http://www.egejfas.org
Ege Journal of Fisheries and Aquatic Sciences, 41(1), 30-36 (2024)

Su Ürünleri Dergisi (2024)
DOI: 10.12714/egejfas.41.1.05

RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

Some biological aspects of White seabream, *Diplodus sargus* (Linnaeus, 1758) from the northeastern Aegean Sea, Türkiye

Kuzeydoğu Ege Denizi'nde (Türkiye) *Diplodus sargus* (Linnaeus, 1758)'un bazı biyolojik özellikleri

İsmail Burak Daban • **Ali İşmen** • **Mukadder Arslan İhsanoğlu***

Department of Fisheries and Fish Processing Technology, Faculty of Marine Sciences and Fisheries, Çanakkale Onsekiz Mart University, 17100, Çanakkale, Türkiye

*Corresponding author: mukadderarslan@gmail.com

Received date: 18.10.2023 Accepted date: 18.01.2024

How to cite this paper:
Daban, İ.B., İşmen, A., Arslan İhsanoğlu, M. (2024). Some biological aspects of White seabream, *Diplodus sargus* (Linnaeus, 1758) from the northeastern Aegean Sea, Türkiye. *Ege Journal of Fisheries and Aquatic Sciences, 41*(1), 30-36. https://doi.org/10.12714/egejfas.41.1.05

Abstract: In the study, the age, growth, mortality parameters and length-weight relationship parameters of *Diplodus sargus* (white seabream) collected by a small-scale fisherman between August 2020 and July 2021 along the northeastern coast of Aegean Sea (Türkiye coast), were investigated. *D. sargus* had a range of total length and weight from 14.3 cm to 36.7 cm and from 50.5 g to 836.5 g, respectively. The length-weight relationships (LWRs) were calculated as $W=0.02368*L^{2.881}$ for females, $W = 0.01847*L^{2.959}$ for males and $W = 0.01989*TL^{2.936}$ for both sexes. Using data from fish scales, the maximum age was determined to be 11 years. von Bertalanffy growth parameters have been calculated as follows $L\infty=39.01$ cm TL, $K=0.13$ year^{-1}, and $t_0= -2.58$ year for both sexes combined. Total (T), natural (N) and fishing (F) mortalities were defined as Z: 0.83 year^{-1}, M: 0.33 year^{-1} and F: 0.50 year^{-1} for both sexes combined. The exploitation rate (E) was calculated as 0.70, 0.44 and 0.60 for females, males and combined, respectively.

Keywords: Age, growth, mortality, length-weight relationship, white seabream, Aegean Sea

Öz: Bu çalışmada, Ağustos 2020 ve Temmuz 2021 tarihleri arasında Ege Denizi'nin kuzeydoğu kıyılarında (Türkiye kıyıları) küçük ölçekli bir balıkçı tarafından toplanan *Diplodus sargus*'un (Sargos) yaş, büyüme, ölüm parametreleri ve boy-ağırlık ilişkisi parametreleri incelenmiştir. *D.sargus*'un toplam uzunluğu 14,3 cm ila 36,7 cm ve ağırlığı 50,5 g ila 836,5 g arasında değişmektedir. Boy ağırlık ilişkisi dişiler için $W = 0.02368*L^{2.881}$, erkekler için $W = 0.01847*L^{2.959}$ ve her iki cinsiyet için $W = 0.01989*TL^{2.936}$ olarak tahmin edilmiştir. Balık pullarından hesaplanan yaş verileri maksimum yaşın 11 olduğunu göstermiştir. Belirlenen büyüme parametresi değerleri tüm bireyler için $L_\infty=39.01$ cm, $K=0.13$ yıl^{-1}, $t_0= -2.58$ yıl olarak belirlenmiştir. Toplam ölüm (Z), doğal ölüm (M) ve balıkçılık ölümü (F) tüm bireyler için Z: 0.83 yıl^{-1}, M: 0.33 yıl^{-1} ve F: 0.50 yıl^{-1} olarak belirlenmiştir. Sömürülme oranı (E) dişiler, erkekler ve tüm bireyler için sırasıyla 0.70, 0.44 ve 0.60 olarak hesaplanmıştır.

Anahtar kelimeler: Yaş, büyüme, mortalite, boy ağırlık ilişkisi, Sargos, Ege Denizi

INTRODUCTION

The white seabream, *Diplodus sargus* (Linnaeus, 1758), is an important representative of the family Sparidae with a geographical distribution ranging from the Bay of Biscay to Angola in the eastern Atlantic and from Gibraltar to the Black Sea (Bauchot, 1987; Bilecenoğlu et al., 2014). It has a shallower distribution (<70 m) and is mostly found in the same habitats. These habitats consist of rocky areas and *Posidonia oceonica* beds (Bauchot and Hureau, 1990; Lenfant and Planes, 1996). The white seabream feeds on algae, worms, gastropods, amphipods, bivalves, echinoderms, fishes and fish eggs (Maigret and Ly, 1986; Bianchi et al., 1999; Figueiredo et al., 2005).

It is known to be a common species in the northern Aegean Sea and is mainly caught in the shelf and coastal areas. The northeastern Aegean Sea is known as one of the areas where the most intensive small-scale fishing is carried out. The most preferred fishing gears are gillnets, trammel nets, longlines and hand lines. Hand lines and longlines are mainly used to catch white seabream. White seabream is more economically important than most other species in the region's fisheries. White seabream caught are exported and the approximate yield is 10 dollars per kilogram in 2021. Due to the problem of unrecorded fishing in the small-scale fisheries inTürkiye, the recorded catch rates are lower than the realised catch rates. The landed catch of white seabream is estimated at 26 tonnes according to the Turkish Statistical Institute Fisheries Report in 2022 (TUIK, 2023). The scientific knowledge on the biology of white seabream in Turkish seas is limited, although it is known as a common species of Sparidae.

Ayyıldız and Altın (2020) studied the daily growth of juvenile white seabream, Balık and Emre (2016) determined the age and growth of specimens with a total length of 13-16 cm from Beymelek Lagoon, southwest of Turkey. Some valuable literature on age, growth and feeding of white seabream has been published from Algeria, Portugal, Western and Eastern Mediterranean (Lloret and Planes, 2003; Benchalel and Kara, 2013; Al-Beak et al., 2015; Paiva et al., 2018; Boufekane et al., 2021). While the population characteristics of fish are significant factors in managing and controlling fisheries resources (Froese et al., 2008) and the

mortality rates, the age distribution offers crucial insights into the size and structure of the stock. The literature currently lacks information on the age, growth, and mortality parameters of *D. sargus*, posing potential hurdles for the management of the stock due to the paucity of data on the population biology in the Eastern Mediterranean, Aegean, Marmara, and Black Seas. The objective of this study is to offer initial insight into the growth parameters of white seabream in the northeast Aegean Sea. This research holds significance as it reveals the first findings of the population parameters of *D. sargus* in the Northeast Aegean Sea.

MATERIALS AND METHODS

Specimens were collected from fish captured by a fisherman with a handline and longline in the northeastern coast of Türkiye between August 2020 and July 2021. During the research, 30 samples were taken every month. A total of 322 fish were examined. TL (total length) and FL (fork length) were measured to the nearest millimetre. Total weight (TW) and gonad weight (GW) were also weighed to the nearest 0.01 grams. Subsequently, the exponential regression $W = a*TL^b$ was used to estimate the length-weight relationship (Le Cren, 1951), where W represents the total weight (grams) and TL denotes the total length (centimetres). Linear least squares regression after logarithmic transformation was used to estimate the constants a and b. Growth type was determined via t-test on the value of 'b', which reflects the allometry of growth (Sokal and Rohlf, 1987). At first, age determination was assessed for both otoliths and scales, and it was concluded that the fish scales was the most appropriate method for white seabream. The age of 322 white seabream specimens was ascertained from intact scales underneath the pectoral fin's left section. The translucent zones were identified as annuli and counted. Both sets of scale ring measurements were conducted by three independent observers using a binocular microscope. For the entire dataset, we estimated growth parameters using the von Bertalanffy growth equation: $L(t)= L_\infty\ [1-exp(-k(t-t_0))]$ where L(t) represents total length at time t, L_∞ denotes asymptotic length (cm), K indicates the growth coefficient (y^{-1}) and t_0 is the age of the fish when its size is zero (von Bertalanffy, 1938). The von Bertalanffy growth parameters were estimated using FISAT II programme. Instantaneous total mortality (Z) was determined using the age-converted catch curve method of Pauly (1984). Natural mortality (M) was calculated using Pauly's (1980) empirical formula, which includes von Bertalanffy growth parameters and mean annual seawater temperature (15.7°C; Türkoğlu, 2010). The fishing mortality rate was computed via the formula F = Z - M (Bingel, 2002). To compute the exploitation rate (E), Gulland's formula (1979) was utilised: E = F/Z. Calculating the growth performance index, ϕ, involved using this formula: $\phi = \log K + 2 X \log L_\infty$.

RESULTS

The lengths of 322 white seabreams ranged from 14.3 cm to 36.7 cm TL. The mean TL was calculated to be 23.8 ± 0.18 cm (Table 1). Individual weights ranged from 50.5 g to 836.5 g with a mean of 232.4 ± 5.7 g. It was observed that the most common length group was 24 cm TL with 17.4% of the total individuals, and almost half of the total individuals were between 22 cm and 24 cm TL (Figure 1). Looking at the monthly variation in mean TL, the highest mean length was observed in May and the lowest in August. The length-weight relationship was calculated as $W = 0.02368*TL^{2.881}$ ($r^2 = 0.93$) for females, $W = 0.01847*L^{2.959}$ ($r^2 = 0.93$) for males and $W = 0.01989*TL^{2.936}$ ($r^2 = 0.93$) for both sexes (Table 2). The regressions showed negative allometric growth for males, females and both sexes. According to the fish scale readings, white seabream was distributed between 1 and 11 years of age (Table 3, Figure 2). The most common age groups were 5, 4 and 6 years with 27.6%, 21.1% and 16.1% of the total individuals.

Table 1. The range of total length (TL), and weight (g) of *D. sargus*

	Total Length(cm)				Weight (g)		
	N	Mean ± Sx	Min	Max	Mean	Min	Max
Male	176	23.47 ± 0.22	14.3	31.6	220.74 ± 6.53	50.46	542.12
Female	143	24.19 ± 0.28	15.9	36.7	243.67 ± 9.66	71.32	836.51
Total	322	23.83 ± 0.18	14.3	36.7	232.36 ± 5.67	50.46	836.51

Table 2. Length-weight relationships (LWRs) parameters of *D. sargus*

Sex	N	a	%95 CI a	b	%95 CI b	r^2	Growth type
Female	143	0.0236	0.0155-0.0360	2.88	2.749-3.013	0.93	A(-)
Male	176	0.0184	0.0125-0.0272	2.96	2.835-3.082	0.93	A(-)
Total	322	0.0199	0.0149-0.0263	2.94	2.847-3.025	0.93	A(-)

A(-) : negative allometry

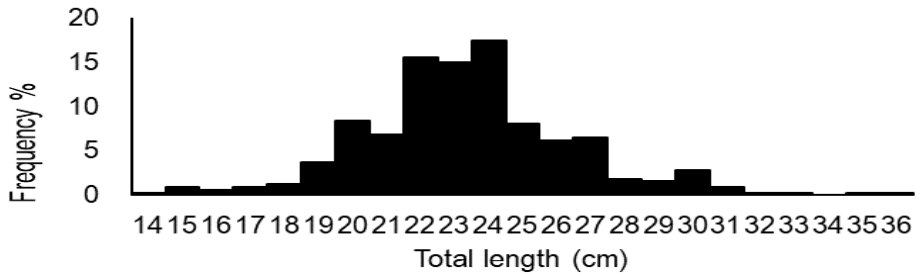

Figure 1. Frequency distribution of the length of *D. sargus*

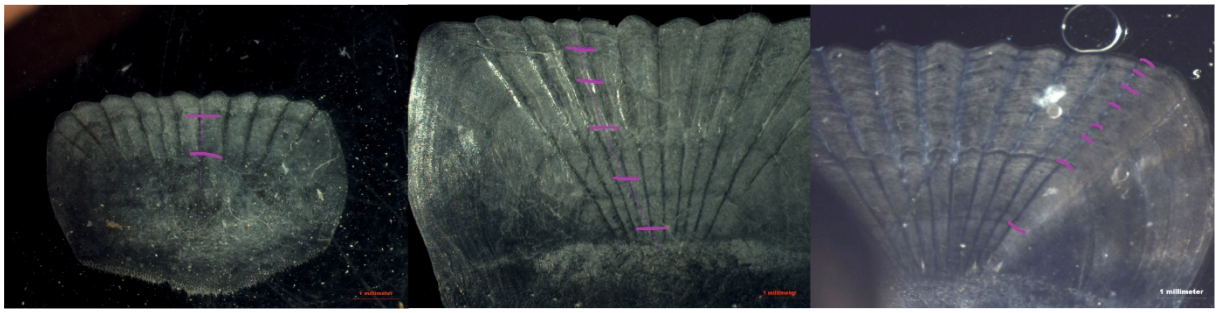

Figure 2. Annual growth rings (pink lines) on the scales in different ages of *D. sargus*

Table 3. Key to the age-total length of *D. sargus*

Total length (cm)	Age										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
14	1										
15		3									
16		2									
17		3									
18		2	2								
19			11	1							
20		4	19	3	1						
21			7	14	1						
22			2	34	14						
23			1	13	33	1					
24				3	29	22	2				
25					7	14	5				
26					3	7	7	3			
27					1	5	9	6			
28						1	2	3			
29						2	1	2			
30								8	1		
31									3		
32									1		
33										1	
34											
35										1	
36											1
N	1	14	42	68	89	52	26	22	5	2	1
Mean length (cm)	14.3	17.9	20.4	22.4	23.8	25.5	26.7	28.6	31.4	34.5	36.7

We employed the FISAT II programme to study the length and age data as well as the growth parameters of 322 individuals. The values of the growth parameters for the entire population were calculated as L_∞=39.01 cm TL, K=0.13 year^{-1}, and t_0=-2.58 years. Growth parameters for female individuals were determined as L_∞=37.96 cm TL, K=0.14 year^{-1}, t_0=-2.0 years. For male individuals, the growth parameters were L_∞=32.86 cm TL, K=0.19 year^{-1}, t_0=-2.0 years.

Graphs depicting von Berlanffy growth curves for females, males, and all individuals of *D.sargus* are illustrated in Figure 3. Total mortality (Z), natural mortality (M) and fishing mortality (F) were determined as Z: 0.83 t^{-1}, M: 0.33 t^{-1} and F: 0.50 t^{-1} for the combined sexes. Z, M and F were determined to be 0.64 t^{-1}, 0.35 t^{-1} and 0.29 t^{-1} for females and 0.81 t^{-1}, 0.45 t^{-1} and 0.36 t^{-1} for males. The exploitation rate (E) was calculated as 0.70, 0.44 and 0.60 for females, males and both sexes, respectively.

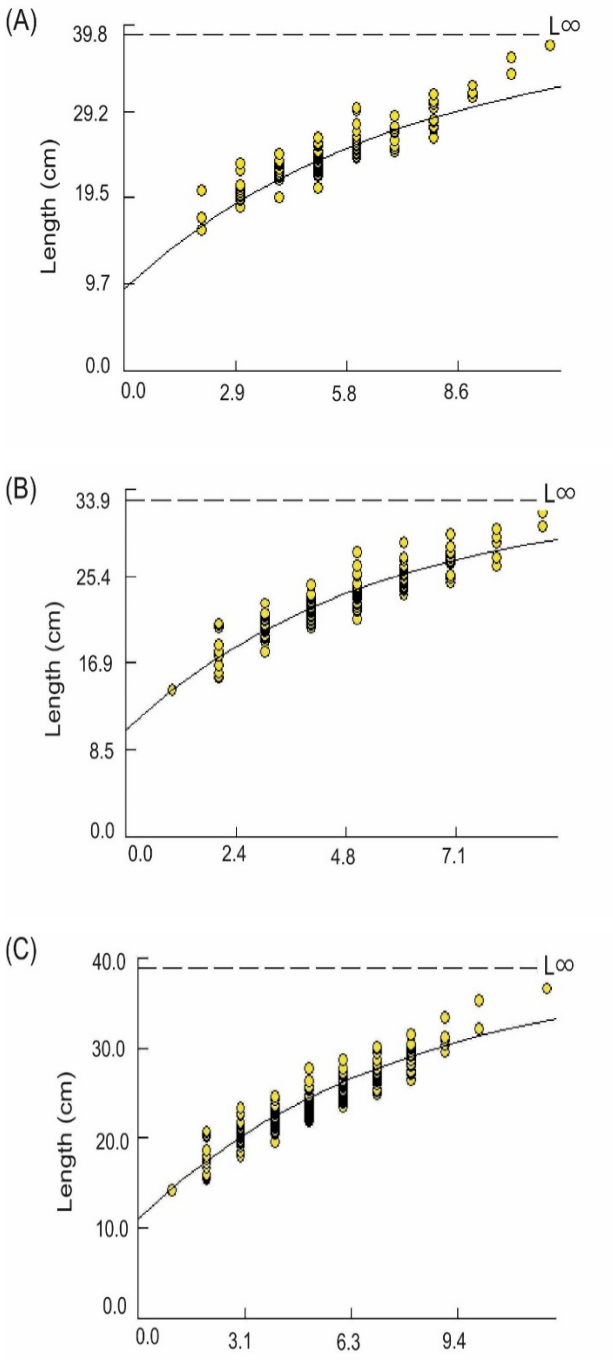

Figure 3. The growth curve of female (A), male (B) and (C) total individuals of *D. sargus*, as modelled by the von Bertalanffy equation

Mortality parameters were calculated for all individuals, yielding the following values: Z = 0.83 year^{-1}, M = 0.33 year^{-1} and F = 0.50 year^{-1} (Figure 4). Exploitation rate was ascertained at (E): 0.60. For male subjects, mortality parameters were Z: 0.81 year^{-1}, M: 0.45 year^{-1}, F: 0.36 year^{-1}, and E: 0.45. For females, the mortality parameters were calculated as Z: 0.64 year^{-1}, M: 0.35 year^{-1}, F: 0.29 year^{-1}, and E: 0.45.

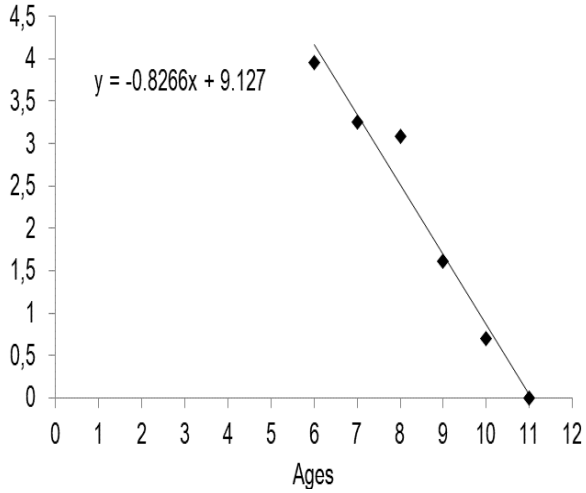

Figure 4. Total mortality-age curve of sexes combined of *D. sargus*

DISCUSSION

The b-value of the length-weight relationship for this species has been reported by various authors in different regions. Man Wai and Quignard (1982) reported a b-value of 3.123 in the Gulf of Lion, Mouine et al. (2007) found a value of 3.05 in the Central Mediterranean (Tunis), Lahlah (2004) reported a value of 2.859 in Egyptian Mediterranean waters, Mahmoud et al. (2010) found a value of 2.942 in the Abu Qir Bay of Egypt, El-Maghraby and Botros (1981) reported a value of 3.144 in the Mediterranean waters of Egypt, and Morato et al. (2003) found b value of 3.18 in the North Eastern Atlantic, Balık and Emre (2016) found that the b value is 3.1028 in the Mediterranean Sea. This study recorded b value of 2.88 in females, 2.96 in males in the Northeastern Aegean Sea (Table 4). This could be due to differences in environmental conditions, sampling methods and size range coverage. The samples primarily comprised of small individuals which could have influenced the b value of the length-weight relationship. However, our results contrast with those previously reported, which may be due to differences in the size distributions of samples taken from different habitats.

Benchalel and Kara (2013) found that the age distribution of *D. sargus* species on the east coast of Algeria ranged from 0-10 years in the length group between 12.2 cm and 34.6 cm TL, El-Maghraby and Botros (1981) found that individuals on the Egyptian coast ranged from 1-8 years of age in the length range of 6-39 cm. In this study, the TL range was 14.3-36.7 cm and the age distribution was between 1-11 years. Age distributions were similar between the studies, but it was understood that there was a smaller age distribution in the Egyptian coast in contrast to the larger length distribution. It is thought that this may be due to the difference in the method used during age reading or the faster growth on the Egyptian coast. In the study carried out in our country, Balık and Emre (2016) reported that the age distribution in the length range of 13-16 cm TL in Beymelek Lagoon was 0-3 years old. In this

study, it was determined that the length of the youngest individual aged 3 years was 18.5 cm TL (Table 5). In both studies, it was observed that the majority of individuals in this length range were 2 years old. The variations of the results can be attributed to the differences in study regions, environmental variables, and the number of individuals involved. The researchers also determined the growth parameter values of the species. The discrepancy in age distribution and growth parameter values found in this study compared to other studies is attributed to the different methods employed. While many researchers used otoliths, the age determinations in this study were made from fish scales similar to Abecasis et al. (2008). The age determination from the fish scales specific to the species was easier to determine.

Table 4. The b values of length-weight relation of *D. sargus* reported for some populations living in different locations

Author	Sex	N	b	Area	Growth type
El-Maghraby and Botros (1981)			3.144	Egypt Mediterranean waters	
Man Wai and Quignard (1982)			3.123	Gulf of Lion	
Morato et al. (2003)	Male	231	3.032	North Eastern Atlantic	I
	Female	446	3.054		I
	Total	1178	3.181		I
Lahlah (2004)			2.859	Egyptian Mediterranean waters	
Mouine et al. (2007)	Male	37	3.129	Central Mediterranean (Gulf of Tunis)	I
	Female	108	2.994		I
	Total	247	3.051		A(+)
Mahmoud et al. (2010)	Total		2.942	Abu Qir Bay of Egypt	A(-)
Balık and Emre (2016)	Total	355	3.1028	Beymelek Lagoon S.W. coast of Türkiye at the Med. Sea	
This study	Female	143	2.88	NE Aegean Sea of Türkiye	A(-)
	Male	176	2.96		A(-)
	Total	322	2.94		A(-)

I: izometry, A(+): positive allometry, A(-): negative allometry

Table 5. The von Bertalanffy growth parameters of *D. sargus* reported for some populations living in different locations

Author	Area	Age range	Method	L_∞	K	t_0
El-Maghraby et al. (1981)	Egypt	1-8	Otolith			
Man Wai and Quignard (1982)	N/W Mediterranean	-	Otolith	46.70	0.12	-0.63
Man Wai and Quignard (1982)	Gulf of Lion	-	Otolith	45.86	0.17	-1.18
Martinez-Pastor and Villegas-Cuadros (1996)	Cantabrian Sea	1-11	Otolith	48.48	0.18	-0.06
Gordoa and Moli (1997)	N/W Mediterranean	-	Otolith	41.70	0.25	-0.08
Mann and Buxton (1997)	South Africa	-	Otolith	30.94	0.25	-1.05
Abecasis et al. (2008)	South Portugal	0-18	Otolith	40.93	0.18	-0.86
		0-16	Scale	39.55	0.15	-1.89
Lahlah (2004)	Egypt	-	Otolith	32.72	0.13	-1.84
Mahmoud et al. (2010)	Abu Qir Bay	0-6	Otolith	31.38	0.26	-0.73
Benchalel and Kara (2013)	Algeria	1-10	Otolith	36.39	0.15	-0.49
Balık and Emre (2016)	Mediterranean	1-3	Otolith			
This study	NE Aegean Sea	1-11	Scale	39.01		

The mortality parameters, exploitation ratio and reproductive characteristics of fishes are key elements in the consideration and control of fisheries resources. There is no data of mortality parameters and exploitation ratio of *D.sargus* in our seas. One study is represented the first sexual maturity length of the species that is 22.69 cm in females and 25.2 cm in males, respectively (Daban et al., 2023). In the communiqué issued by the Ministry of Agriculture and Forestry, which regulates commercial fishing, the minimum length of *D. sargus* species is set at 21 cm TL, that result is smaller than the first maturity length. And, in this study the mortality parameters were calculated and the exploitation rate was found as E:0.60. According to all these results it is possible to say that the species is under fishing pressure.

CONCLUSION

Understanding the biological characteristics of populations is crucial for maintaining species continuity. This research

focuses on *D. sargus*, an economically important species, and investigates its age distribution, growth parameters, and mortality parameters. According to the results obtained, it is seems that the first capture length should be increased in order to ensure the continuity of the stocks. In order to reduce the fishing pressure on the species, increasing the mesh size of the gillnets, which is one of the fishing gears where selectivity can be adjusted most easily, can be effective in reducing the fishing power.

ACKNOWLEDGEMENTS AND FUNDING

This study was supported by Çanakkale Onsekiz Mart University Scientific Research Projects Commission with the project number FBA-2020-3295.

AUTHORSHIP CONTRIBUTIONS: All authors contributed to the idea and design of the study.

CONFLICT OF INTEREST STATEMENT: The authors declare that there are no conflicts of interest or competing interests.

ETHICS APPROVAL: No specific ethical approval was necessary for this study.

DATA AVAILABILITY: For questions regarding datasets, the corresponding author should be contacted.

REFERENCES

Abecasis, D., Bentes, L., Coelho, R., Correia, C., Lino, P.G., Monteiro P., Gonçalves J.M.S., Ribeiro J., & Erzini, K. (2008). Ageing Seabream: A comparative study between scales and otoliths. *Fisheries Research*, *89*(1), 37-48. https://doi.org/10.1016/j.fishres.2007.08.013

Al-Beak, A., Ghoneim, El-Dakar, A., & Salem, M. (2015). Population dynamic and stock assesment of white seabream *Diplodus sargus* (Linnaeus, 1758) in the coast of North Sinai. *Fisheries and Aquaculture Journal, 6*(4), 152. https://doi.org/10.4172/2150-3508.1000152

Ayyıldız, H., & Altin, A. (2020). Hatching time and early growth of *Diplodus sargus sargus* inhabiting a coastal area of Gökçeada Island, Turkey. *Thalassas: An International Journal of Marine Sciences*, *36*, 1-8. https://doi.org/10.1007/s41208-019-00185-9

Balık, I., & Emre, Y. (2016). Population structure, length-weight relationship and growth of white seabream, *Diplodus sargus sargus* (Linneaus, 1758), in Beymelek lagoon, Turkey. *Journal of Applied Ichthyology, 32*(3), 602–605. https://doi.org/10.1111/jai.13075

Bauchot, M.-L. (1987). Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) *Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II.* Commission des Communautés Européennes and FAO, Rome.

Bauchot, M.L. & Hureau, J.C. (1990). Sparidae. p. 790-812. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post, & L. Saldanha (Ed.) *Check-list of the fishes of the eastern tropical Atlantic (CLOFETA)*. JNICT, Lisbon; SEI, Paris; and UNESCO, Paris.

Benchalel, W., & Kara, M.H. (2013). Age and growth and reproduction of the white seabream *Diplodus sargus sargus* (Linneaus, 1758) off the eastern coast of Algeria. *Journal of Applied Ichthyology*, *29*, 64-70. https://doi.org/10.1111/j.1439-0426.2012.02057.x

Bianchi, G., Carpenter, K.E., Roux, J.P., Molloy, F.J., Boyer, D., & Boyer, H.J. (1999). *FAO species identification guide for fishery purposes. Field guide to the living marine resources of Namibia.* FAO, Rome.

Bilecenoğlu, M., Kaya, M., Cihangir, B., & Çiçek, E. (2014). An updated checklist of the marine fishes of Turkey. *Turkish Journal of Zoology, 38*, 901-929. https://doi.org/10.3906/zoo-1405-60

Bingel, F. (2002). Identification of Fish Populations. Icel: Baki Press.

Boufekane, B., Chakroun-Marzouk, N., Kelai, E., Alioua, Z., Amira, S., & Harchouche, K. (2021). Reproductive Traits and Somatic Growth of *Diplodus sargus sargus* (Linnaeus, 1758) in the Central Algerian Coast (Southern Mediterranean Sea). *Turkish Journal of Fisheries and Aquatic Sciences, 21*(8), 381-399. https://doi.org/10.4194/1303-2712-v21_8_03

Daban, İ.B., İşmen, A., & Arslan İhsanoğlu, M. (2023). Reproductive biology of white seabream, *Diplodus sargus* from northeastern Aegean Sea, Türkiye. VII. International Congress On Domestic Animal Breeding, Genetics And Husbandry, (pp.115-117). Krakow, Polonya, Proceedings Book.

El-Maghraby, A. M., Botros, G. A., Hashem, M. T., & Wassef, E.A. (1981). Maturation, spawning and fecundity of two sparid fish, *D. sargus and D. vulgaris* Geoff. in the Egyptian Mediterranean waters. *Bulletin of the National Institute of Oceanography and Fisheries, 8*, 51–67.

Figueiredo, M., Morato, T., Barreiros, J. P., Afonso, P., & Santos, R. S. (2005). Feeding ecology of the white seabream, *Diplodus sargus*, and the ballan wrasse, *Labrus bergylta*, in the Azores. *Fisheries Research*, *75*(1-3), 107-119.

Froese, R., Stern-Pirlot, A., Winker, H., & Gascuel, D. (2008) Size matters: how single-species management can contribute to ecosystem-based fisheries management, *Fisheries Research, 92*(2–3), 231–241. https://doi.org/10.1016/j.fishres.2008.01.005

Gordoa, A., & Moli, B. (1997). Age and growth of the sparids *D. vulgaris*, *D. sargus* and *D. annularis* in adult populations and the differences in their juvenile growth patterns in the North Western Mediterranean Sea. *Fisheries Research, 33*(1-3), 123-129. https://doi.org/10.1016/S0165-7836(97)00074-X

Gulland, J.A. (1979). Report of the FAO/IOP workshop on the fishery resources of the Western Indian Ocean south of the equator. Rome.

Lahlah, M. (2004). Ecological studies on two fish species inhabiting coastal seaweed meadows in Alexandria waters. Doctoral dissertation. Alexandria University, Egypt.

Le Cren, E.D. (1951). The length–weight relationship and seasonal cycle in gonad weight and condition in perch (*Perca fluviatilis*). *Journal of Animal Ecology*, *20*(2), 201–219. https://doi.org/10.2307/1540

Lenfant, P., & Planes, S. (1996). Genetic differentiation of white sea bream within the Lion's Gulf and the Ligurian Sea (Mediterranean Sea). *Journal of Fish Biology*, *49*(4), 613-621. https://doi.org/10.1111/j.1095-8649.1996.tb00058.x

Lloret, J., & Planes, S. (2003). Condition, feeding and reproductive potential of white seabream *Diplodus sargus* as indicators of habitat quality and the effect of reserve protection in the northwestern Mediterranean. *Marine Ecology Progress Series*, *248*, 197-208. https://doi.org/10.3354/meps248197

Mahmoud, H., Osman, A., Ezzat, A., & Saleh, A. (2010). Fisheries biology and management of *Diplodus sargus sargus* (Linnaeus, 1758) in Abu Qir Bay, Egypt. *Egyptian Journal of Aquatic Research. 36*(1), 123–131.

Maigret, J., & Ly, B. (1986). *Les poissons de mer de Mauritanie*. Centre National de Recherches Océanographiques et des Pêches, Nouadhibou (R.I.M.)

Martinez-Pastor, C., & Villegas-Cuadros, M. L. (1996). Edad, crecimiento y reproduccion de *Diplodus sargus* Linnaeus, 1758 (Sparidae) en aguas asturianas (norte de Espana). *Boletin del Instituto Español de Oceanografía, 12*(1), 65–76.

Mann, B.Q., & Buxton, C.D. (1997). Age and growth of *Diplodus sargus capensis* and *D. cervinus hottentotus* (Sparidae) on the Tsitsikamma coast, S. Africa. *Cybium*, *21*, 135-147.

Man Wai, R., & Quignard, J.P. (1982). The seabream *Diplodus sargus* (Linné 1758) in Gulf of Lion: growth of the seabream and characteristics of landings from the commercial fishing grounds of Sete and Grau-du-Roi. *Revue des travaux de l'Institut des pêches maritimes, 46*(3), 173–194.

Martinez-Pastor, C. & Villegas-Cuadros, M.L. (1996). Age, growth and reproduction of *Diplodus sargus* Linnaeus, 1758 (Sparidae) North of Spain. *Bol. Inst. Esp. Oceanogr*., 12(1), 65-76.

Morato, T., Afonso, P., Lourinho, P., Nash, R. D. M., & Santos, R.S. (2003). Reproductive biology and recruitment of the white seabream in the Azores. *Journal of Fisheries Biology*, *63*(1), 59–72. https://doi.org/10.1046/j.1095-8649.2003.00129.x

Mouine, N., Francour, P., Ktari, M.H., & Chakroun-Marzouki, N. (2007). The reproductive biology of *Diplodus sargus sargus* in the Gulf of Tunis (central Mediterranean). *Scientia Marina, 71*(3), 461–469. https://doi.org/10.3989/scimar.2007.71n3461

Paiva, B.R., Neves, A., Sequeira, V., Vieira, A., Costa, M., & Gordo, L. (2018). Age, growth and reproduction of the protandrous hermaphrodite fish, *Sarpa salpa*, from the Portuguese continental coast. *Journal of the Marine Biological Association of the United Kingdom, 98*(2), 269-281. https://doi.org/10.1017/S0025315416001405

Pauly, D. (1980). On the interrelationships between natural mortality, growth parameters, and environmental temperature in 175 fish stocks. *Journal du Conseil / Conseil Permanent International pour l'Exploration de la Mer, 39*(2), 175-192. https://doi.org/10.1093/icesjms/39.2.175

Pauly, D. (1984). *Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Studies and Reviews 8*. International Center for Living Aquatic Resources Management, Manilla, Philippines.

Sokal, R.R., & Rohlf , F.J. (1987*) Introduction to Biostatistics*. Freeman & Company, New York

TUIK, (2023, September 21). Fisheries statistics. Turkish statistical institute. https://biruni.tuik.gov.tr/medas/?locale=tr

Türkoğlu, M. (2010). Temporal variations of surface phytoplankton, nutrients and chlorophyll a in the Dardanelles (Turkish straits system): a coastal station sample in weekly time intervals. *Turkish Journal of Biology*, *34*(3), 319-333. https://doi.org/10.3906/biy-0810-17

Von Bertalanffy, L. (1938). A quantitative theory of organic growth (inquiries on growth laws II). *Human Biolology, 10*, 181–213.