

Fishery of Sinop Coasts in the Black Sea Surveys

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ABSTRACT

Objective: The current work was carried out between 2013-2014 during the fishing periods to evaluate certain fish agglomerations within 3 miles of the coastal zone. Therefore, some basic characteristics of fish populations along the Inceburun coast of the Sinop province of the Black Sea were examined.

Materials and Methods: Data was collected from 5 trawl operations in the Sinop-Inceburun Region of the Black Sea at depths of 20 to 39 meters at 5 different locations. Biometric measurements of each species was made. A literature search was performed to gather information about the status of threatened fish species found in the region. The length-weight parameters of 4 commercial fish species were estimated.

Results: During the fishing season between 1st September 2013 and 15th April 2014 different fish species were captured depending on the season and climate. In these surveys, 16 teleost species from 15 families, 2 elasmobranch species from 2 families and 2 species of invertebrates were recorded from 5 different stations. In these surveys random samples of red mullet, bluefish, horse mackerel, turbot etc. were collected from 5 different stations. The total mean CUPA was estimated at 425.30 kg/km².

Conclusion: The Black Sea areas including those around the Sinop coast have an important effect on the entire production of sea fish of the Turkish fishery. In addition, Sinop fisheries generate significant fishery production supporting logistics and employment. In the Sinop peninsula, there is an increasing trend towards the production of commercial species of the Black Sea.

Keywords: Black Sea, Inceburun, Sinop, fishery, bottom trawl

INTRODUCTION

The Black Sea contains the most isolated of ecosystems of all natural inland seas, connected to the Mediterranean by a very thin waterway through the Turkish Straits. The Black Sea contains a comparatively large variety of marine fauna (1), in spite of its brackish waters (17‰) and anoxic conditions below a depth of 180 m (with high levels of H₂S). Approximately 3,800 species have been reported in the Black Sea. 42.9% of them belong to fungi, algae and higher plants, 52.5% are invertebrates, 4.5% fishes and 0.1% mammals (2).

Fish are one of the top aquatic organisms which serve as a source of protein (3,4). The fishery industry pays a

major role in Turkey's economy as a source of employment and revenue from exports. Turkey has many commercially important marine fishery resources which include demersal and small pelagic fish species. Fish production decreased from 589 129 tonnes in 2007 to 301 463,6 tonnes in 2016 (5). One of the problems associated with the fishing industry is the over-fishing of commercial fish species throughout the year. Being the most important fishing area, the Black Sea is being developed by the government of Turkey as a fishing center. The Black Sea is heavily influenced by various types of contaminants (6-9). Household and industrial waste are causing great harm to the fishing industry in Turkey. The City of Sinop is one of the most important fishing cities on the Black Sea coast (10). Besides com-



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mercial fishing, recreational fishing is also common in Sinop. Being surrounded by sea on three sides, Sinop is an important area for the fishing industry (10). The fresh catch from marine fisheries is supplied to local fish markets. The national per capita consumption was only 6.2 kg p.a. in 2015 (5). This value is higher in Turkey's coastal cities including Sinop. Sinop is the center of the fishing industry with many trawlers and fishing vessels using Sinop Fish Harbour. A recent review has pointed out that numerous contaminants, several of which are carcinogenic, and toxic materials such as heavy metals have been found in the marine ecosystem (6). These hazardous pollutants are also moving into the diet of human beings consuming the seafood including fish. However, many recent studies indicate that heavy metals in commercial fish species caught near the Sinop coast are well below the acceptable levels set for EU Commission Regulations and TFC (11-21). In this respect, the fish obtained from Sinop shores are among the better species for consumption.

Although fish constitute only a small portion of the biodiversity of the Black Sea, the main species include anchovy (*Engraulis encrasicolus*), sprat (*Sprattus sprattus*), whiting (*Merlangius merlangus*) and Atlantic bonito (*Sarda sarda*) which have always been important in the area because of their great commercial value. The current study was carried out between the fishing periods of 2013 and 2014, and several fundamental features of the fish population along the Inceburun coast of the Sinop province of the Black Sea were examined.

MATERIALS AND METHODS

Samples of fish were taken from waters along the Inceburun coast of the Sinop province in the Black Sea. Samples were collected at depths of between 20-39 m within 3 miles of the coastal zone at 5 different locations using bottom trawling hauls by a fishing vessel during the fishing season of 2013-2014 (Figure 1).

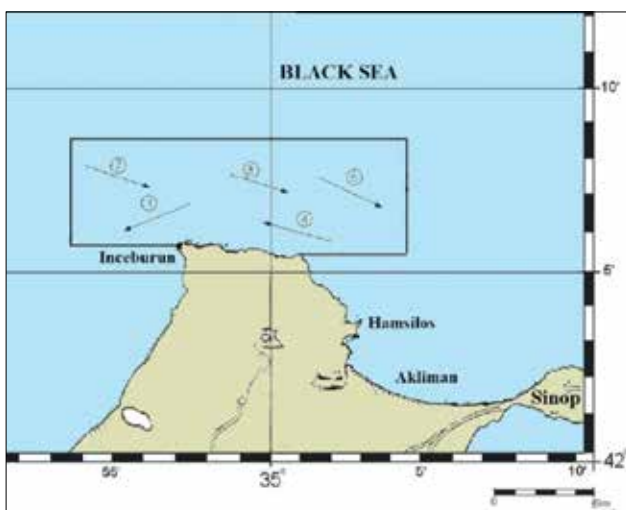


Figure 1. Trawl locations in the Sinop-Inceburun area (Black Sea)

The sizes of the trawl net used were as follows: head rope length – 10 m; mesh size – 44 mm. Haulings were carried out during daylight hours with 30-45 min hauling duration at a vessel speed of 3.66 km/h on the ground (Table 1). After each haul, the total catch was sorted and placed into boxes by species. After this process, biometric measurements of each species were taken.

Length-Weight Relationship

Equation 1 was used to determine length-weight relationship (22):

$$W = a * L^b \quad (1)$$

where;

W : Weight (g)

L : Total length (cm)

a and b : regression coefficients

Fulton's Condition Factor (K)

$$K = \frac{W}{L^3} * 100 \quad (23)$$

Biomass Estimation

Biomass was estimated using the swept area method. The swept area, a, can be calculated from equation 2 (24)

$$a = D * hr * X2 \quad (2)$$

$$D = V * t$$

where:

a : Swept area

V : Velocity of the trawl over the ground

X2 : Fraction of the head – rope length

hr : Headrope length

t : Duration of haul

D : Distance covered

Equation 3 (24) was used for the estimation of relative biomass, the catch per unit of area (CPUA)

$$CPUA = \frac{Cw}{a} \quad (3)$$

Where;

a : Swept area (km²)

Cw : Catch (kg)

Once caught, species were weighed and measured then stored in 4% formalin for laboratory analysis, excluding bigger fish. Specimens were classified using the identification keys of

Table 1. Information on trawl operations in the period of 2013-2014 in the Sinop-Inceburun region (Black Sea)

Hauls	Coordinate		Time		Total Duration (min)	Average Depth (m)
	Start	Finish	Start	Finish		
1	42° 7'48.47"N	42° 7'23.67"N	09:45	10:15	30	39
	34°57'42.84"E	34°56'36.23"E				
2	42°10'44.32"N	42°10'9.83"N	11:10	11:40	30	20
	34°53'46.37"E	34°54'42.27"E				
3	42° 9'41.56"N	42° 9'4.59"N	12:35	13:05	30	29
	34°57'44.13"E	34°58'36.74"E				
4	42° 6'15.19"N	42° 6'48.04"N	14:35	15:20	45	34
	35° 2'39.06"E	35° 1'42.31"E				
5	42° 7'56.96"N	42° 7'16.19"N	16:10	16:55	45	35
	35° 2'38.75"E	35° 3'21.51"E				

Table 2. Fish of Sinop coasts during the trawl operations in the period of 2013-2014 in the Sinop-Inceburun region (Black Sea)

Class	Ordo	Familia	Species	Common name	
Chondrichtyes	Myliobatiformes	Dasyatidae	<i>Dasyatis pastinaca</i>	Common stingray	
	Rajiformes	Rajidae	<i>Raja clavata</i>	Thornback ray	
Osteichtyes	Perciformes	Mullidae	<i>Mullus barbatus</i>	Red Mullet	
		Pomatomidae	<i>Pomatomus saltatrix</i>	Bluefish	
		Carangidae	<i>Trachurus mediterraneus</i>	Horse mackarel	
		Centracanthidae	<i>Spicara maena</i>	Blotched picarel	
		Trachinidae	<i>Trachinus draco</i>	Greater weever	
		Gobiidae	<i>Neogobius melanostomus</i>	Round goby	
			<i>Mesogobius batrachocephalus</i>	Toad goby	
		Uranoscopidae	<i>Uranoscopus scaber</i>	Atlantic stargazer	
		Sciaenidae	<i>Umbrina cirrosa</i>	Shi drum	
		Pleuronectiformes	Scophthalmidae	<i>Scophthalmus maximus</i>	Turbot
			Bothidae	<i>Arnoglossus laterna</i>	Mediterranean scaldfish
Soleidae	<i>Pegusa lascaris</i>		Sand sole		
Gadiformes	Lotidae	<i>Gaidropsarus mediterraneus</i>	Shore rocking		
Clupeiformes	Clupeidae	<i>Alosa agone</i>	Twait shad		
Scorpaeniformes	Scorpaenidae	<i>Scorpaena porcus</i>	Black scorpionfish		
Syngnathiformes	Syngnathidae	<i>Hippocampus hippocampus</i>	Sea horse		

Whitehead et al. (25), Fischer et al. (26) and Bat et al. (27). The specimens caught were classified to the smallest taxon according to the identification key. A literature study was carried out to gather information on the status of threatened fish species.

In order to gain insight into regional fishing activities and current issues in the region, local fishermen were interviewed to gather information concerning the condition of commercially utilized fish stocks and threatened fish species. Available pub-

lished papers were examined, particularly for species formerly present in the Sinop coasts of the Black Sea, and additional species were included into the inventory of native ichthyofauna.

Table 3. Calculated Fulton's Condition Factors for 9 fish species from trawl operations in the Sinop-Inceburun region (Black Sea)

Species	K	N
<i>Mullus barbatus</i>	1.15±0.14	188
<i>Pomatomus saltatrix</i>	0.91±0.01	100
<i>Trachurus mediterraneus</i>	0.86±0.02	56
<i>Uranoscopus scaber</i>	1.61±0.03	29
<i>Raja clavata</i>	1.64±0.01	28
<i>Scorpaena porcus</i>	1.93±0.08	22
<i>Trachinus draco</i>	0.20±0.07	8
<i>Gobius melanostomus</i>	1.27±0.05	20
<i>Gobius batrachocephalus</i>	0.84±0.04	4

RESULTS

In the survey; 16 teleost species from 15 families, 2 elasmobranch species from 2 families and 2 species of invertebrates were sampled (Table 2). Fulton's Condition Factor has been calculated and is illustrated in Table 3. The catch per unit area (CPUA) values of sampled fish of trawl operations in the Sinop-Inceburun region are shown in Table 4. The total mean CPUA

is estimated at 425.30 kg/km². The minimum, maximum and average length and weight values of each species are shown in Table 5. As tunicates, crabs and seahorses were released back to sea immediately after hauling, only the numbers of those samples were recorded (Table 6).

The main target species of bottom-trawl are whiting (*Merlangius merlangus*) and red mullet (*Mullus barbatus*) in the region. Whiting was not recorded in the hauls. Moreover, approximately 90% of total catch consisted of bycatch. 63% of the red mullet caught were under the legal catch size which is 13 cm. Furthermore, red mullet was the most abundant species in terms of individual numbers.

Table 4. Estimated CPUA values of fish samples in the Sinop-Inceburun region during the surveys in the fishing period 2013-2014.

Species	CPUA (kg/km ²)					
	Stations					
	I.	II.	III.	IV.	V.	Average
<i>Mullus barbatus</i>	69.02	55.30	24.54	2.33	33.92	37.02±11.68
<i>Pomatomus saltatrix</i>	70.93	2.62	0	23.13	110.05	41.35±21.37
<i>Trachurus mediterraneus</i>	18.25	5.41	2.35	7.98	1.09	7.02±3.05
<i>Uranoscopus scaber</i>	17.54	12.46	20.38	5.94	13.37	13.94±2.46
<i>Dasyatis pastinaca</i>	8.96	470.93	50.00	59.89	182.26	154.41±84.25
<i>Scorpaena porcus</i>	0	0	0	25.17	0	5.03
<i>Neogobius melanostomus</i>	36.12	0.00	0.00	12.20	6.19	10.90
<i>Trachinus draco</i>	0.00	7.27	1.91	0	1.46	2.13
<i>Mesogobius batrachocephalus</i>	17.87	0	0	0	0	3.58
<i>Scophthalmus maximus</i>	0	2.62	12.57	3.39	0	3.71
<i>Umbrina cirrosa</i>	0	44.64	17.49	0	0	12.43
<i>Spicara maena</i>	0	0	0	0.40	1.09	0.30
<i>Raja clavata</i>	493.83	0	0	128.93	39.78	132.51
<i>Pegusa lascaris</i>	0	1.75	0	0	0	0.35
<i>Arnoglossus laterna</i>	0	0	0	0.55	0	0.11
<i>Gaidropsarus mediterraneus</i>	2.62	0	0	0	0	0.52
Total	735.14	603.01	129.23	269.91	389.22	425.30±109.69

Table 5. Total length and weight values (means \pm SE) of fish species obtained from trawl operations in the Sinop-Inceburun region (Black Sea)

Species	N	Min. Length (cm)	Max. Length (cm)	Mean \pm SE	Min. Weight (gr)	Max. Weight (gr)	Mean \pm SE
<i>Mullus barbatus</i>	188	3.8	18.5	12.07 \pm 0.18	2	64	19.78 \pm 0.84
<i>Pomatomus saltatrix</i>	100	12	22.9	17.43 \pm 0.21	12	110	50.02 \pm 1.81
<i>Trachurus mediterraneus</i>	56	8	18	11.18 \pm 0.26	3	58	12.95 \pm 1.07
<i>Uranoscopus scaber</i>	29	9.5	20.4	14.1 \pm 0.46	12	150	50.07 \pm 5.72
<i>Raja clavata</i>	28	20	46	31.64 \pm 1.11	121.83	1699.58	583.76 \pm 67.02
<i>Scorpaena porcus</i>	22	8.5	17	11.67 \pm 0.40	15	62	31.41 \pm 2.64
<i>Neogobius melanostomus</i>	20	11.4	22.8	15.96 \pm 0.57	20	170	58.3 \pm 7.03
<i>Trachinus draco</i>	8	11	18	15.86 \pm 0.41	15	35	26 \pm 1.23
<i>Mesogobius batrachocephalus</i>	4	20.5	22.2	21.3 \pm 0.13	70	105	81.75 \pm 2.93
<i>Scophthalmus maximus</i>	3	15	24	19.3 \pm 0.84	48	93	70.5 \pm 5.91
<i>Umbrina cirrosa</i>	2	20	42	31 \pm 2.89	200	817	508.5 \pm 81.02
<i>Spicara maena</i>	2	9.5	15	12.25 \pm 0.72	11	30	20.5 \pm 2.49
<i>Dasyatis pastinaca</i>	3	40	78	58.67 \pm 3 .53	63.79	9036.68	4555.94 \pm 757.54
<i>Pegusa lascaris</i>	1	-	-	16.5	-	-	32
<i>Arnoglossus laterna</i>	1	-	-	12.5	-	-	15
<i>Gaidropsarus mediterraneus</i>	1	-	-	19	-	-	48

Table 6. Numbers of Tunicates, Sea horses and Crabs by Stations.

Species	I. Station	II. Station	III. Station	IV. Station	V. Station	Total
<i>Ascidia aspersa</i> (Tunicate)	320	18	-	-	-	338
<i>Hippocampus hippocampus</i> (Seahorse)	11	2	1	-	-	14
<i>Liocarcinus depurator</i> (Crab)	63	124	80	250	95	612

Length–Weight relationships of sampled fish which were of sufficient sample size are illustrated in Figure 2. Red mullet, horse mackerel (*Trachurus mediterraneus*) and black scorpionfish (*Scorpaena porcus*) showed negative allometric growth while bluefish showed isometric growth. The average length values of red mullet which is the target species of demersal trawl were as follows; 12.01 cm, 12.06 cm, 10.75 cm, 10.15 cm, 13.89 cm respective to station number. The average length of red mullet specimens caught in Station V was significantly higher than those derived from other stations according to the One-Way Anova statistical test ($p < 0.05$).

DISCUSSION AND CONCLUSION

In the present study bottom trawler fishing in the region of the Sinop coast reveals very small numbers of the target species. The majority of commercial fish species were Red mullet

followed by Turbot (*Scophthalmus maximus*) and Thornback Ray (*Raja clavata*) (see Table 4).

Rays and sharks are usually seen as unwanted fish species which are discarded due to the fact that they are not consumed in the domestic market. Several pelagic fish species such as Bluefish (*Pomatomus saltatrix*) and Twaite shad (*Alosa agone*), are also accidentally caught in bottom trawl fisheries but they are generally discarded excluding those large enough to be commercially marketed.

Sinop which is located on the Boztepe Peninsula is the northernmost point of the Turkish Black Sea coast and is referred to as the midpoint of the Black Sea. The fact that three sides of the city of Sinop are surrounded by the Black Sea has made fishing an important industry. Gerze, Ayancik and Türkeli are seaside districts of Sinop provincial (10).

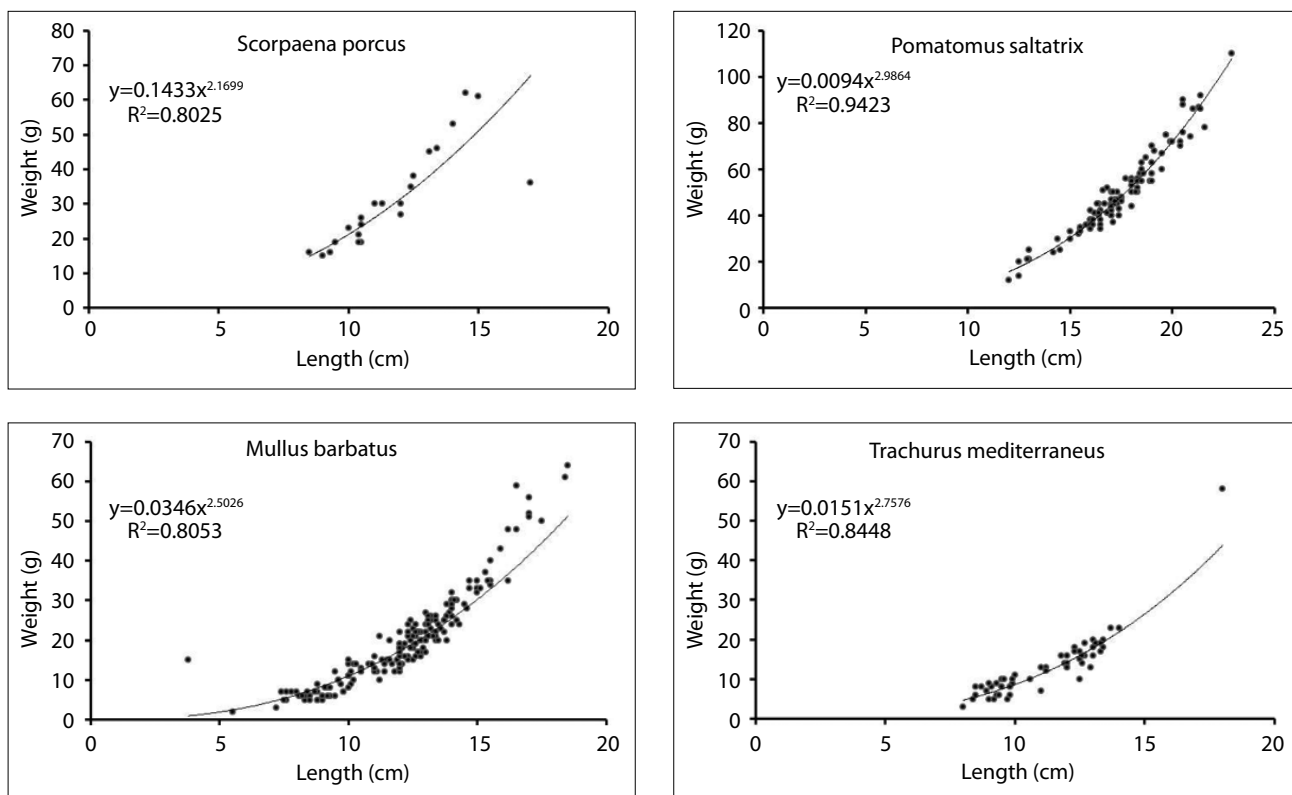


Figure 2. Length–weight relationships for *S. porcus*, *P. saltatrix*, *M. barbatus* and *T. mediterraneus* from the Sinop-Inceburun (Black Sea) during the trawl surveys in the fishing period 2013-2014.

Commercial fishing is carried out in two ways; large-scale (purse seine and trawl fisheries) and small-scale (fishing boats smaller than 12 m which operate gillnet, fishing line etc.). A considerable amount of the anchovy captured in the Black Sea is along the Sinop coast.

The length-weight relationship is widely used in the analysis of fishery data (28, 29), mostly because of the difficulty and time required to record weight in the field (30). The relationship is often used to convert growth-in-length equations for prediction of weight-at-age and used in stock assessment models (31), to calculate condition indices (32) and for lifetime and morphological comparison of populations from various regions (33). In the equation; $b = 3$ refers to isometric growth, $b < 3$ or $b > 3$ refers to allometric growth.

Data concerning the marine fish of the Sinop coast is limited. Information on local fish faunas is scarce. A total of 94 species of 44 families along the Sinop – Samsun coastline have been identified (34). Gönener and Bilgin (35) reported that whiting, horse mackerel, red mullet, turbot, black scorpion fish, Thwaite shad, picarel (*Spicara maena*), picked dogfish (*Squalus achantias*), thornback ray and goby (*Gobius* sp.) were sampled with bottom-trawl in the Sinop-Inceburun area during the 2007 and 2008 fishing seasons. Similarly, Gönener and Özdemir (36) studied annual, monthly and daily catch amounts from the Sinop-Inceburun region during the 2008 and 2009 fishery seasons. They found whiting, red mullet, turbot, shad, picarel, horse

mackerel, shark and goby (*Gobius* sp.) in the same region of the Black Sea. Sampled species are similar to the current study except for whiting. Whiting could not be caught in our study, which may be due to the fact that the hauling was performed in shallow waters.

A sum of 3455 authorized fishermen and 536 fishing boats are present in the Sinop region with ports like Gerze and Ayancık (37). Fishing operations continue throughout the year depending on with meteorologic conditions and the fishing season lasts between 60 and 270 days. The quantity of catch varies. The areas in which seaside fishing operations take place are Akliman, Sarkum, Inceburun and Gerze (Çakıroğlu) (37).

As a consequence of eutrophication caused by a rise in the influx of nutrients from large northwest rivers over the past several decades, the Black Sea environment has changed considerably. The effects of the change in nutrient levels can be seen in the quality of biota with the inclusion of ichthyofaunal (34). The Black Sea has a fairly straight continental shelf and very weak oxygenated surface thickness and a eutrophic structure which provides a habitat for pelagic fishes. There is an increase in the fish composition caught at depths in which small pelagic fish constitute more than 90% of the total amount (38). Bottom trawls are an extremely effective fishing technique in demersal fishing with a catch rate of 60% (39). The most profitable sea yields off the Black sea coasts include pelagic species such as anchovy, horse mackerel, sprat, bluefish, bonito, benthic fish such as red mul-

let, whiting, turbot as well as and sea snails and mussels, (40). The fish caught in the Sinop area are generally of similar species. Moreover, the Black Sea, particularly around the Sinop shores is one of the best spawning fields for whole commercial fish species, including predator species, which migrated for spawning or feeding (34). It is indicated that marine fishery accounts for 76% of the total production of Turkish fisheries in 2007 (41). With respect to TUIK (5) anchovy accounts for 67% of the Black Sea fishing catch and 49% of fisheries in Turkey. Thus, variations in the distribution of anchovy and the amount of catch in any given fishing season have a serious influence on overall yearly fishing quantity (40). To support the fishing industry, the Turkish Government have implemented 1) a tax relief scheme for the diesel oil used in fishing vessels and 2) a subsidized credit scheme for fishermen (35). Gücü (38) claimed that reducing the expense of fishing has, to some extent, eased the situation for the fisheries, however, on the other hand, it has had a harmful effect on fish stocks. In general, fishing in Turkey, including in the Sinop region, operates on a diurnal basis, fishing in deep waters during the day and then returning to harbor (42). Moreover, it is rather apparent that the Black Sea area including the Sinop coast has a substantial effect on total production of marine fish of Turkish fisheries and Sinop fisheries constitute an important fishery industry and contribution to employment. There is an improvement in the availability of catch and biological data for economic species caught from the Sinop coast of the Black Sea. It should be noted that bio-ecologic information on capture and working statistics for all commercial fishing is still extremely limited. Therefore, it is suggested that further research to be carried out before any outcome is drawn.

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Conflict of Interest: The authors have no conflict of interest to declare.

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