Population Dynamic and Stock Assesment of White Seabream *Diplodus sargus* (Linnaeus, 1758) in the Coast of North Siani

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Abstract

In the present study fisheries, population dynamic and stock assessment of *Diplodus sargus* in the coast of North Siani (Eastern Mediterranean, Egypt) studied. Length weight relationship, catch length structure, length scale relationship, total length by the end of each year of life, growth in weight, Von Bertalanffy parameters, the values of (total, natural and fishing mortalities), survival rates, Approximate maximum length with the highest biomass of *D. sargus* and approximate maximum age t_{max}. Also Cohort analysis (VPA, age based) which represent the estimated values of the population numbers, survivors, natural and fishing mortalities for each year of life of *D. sargus* were studied.

Keywords: Eastern mediterranean; Age and growth; *Diplodus sargus*

Introduction

The white seabream *Diplodus sargus* [1] is a commercial species found throughout the eastern temperate Atlantic and Mediterranean Seas [2,3] where it occurs in coastal rocky reef areas and Posidonia beds.

Due to its economic importance this species made the subject of study of various scientists in different countries [4-23].

White seabream was a good valuable commercial fish in Egypt, representing nearly 757 tons yearly about 1.1% by value of total catches for the Egyptian Mediterranean yield from year 2001 to year 2012 [24].

The aim of this study is to establish biological key characteristics and population parameters, where it is necessary for management and fish stock assessment in the Eastern Mediterranean and to compare these with data from other Mediterranean regions.

Materials and Methods

All of 991 fishes specimens of *D. sargus* (TL=11-38 cm) where collected during the period from September 2010-April 2012, in El-Arish Marin Seaport from the catches by El-Dabba (Trammel net) gear about 95%, and by the Long line gear about 5%.

Several scales (5-6) were removed from the area below the pectoral fin, making sure that they were not regeneration scales, washed and stored dry in individually labeled envelopes.

Total length (TL) was measured to the nearest mm. And Total weight (TW) recorded to the nearest gram.

Total length-Scale radius relationship computed according to [25] total length-total weight relationship was computed according to [26]. Estimate the growth parameters of the [27] by fitting the [28,29] while "to" was estimated by inverse [27] for t_o from L_∞ and K, and the asymptotic weight "W_∞" was estimated by converting "L_∞" to the corresponding weight using the obtained formula for length weight relationship.

Length with the highest biomass in an unfished population (L_{opt}), estimated according to [30] from the parameters of the [27] growth function and natural mortality.

Estimate of life span (t_{max}) according to [31], where it is the approximate maximum age that fish of a given population would reach.

Instantaneous total mortality coefficient "Z" estimated by means of the following methods [32-35]. The Powell-Wetherall plot based [36] discussed in [37] and Linearized catch curve based on age composition data [38]. Instantaneous natural mortality coefficient "M" estimated by means of the following methods [39-46]. The fishing mortality coefficient "F" estimated by subtracting the natural mortality coefficient from the total mortality coefficient.

The exploitation rate "E" estimated by the formula suggested by [47]. Estimation of survival rates "S" as a number of fish alive after a specified time interval, divided by the initial number, usually on a yearly basis was done according to [38] equation.

Virtual Population Analysis (VPA) has become one of the most commonly used age-and time-dependent fish population models in fisheries science to analyze the historical data for estimation of population parameters of *D. sargus* in the coast of North Sinai [48,49].

Results

Besides, fishery management plans rely on accurate age determinations; if age estimations are not validated, errors in age determination could result in inaccurate mortality estimates, underestimation of strong year classes and longevity [50].

Total length-scale radius relationship

Microscopic examination of scales growth rings showed a linear

regression between Length and scale radius of *D. sargus* represented by a straight line (Figure 1), the following formula representing this relationship:

$$L = 5.305\,S - 2.528r = 0.983$$

where, "L" is the total length (cm) and "S" is the total scale radius (micrometre division).

Length-weight relationship

The obtained equation found to be representing the relation between lengths and weights of *D. sargus* were:

$W = 0.011L^{3.165}$ with r=0.976

This relation can be explained graphically as in (Figure 2).

Theoretical growth in length and weight

Theoretical growth in length and weight of *D. sargus* in the coast of north Sinai by solve [27] growth equation for length and weight and fitting the [28,29] plot, were found as follows and constant as in (Table 1).

For length $Lt = 40.71(1 - e^{-0.2497(t+0.2794)})$

For weight $Wt = 1368.1(1 - e^{-0.2497(t+0.2794)})^{3.165}$

Estimation of L_{opt} and t_{max}

Approximate maximum length with the highest biomass of *D. sargus*, caught from North Sinai coast was 26.63 cm, and approximate maximum age t_{max} was 11.73 years.

Population structure

Demographic structure

Length composition: Total length frequency composition of *D. sargus* distributed with 28 size groups from size range 11-11.9 cm to size range 38-38.9 cm, the size group 16-16.9 cm (about 16.25% of the total frequencies), is the domination in the size groups and the size groups 11-11.9 cm and 38-38.9 (about 0.10% of the total frequencies) were the least size group frequencies (Figure 3).

Age composition: Age composition of *D. sargus* with the percentage of fishes of each five age groups we found the age group (I) is dominant in the catch about 48.34%, where Age group (V) is the least represented group in the catch about 4.14% (Figure 4).

Instantaneous mortality and survival rats: Instantaneous total mortality rate "Z" of *D. sargus* found 0.7066 year^{-1}, even as the instantaneous natural mortality "M" and instantaneous fishing mortality "F" was 0.3961 year^{-1} and 0.3105 year^{-1} respectively. Survival rate from age composition data using [38] equation found 0.4857.

Exploitation rate: Exploitation rate "E" of *D. sargus* in North Sinai coast found 0.4394 where it less than the optimum fishing mortality in an exploited stock suggested by [47], approximately 0.5.
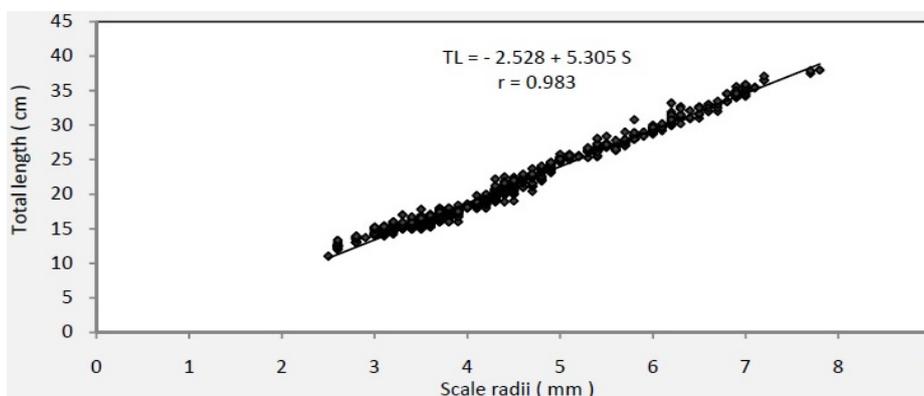

Figure 1: The relation between length and scale radius of *D. sargus* from the coast of North Sinai.
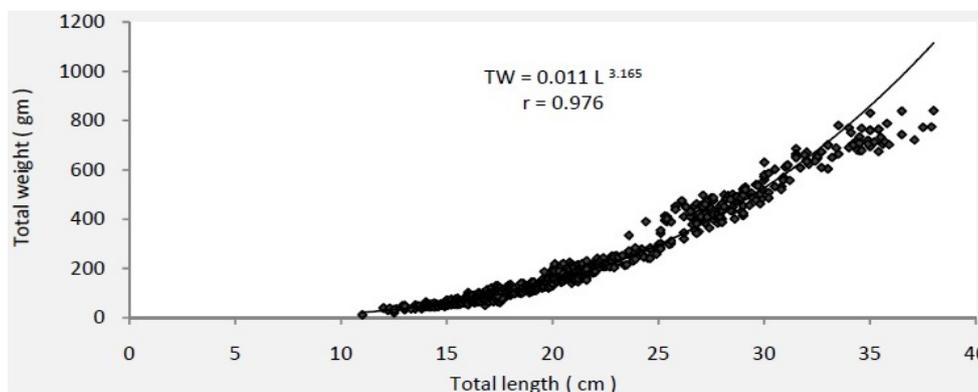

Figure 2: Length-weight relationship of D. sargus from the coast of North Sinai.

Constants	Ford (1933)–Walford (1946)
L∞	40.71 cm.
K	0.2497 year^{-1}
t$_o$	-0.2794 year^{-1}
W∞	1368.1 gm.

Table 1: Constants of Von Bertalanffy's growth equation of *D. sargus* from the coast of North Sinai.

Virtual population analysis

Estimation of age and time-population model done by using [48] cohort analysis as in Figure 5 and we perceive that this model defined cumulative instantaneous rate of fishing mortality "F" of the fish in the population, where it increased to the maximum value at age group 2 (0.4295 year^{-1}) then it decreased, age group 1 and 5 have minimum value. Population number and survivors had decreased from age group 1 to 5 by the natural losses of biomass of cohort and fishing losses, while catches number increased in smaller ages (1 and 2) and decreased in older ages (4 and 5) where that means there was fishing pressure of smallest fishes.

Discussion

Biological management of fisheries resources is generally aimed at preventing overfishing and optimizing yield. Age and growth parameters are the most important study to our understanding of the species biology was enable to control of fishing.
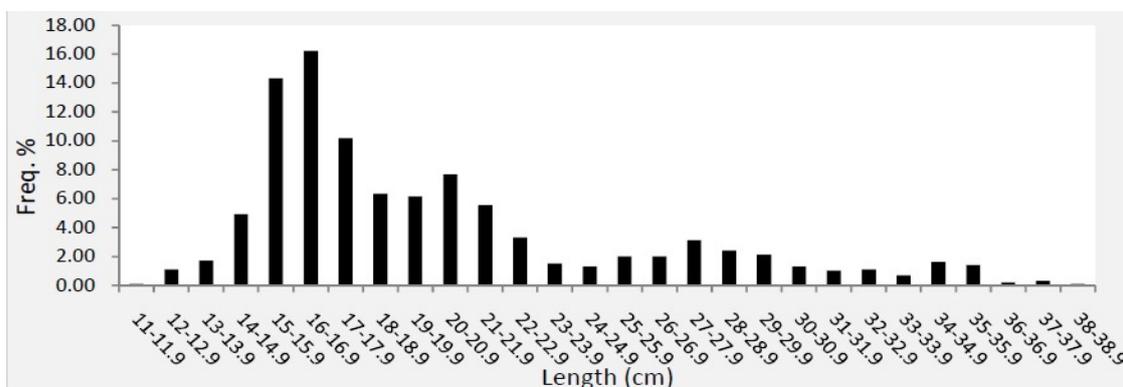

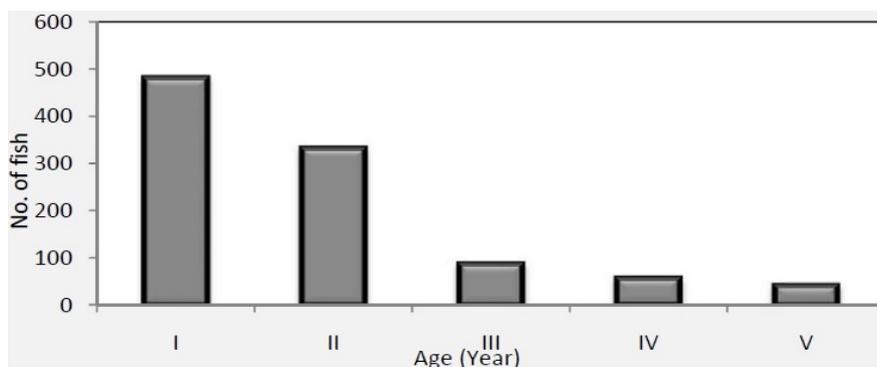**Figure 3:** Length frequency distribution of *D. sargus* from the coast of North Sinai.

Figure 4: Age composition of *D. sargus* from the coast of North Sinai.
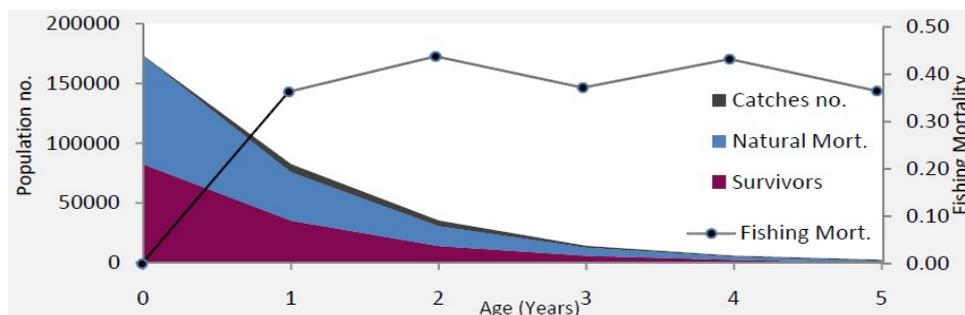

Figure 5: Virtual population analysis of *D. sargus* from the coast of North Sinai.

In the present work, data for body length and scale radius show a linear on their scatter diagram. For length-weight relationship of *D. sargus* in the coast of North Sinai fishery we found "b" parameter (b=3.165), this was agreement with [51] in the Egyptian Mediterranean water b=3.144, [52] in the Gulf of Lion b=3.123, [53] in the Azores b=3.181 for both Males and Females, for Males was b=3.032 and for Females was b=3.054. Less than [54] in the South-East coast of South Africa b=3.242 and more than [55] in the Egyptian Mediterranean water b=2.859, [21] in the Gulf of Tunis b=3.129 for Males, for Females b=2.994 and for all individuals b=3.051, [23] in Abu Qir bay b=2.942 and [56] in the Eastern cost of Algeria b=2.987.

Growth parameters of the [27-29] by fitting the plot are arranged (Table 2). From this table we can perceive a varied diverse between authors and we can deduce that there are difference between growths in different locations; it may be return to the water surface temperature and food abundance.

The approximate maximum age (t_{max}) of *D. sargus* in the coast of North Sinai are less than [57] in South Africa t_{max}=21 years and t_{max}=14 years. Similar with [17] t_{max}=12 years, t_{max}=13.4 years and [23] in Abu Qir bay t_{max}=11.45 years, these means that *D. sargus* have the same maximum age in the nearest geographic locations.

Length frequency distributions provide snapshots of the combination of fish species present and the sizes of individuals at particular locations and times. The smallest fish length in the catch of *D. sargus* in present work was 11 cm TL, while the biggest length was 38 cm TL, this result indicates that the *D. sargus* in the coast of North Sinai was fishing in small lengths at the first year of life.

In addition, if the length composition of our sample reflects the commercial fishery catches, we must point out that more than 70% of the fish caught were smaller than length at first maturity. Therefore, in order to improve the stock management of *D. sargus* and the conservation of this species in the coast of North Sinai, an increase

in the minimum legal length authorized for capture is strongly recommended.

The most dominant age in the catch of *D. sargus* is age group I where it contributes about 48.34%, this result was similar with [52,56] that indicate not only there was a fishing pressure on this fish but also that occur in different locations.

Before estimating the fishing and natural mortalities separately, it is convenient to estimate the total mortality. Instantaneous total mortality coefficient "Z" of *D. sargus* in the coast of North Sinai fishery was 0.7066 year^{-1}. [53] estimated the total mortality for *D. vulgaris* in the South coast of Portugal, which was 0.625 year^{-1}, [23] found total mortality was 1.092 year^{-1} for *D. sargus* and 1.049 year^{-1} for *D. vulgaris*.

Estimating natural mortality "M" is one of the most difficult and critical elements of a stock assessment [58]. Natural mortality "M" of *D. sargus* in present study was 0.3961 year^{-1}, [23] estimated natural mortality which was 0.606 year^{-1} for *D. sargus* and 0.600 year^{-1} for *D. vulgaris*. The same species may have different natural mortality rates in different areas depending on the density of predators and competitors, whose abundance is influenced by fishing activities [59].

Estimates of fish mortality rates are often included in mathematical yield models to predict yield levels obtained under various exploitation scenarios. Fishing mortality "F" in present study was 0.3105 year^{-1}.

Exploitation rate is the fraction of an age class that caught during the life span of a population exposed to fishing pressure, the exploitation rate was 0.4394, [22] found exploitation rate was 0.445.

Virtual Population Analysis (VPA) cohort analysis was first developed as age based methods. It is commonly used for studying the dynamics of harvested fish populations [49] the feature of VPA that is most important for practical use is that, given a high fishing pressure, estimates of population size obtained tend to converge rapidly toward their true value, and hence usually provide, given a reasonable estimate of M, reliable estimates of recruitment [48]. Present study could be considered as a base for future studies that help to predict the future catch in North Sinai coast and demonstrate that the *D. sargus* died by natural mortality more than those which die by fishing mortality. It could also be seen that, the increase in fishing mortality as the fish increases in age was accompanied by a decrease in the population numbers of the species understudy. On the other hand, the natural mortality decreases as the fish gets older. These results are in agreement with [23] in Abu Qir bay, Alexandria, Egypt.

From previous results we can conclude that the white seabream *D. sargus* in the coast of North Sinai facing more stress which fishing effort is more based on age groups I and II with small lengths from 14 to 17 cm. Also, it must to catch these fishes at ages more than 2 till 3 years to give it chance to grow to economical preferred size and to reduce overfishing of its first year of life.

Author and date	Method	L_∞	K	t_o	W_∞	Location
[52]	Scales	46.7	0.12	-1.63	2089	N/W Medit.
		0			7	
[60]	Otoliths	48.4	0.18	-0.06	-	N/E Atlantic
		8			-	
[9]	Otoliths	41.7	0.25	-0.08	-	N/W Medit.
		0			-	
[57]	Otoliths	30.9	0.25	-1.05	-	South Africa
		4			-	
[17]	Otoliths	47.3	0.14	-1.97	-	Canary Islands
		0			-	
[22]	Otoliths	40.9	0.18	-1.28	-	South Portugal
	Scales	39.5	0.15	-1.89	-	
[61]	Otoliths	41.2	0.18	-0.86	524	South
[55]	Scales	32.7	0.13	-1.84	-	Egypt
[23]	Scales	31.3	0.26	-0.73	-	Abu Qir Bay
		8			-	
[56]	All	36.3	0.15	-0.49	-	Eastern Algeria
	Males	35.1	0.16	-0.43	-	
	Females	35.4	0.16	-0.6	-	
Present study	**Scales**	**40.7**	**0.25**	**-0.28**	**1368**	**E. Medit.**

Table 2: Von Bertalanffy's growth parameters (L_∞, K, t_o and W_∞) for *D. sargus* for various authors and in different locations.

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