGA. The Iclarm. Quaterly. **290x**, 33-34.
- Fisher W, Bauchot ML, Schneider M.** 1987. Méditerranée et Mer Noire. Vertébrés. *In* : Fishes. FAO d'identification des Espèces pour les Besoins de la Pêche. Rome. Vol II, 761-1530.
- FAO.** 2012. La Situation Mondiale des Pêches et de l'Aquaculture. FAO : Rome. 241p.
- Gayanilo FC, Sparre P, Pauly D.** 2005. FAO-ICLARM. Outils d'évaluation des stocks II (FISAT II). Version révisée. Guide d'utilisation. FAO Série informatique. Pêche. No. 8, Version révisée. Rome, FAO. 190 p.
- Gharbi H, BenMeriem S, Bedoui R, El Abed A.** 2004. Les pêcheries tunisiennes du rouget de vase (*Mullus barbatus* Linnaeus, 1758): Evaluation des stocks et aménagement des pêcheries. *Marine. Life*, **14**: 49-57.
- GULLAND JA.** 1971. The fish resources of the ocean. West By fleet, Survey, Fishing News (Books), Ltd., for FAO, 255p. Revised edition of FAO Fisheries Technical Paper, (**97**), 425p.
- Hebbar C, Kerfouf A, Boutiba Z.** 2012. Contribution à l'étude de la reproduction du rouget barbet de vase *Mullus barbatus barbatus* (Linné, 1758) de la baie d'Oran (Algérie). *Journal des Sciences Halieutiques et Aquatiques*, **5** :144-151.
- Hemida F.** 2005. Les séliaciens de la côte algérienne: bio systématique des requins et des raies ; écologie, reproduction et exploitation de quelque populations capturées Thèse de Doctorat. Université des Sciences et de la Technologie Houari Boumediene (USTHB). 233p.
- Hilborn R, Walters CJ.** 1992. Quantitative Fisheries Stock Assessment: Choice, Dynamics, & Uncertainty. Chapman and Hall, New York.
- Joksimović A, Regner S, Kasalica O, Đurović M, Pešićand A, Mandić M.** 2008. Growth of the red mullet, *Mullus barbatus* (linnaeus, 1758) on the Montenegrin shelf (south Adriatic). *Electronic Journal of Ichthyology*, **1**: 1-7.
- Joksimović A, Regner S, Gačić Z.** 2009. Mortality of red mullet (*Mullus barbatus*) on the Montenegrin Shelf (South Adriatic). *Archives of Biological Science. Belgrade.*, **61(3)**: 503-509. doi: 10.2298/ABS0903503J.

- Lalami Y.** 1979. Etude biologique et halieutique du rouget de vase (*Mullus barbatus*. L) des côtes algériennes. Thèse de doctorat es Sciences Naturelles. Université Sciences et Technologie du Languedoc. Montpellier, France.
- Layachi M.** 2007. Biologie et conditions d'exploitation du rouget barbet de vase (*Mullus barbatus* L., 1758) du littoral méditerranéen de Nador. Thèse de doctorat national en sciences biologiques. Université Mohamed 1^{er}. Oujda. Maroc. 118p.
- Livadas RJ.** 1988. The selectivity of certain trawl cod-end in Cyprus. FAO Rapport de Pêches. **412**, 180-189.
- Lombarte A, Aguirre H.** 1997. Quantitative differences in the chemoreceptor systems in the barbells of two species of Mullidae (*Mullus surmuletus* and *M. barbatus*) with different bottom habitats. Marine Ecology Progress Series. **150**, 57-64.
- Martin P, Sartor P, García-Rodriguez M.** 1999. Comparative analysis of the exploitation strategy of the European hake (*Merluccius merluccius*), Red mullet (*Mullus barbatus*) and striped red mullet (*Mullus surmulletus*) in the Western Mediterranean. Journal of Applied Ichthyology, **15**, 24-28.
- MPRH.** 2009. Ministère de la Pêche et des Ressources Halieutiques, Algérie 2009.
- Pauly D.** 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. Journal du Conseil International pour l'Exploration de la Mer, **39(3)**, 175-192.
- Pauly D.** 1985. Length-converted catch curves: a powerful tool for fisheries research in the tropics (Part II). ICLARM Fishbyte, **2 (1)**, 17-19.
- Pauly D.** 1987. A review of the ELEFAN system for analysis of length frequency data in fish and invertebrates. In: Length based Methods in Fisheries Research (eds. D. Pauly and G.R. Morgan). ICLARM Conference Proceedings 13. ICLARM, Manila. 7-34.
- PDAU.** 1995. Etude du Plan Directeur d'Aménagement et d'Urbanisme du groupement d'Oran. URSA. Bureau d'étude et de réalisation de l'urbanisme de Saïda. Agence d'Oran. Rapport d'orientation. Novembre, 650p.
- Ramdane Z.** 2010. Identification et écologie des ectoparasites Crustacés des poissons Téléostéens de la côte Est algérienne. Thèse de doctorat en sciences de la mer. Université Badji-Mokhtar. Annaba. 235p.
- Rikhter VA, Efanov VN.** 1976. On one of the approaches to estimation of natural mortality of fish populations. ICNAF Res. Doc. 76/VI/8, 12p.
- Roff DA.** 1984. The evolution of life history parameters in Teleosts. Canadian Journal of Fisheries and Aquatic Sciences, **41**, 989-1000.
- Sparre P, Venema SC.** 1996. Introduction à l'évaluation des stocks des poissons tropicaux. Première partie : Manuel. FAO. Document Technique sur les Pêches, Rome. **306 (1)**, 401 p.
- Suquet M, PersonLeRuyet J.** 2001. Les rougets barbets (*Mullus barbatus*, *Mullus surmuletus*). Biologie, pêche, marché et potentiel aquacole. Ifremer. 47p.
- Taylor CC.** 1959. Temperature, growth and mortality in the pacific cockle. Journal du Conseil International pour l'Exploration de la Mer, **26**, 117-24.
- Tursi A, Matarrese A, Donghia G, Sion L, Maiorano P.** 1995. The yield per recruit assessment of hake (*Merluccius merluccius* L., 1758) and red mullet (*Mullus barbatus* L. 1758) in the Ionian Sea. FAO Fisheries Report, No. 533 (Suppl): 127-141.
- Ungaro N, Rizzi E, Marzano MC.** 1994. Utilizzo del modello di Beverton e Holt, "Rendimento per recluta (Y/R)", per la risorsa "*Mullus barbatus* L." nell' Adriatico Pugliese. Biologia Marina Mediterranean, **1(1)**, 317- 318.
- Vanga AF.** 2011. Evolution de la pêche au lac d'Amamé depuis l'expulsion des pêcheurs non nationaux (Côte d'Ivoire). *Tropicultura*, **29(1)**, 8-13.