www.trjfas.org
ISSN 1303-2712
Turkish Journal of Fisheries and Aquatic Sciences 17: 387-394 (2017) DOI: 10.4194/1303-2712-v17_2_18

RESEARCH PAPER

The Common Problem in the Black Sea Fisheries: By-catch and Its Effects on the Fisheries Economy

Nazli Kasapoglu[1], Ertug Duzgunes[2]

[1] Central Fisheries Research Institute, Fisheries Management, Trabzon, Turkey.
[2] Karadeniz Technical University, Fisheries Technology Engineering, Trabzon, Turkey.

* Corresponding Author: Tel.: +90.505 387 0540;
E-mail: nazliktu@gmail.com

Received 22 August 2016
Accepted 17 October 2016

Abstract

In this research, bycatch rates of industrial and artisanal fishing gears were determined for the Turkish Black Sea fisheries. Surveys were conducted in 9 major fishing locations along the Black Sea coast (from Istanbul to Artvin) between December 2008 and December 2011. Data provided from to the fishing operations have shown that bycatch rates as the proportion of bycatch weight to total catch weight were calculated as 30% for gill nets, 37% for purse seines, 62% for trawls and 19% for hydraulic dredges. Bycatch rates in number of fish basis were also detected as 34% for gill nets, 11% for purse seines, 62% for trawls and 23% for hydraulic dredges. All figures indicate that there is rather high impact of fishing gears on exploited stocks causing growth and recruitment overfishing. It is very important to reduce bycatch rates for sustainable fisheries by using more selective fishing methods. As a result of the comprehensive surveys, some practical management advices was provided for the fisheries management authority in order to increase selectivity of the gears and reduce bycatch rates for the sustainable of the living resources in the Black Sea.

Keywords: Bycatch, Gill Nets, Purse Seine, Trawl, Hydraulic Dredge.

Introduction

The Black Sea has less diversity but more abundant in terms of each species. For this reason, industrial fishing methods (trawling and purse seining) are often used in the Black Sea. 70% of Turkish fishery production is obtained from the seas, and Black Sea provides 80%of total production (Turkish Statistical Institute, TSI, 2013). Bycatch is a global problem for all types of fisheries. Many researchers seen not bycatch a new problem, but evaluate the solutions for it as new (Alverson *et al*., 1994). Reduction of bycatch is important for The Common Fisheries Policy (CFP) of European Union. Alverson *et al*. (1994) reported that 93 million tons seafood was caught in the world in 1994 and 28.7 million tons (30%) of it was reported as bycatch. Later, Kelleher (2005) estimated the amount of discard as 7.3 million tonnes (8%). Saila (1983) stated quantity of bycatch and discards for the Mediterranean and The Black Sea as 0.3 and 0.3 millions of tones, respectively. Alverson *et al*. (1994) estimated the discard amount as 0.6 millions of tons in the same area. Discard value for Mediterranean and Black Seas was determined as 24% of the 1.5 million tons of the recorded catch. This information emphasizes the lack of knowledge for the area 37th of the FAO relating to bycatch. Moreover, Turkey is defined on the country list with no discard report within the Black Sea countries. FAO report also emphasizes the shortage of bycatch data in the Black Sea and the Mediterranean. Therefore, this research aimed to provide information contribute data for the scientific community, fishery managers and organizations and the impact of fishing gears used in the Black Sea fisheries and technical advices of reducing untargeted catch of species and undersized individuals.

Materials and Methods

Bycatch material obtained from the commercial fishing operations; namely trawls (14 surveys), purse seines (15 surveys), dredges (67 surveys) and gillnets (36 surveys) in nine stations (Hopa (Artvin), Rize, Trabzon, Giresun, Ordu, Samsun, Sinop, Karasu (Sakarya), Şile (Istanbul)) located on the coast of the Black Sea between December 2008 and December 2011 (Figure 1). Sampling was carried out from each type of fishing vessel by collecting of bycatch species separated. After separation process, bycatch species were sampled, weighed and counted. Samples were

kept in cold store of the vessel at +4 °C before transportation, and then they were kept in freezers at -18 ° C until laboratory studies. Samplings were realized via gillnets (mesh size 17 or 18 mm), purse seines (mesh size in the bunt is usually between 5.5 to 6.5 mm for anchovy, 12-15 mm for horse mackerel and 24-28 mm for Atlantic bonito), bottom trawls (cod-end mesh size varies between 20-24 mm), hydraulic dredges (3.5 m width and 8.5 mm bar distance). Samples were weighed with 0.01 g precision, total lengths were measured to the nearest 0.1 cm, and shellfish and crustaceans were measured (total length, width, thickness and carapace length) with digital callipers with 0.01 mm sensitivity. Classification of total catch, targeted catch and bycatch were made according to the definitions given below;

- Total catch: All living and dead materials caught with fishing gears
- Targeted Catch: Amount of a species over minimum landing size with certain fishing gear for a given fishery
- Bycatch: Amount of untargeted catch (discards due to any reason and undersized individuals of the targeted species)

In order to calculate bycatch rates, the equation given below was used (Sparre and Venema, 1998; Matsuoka, 1999).

$$r_h = D_h/C$$

In this equation: D_h: Bycatch quantity (numbers and weight), C: Total catch, r_h: Bycatch rate (%). Catch per Unit Effort (CPUE) was calculated for targeted catch and bycatch, separately using the method of CPUE by Phiri and Shrikihara (1999).

$$CPUE = \frac{\sum C_i/N_h}{\sum t/N_h}$$

C_i: Quantity of catch in each operation (kg), t: Active operation time (hour), N_h: Number of operations

Results

In the survey, out of 132 operations 51% were carried out with hydraulic dredges due to shortest operational time during each haul. In the rest of operations, gillnets, purse seines and bottom trawls were accounted as 27%, 11% and 11%, respectively. This research represents the results obtained from sub-sampling after 132 fishing operations consisting 36 species, 111.76 kg (5193 individuals) in total. The majority of the samples were found anchovy as 31%, followed by whiting as 16% and Mediterranean horse mackerel as 12%. The great part of catch was whiting and stingray (18% each) followed by Atlantic bonito (12%). Samples contained 29 finfish, 3 bivalvia, 1 mollusc, 2 crustaceans and 1 chondrichthyes species (Table 1). Commercially important species are red mullet, anchovy, whiting, Mediterranean horse mackerel, Atlantic bonito, shad, garfish and striped red mullet for the Black sea fisheries. Moreover, the protected species such as seahorse caught by bottom trawls whilst sturgeon and gurnard are occasionally seen in the catch composition of gill nets.

Gillnets

Analysis of gillnet operations were carried out with bottom gillnets (67%), trammel nets (25%), surface gill nets (3%) and Atlantic bonito gillnets (5%). Total amount of samples provided by gillnets was 309 kg (12583 individuals) and the overall bycatch weight was 91 kg (4263 individuals). The highest bycatch rate was observed in weight in Hopa, in numbers in Rize. In terms of depth, bycatch rate was higher in shallow waters than deeper by using

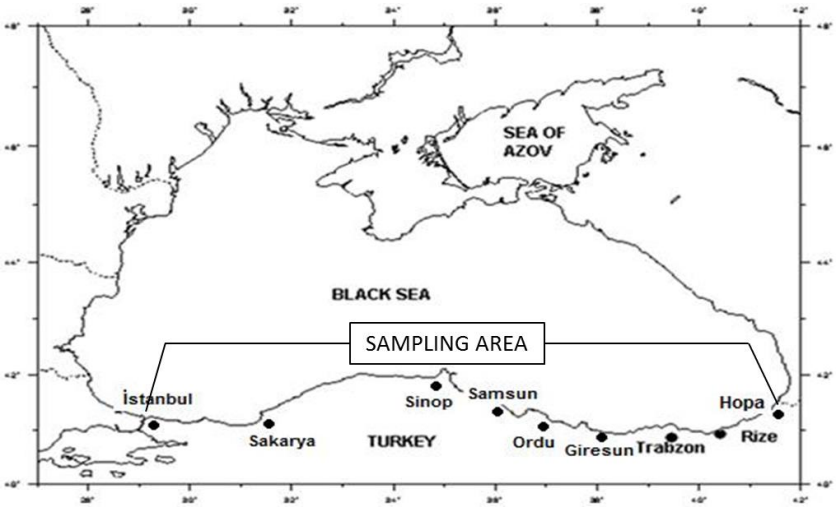

Figure 1. Sampling Area.

bottom gillnets. Figure 2 shows that bycatch rate at 70 m depth is lower than 60 m in all sampling locations. The results of trammel net samplings were calculated as 43 kg (1177 individuals) and bycatch was estimated as 25 kg (500 individuals). Bycatch rate was obtained from the trammel nets as "in weight" as 58% and "in number" as 43%. Bycatch rate was found lower in 18 m depth than 15 m. Lower amount was obtained with the samplings of Atlantic bonito gillnets as 7.2 kg (50 individuals) in total. Bycatch rate was obtained from the Atlantic bonito gillnets as 7% in weight and 66% in number basis. Surface gillnet sampling was only carried out at Trabzon station. As a result of operations, total catch was 60 kg (7762 individuals) which is equal to 12% in weight and 26% in number basis.

Purse Seine Nets

As a result of observations on 15 anchovy purse seine operations, the total amount of bycatch in purse seine nets was calculated as 35798 kg and 859406 individuals. The highest bycatch rate was observed in Trabzon and Ordu in weight and number of individuals, respectively. On the other hand, the lowest values were obtained in Hopa (Table 2). Bycatch rates were significantly different by the sampling locations ($p < 0.05$) and shown in Figure 3. Due to abundance of anchovy in the purse seine nets, sub-sampling strategy was realized. The results of anchovy purse seine samplings showed that 23% of samples were under the minimum catch size of anchovy (9 cm). Red mullet has high economic value in the market and accepted as bycatch for the purse seine nets. Its minimum landing size is 13 cm and total amount of red mullets (100%) caught by purse seine nets were under 13 cm. Mediterranean horse mackerel and whiting are also commercially important species. Bycatch rate of these species were calculated as 98% and 93%, respectively. The highest bycatch rate in numbers was found in 20 m depth and the lowest in 45 m depth (Figure 3).

In horse mackerel purse seine operations, the amount of bycatch was calculated as 3749 kg (184084

Table 1. Species obtained from the sub-sampling

Scientific name	Number	%	Weight (kg)	%
Anadara inaequivalvis	50	0.96	0.22	0.20
Mullus barbatus	611	11.77	10.95	9.80
Sprattus sprattus	156	3.00	0.61	0.55
Solea lascaris	68	1.31	0.95	0.85
Hippocamous guttlulatus	27	0.52	0.06	0.05
Syngnathus acus	1	0.02	0.002	0.002
Rapana venosa	21	0.40	0.35	0.31
Gaidropsarus mediterraneus	19	0.37	0.77	0.69
Engraulis encrasicolus	1588	30.58	12.83	11.48
Parablennius tentacularis	1	0.02	0.04	0.04
Scorpaena porcus	33	0.64	2.02	1.81
Diplodus annularis	6	0.12	0.03	0.03
Trachurus mediterraneus	623	12.00	10.84	9.70
Ostrea edulis	1	0.02	0.002	0.002
Spicara smaris	77	1.48	2.54	2.27
Crangon crangon	13	0.25	0.03	0.03
Ophidion barbatum	5	0.10	0.25	0.22
Chelidonichthys lucerna	1	0.02	0.03	0.03
Gobius niger	30	0.58	0.69	0.62
Neogobius melanostomus	126	2.43	3.47	3.10
Chamelea gallina	617	11.88	0.15	0.13
Symphodus ocellatus	1	0.02	0.02	0.02
Pomatomus saltatrix	25	0.48	0.75	0.67
Acipencer stellatus	3	0.06	0.13	0.12
Merlangius merlangus	834	16.06	20.46	18.31
Sarda sarda	36	0.69	13.84	12.38
Platichthys flesus	12	0.23	1.19	1.06
Atherina boyeri	1	0.02	0.01	0.01
Mullus surmuletus	39	0.75	0.94	0.84
Alosa fallax	65	1.25	3.53	3.16
Uranoscopus scaber	44	0.85	3.24	2.90
Trachinus draco	6	0.12	0.28	0.25
Raja clavata	17	0.33	20.12	18.00
Mesogobius batrachocephalus	1	0.02	0.16	0.14
Liocarcinus vernalis	31	0.60	0.20	0.18
Belone belone	4	0.08	0.06	0.05
Total	5193	100.00	111.76	100.00

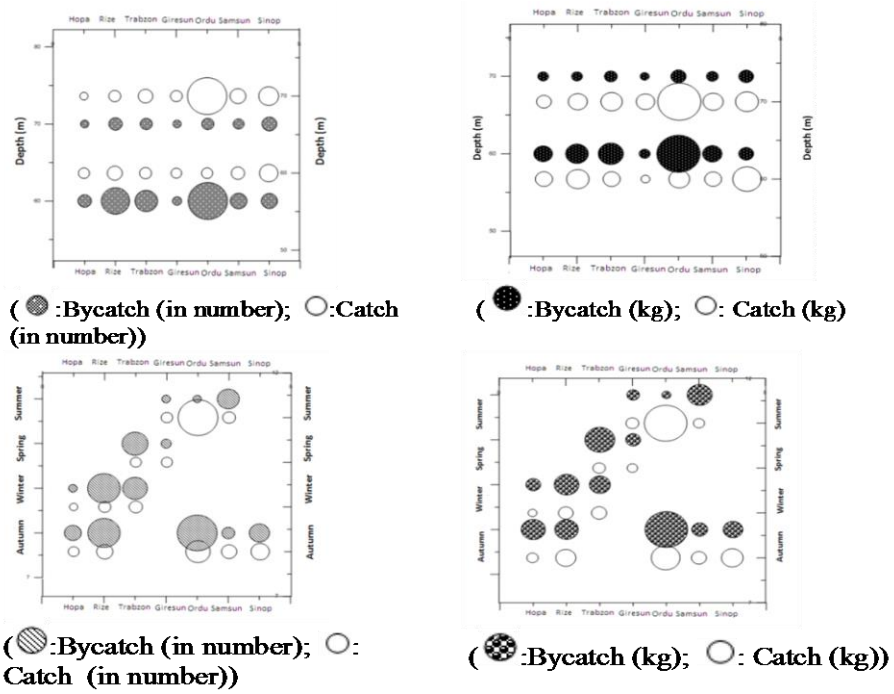

Figure 2. Bycatch distribution according to depth and season in the bottom gillnets.

Table 2. Bycatch distribution in the anchovy purse seine

Station	Bycatch		Target Catch		Bycatch Rates (%)	
	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Hopa	0	0	20000	2170233	0	0
Rize	1439	357810	20531	2256146	7±3.07	14±13.44
Trabzon	33826	332779	10590	1094732	76±6.0	23±13.0
Giresun	665	157815	10735	1217943	6±0.52	12±0.71
Ordu	31	7453	194	20729	14	27
Samsun	16	3549	194	20347	8	15
Total	35978	859406	62243	6780129	37±28.7	11±9.8

± *represents SD*

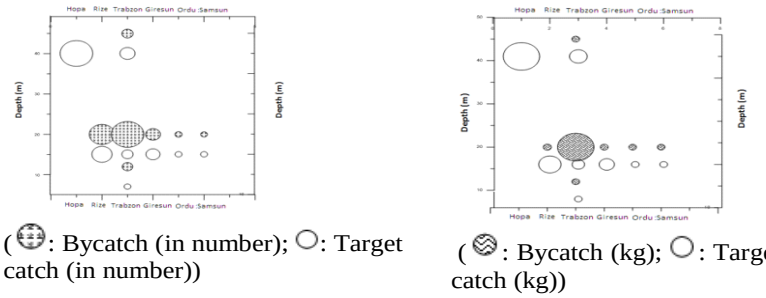

Figure 3. In number and in weight bycatch according to depth obtained by the anchovy purse seine operations.

individuals). The highest rates in terms of weight and numbers were observed in Hopa station (Table 3). Thirty eight percent of Mediterranean horse mackerel samples were observed as below the legal catch size. Red mullet is also accepted as bycatch for the horse mackerel purse seine fisheries and represented by 28% (in number basis). Bluefish is one of the predator migratory species having high economic value and it is not a targeted species for horse mackerel purse seine nets. Bycatch rate of bluefish was 100% in number and 8% in weight basis.

Atlantic bonito purse seine operation was realized in Sinop station; a total of 300 kg, 1711 individuals were caught and 34 kg, 1079 individuals were accepted as bycatch. It was equal to 11% in weight and 63% in number basis. It is interesting to

note that all untargeted species were below the minimum legal catch size while targeted Atlantic bonito size was higher than this value.

Bottom Trawls

Bottom trawls are widely used in the central and western Black Sea. Samplings were carried out mainly in Ordu, Samsun and Sinop coastal waters. As a result of surveys, 1095 kg (33076 individuals) were caught in total by bottom trawl net operations and 678 kg (16463 147 units) of it was determined as bycatch. The highest bycatch rate was observed in weight in Ordu and in numbers in Sinop stations (Table 4). According to the sub-samples taken from each operation, the length of the targeted species red mullet and whiting were found under the minimum catch size with 25% and 20%, respectively. The results showed that out of 20 different species found in bottom trawl nets 18 of them are untargeted species. Although anchovy and Mediterranean horse mackerel were found in the nets over the minimum legal catch size, all bluefish individuals were observed below its legal size. The highest CPUE was calculated in Samsun for the targeted catch (107.3 kg/s) and in Sinop (29.60 kg/s) for bycatch.

Hydraulic Dredges

Hydraulic dredges are mainly used to harvest baby clams in western Black Sea in certain areas which rotationally used for fishing. Main species were baby clam (*Chamelea gallina*) (90%), *Anadara cornea* (7%) and swimming crab (*Liocarcinus vernalis*) (3%) in all operations. The highest bycatch rate was in Sakarya as 34% in weight and in Sile as 69% in numbers. It is legally obligatory that the catch under the permitted size must be separated from the legal sized catch during hydraulic dredge operations. Normally the individuals below legal catch size were released back to the sea and samples collected from selected and unselected catch properly for further laboratory studies. In selected samples, bycatch rates were calculated as 5% in weight and 23% in numbers in Sile, % 14 and % 15 in Karasu, respectively. Bycatch rate in unselected samples were accounted as 19% in weight and 38% in number in Sile, and 37% and 38% in Karasu, respectively.

Discussion

In total, out of 109 tons of total catch obtained in 132 sampling operations, 41 tons are classifies as bycatch (37%) in different fishing gears. Bycatch rate for bottom gillnets was calculated as 30% in weight basis for the bottom gillnets. Kelleher (2005) reported bycatch rate as 15% for gillnets used in the Mediterranean and the Black Seas. In trammel nets bycatch rate was found (58%) which is 8 times higher than Kelleher's (2005) report (7.4%). It is important that bycatch rate of gillnets used for Atlantic bonito was 7%, there were too many untargeted species as sea horse, rapa whelk, sole, anchovy, horse mackerel and crabs. However, bycatch rate of other pelagic gillnets used for horse mackerel was determined as 12%. Kale (2008) reported that bycatch rate of pelagic gillnets as 17% in the Aegean Sea. The difference between these rates can be attributed to the variations in the biodiversity and habitat of two seas. In weight basis, bycatch rates in purse seines for horse mackerel, Atlantic bonito and anchovy were calculated as 8%, 11% and 37%, respectively. Alverson (1994) reported bycatch rate in the anchovy purse seine operations as 3%. Kelleher reported (2005) bycatch rate for the anchovy purse seine as negligible in that non-targeted quantity has been used in fishmeal and oil industry in the Black Sea and the Mediterranean regions. However, accepting bycatch

Table 3. Bycatch distribution in the horse mackerel purse seine operations

Station	Bycatch		Target Catch		Bycatch Rates (%)	
	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Hopa	1753	53916	1072	3845	62±0.70	93±0.71
Trabzon	544	38588	21480	80234	3	33
Ordu	1452	91510	20938	86562	7	51
Total	3749	184084	43489	170641	8±1.06	52±37.76

± *represents SD*

Table 4. Bycatch in the bottom trawl

Station	Bycatch		Target Catch		Bycatch Rates (%)	
	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Ordu	277	3692	93	5290	75±3.7	41±6.2
Samsun	287	6771	188	6805	60±7.8	50±8.2
Sinop	114	6000	136	4519	46	57
Total	678	16463	417	16614	62 ±13.2	50 ±7.4

rate as low for the purse seine nets used to catch anchovy, Mediterranean horse mackerel and sprat in the Black Sea ecosystem, affecting on the stocks causing recruitment and growth overfishing is not a realistic approach. Ceylan (2011) stated that bycatch rate as 2.1% for purse seine net in the western part of the Black Sea while Genc *et al*. (2010) found this rate as 9.85% in the same area. The main reasons of low rates studies mentioned can be summarized as the fact that small fish were not accepted as bycatch and they were available to be processed as fish meal and oil. Additionally, failures were made in the sampling strategy as the samples were provided from fish market instead of the purse seine net. Good sampling procedures is very important to estimate fishing stocks for the sustainable fisheries since bad sampling can cause over estimation of fish population biomass leading to over fishing. Due to having a very short life span, inappropriate sampling procedures of the stocks may be one of the main reasons of the decrease in anchovy production in the Black Sea. Ayyildiz (2006) reported that bycatch rate was estimated as 25.3% in purse seine in the Aegean Sea. This result is lower than the present survey though biodiversity is higher in the Aegean Sea (Table 5). The difference can be explained with the existence of different targeted and untargeted species living in the sea. Namely, chub mackerel, Atlantic mackerel, Mediterranean horse mackerel, scad, bogue, bluefin tuna, frigate tuna, sardine and anchovy are assumed as targeted species in that research. Actually, there is definitional difference in the concept of bycatch in fisheries science as to accept all untargeted species as targeted if they have any market value. This assumption may be too dangerous for the management of Aegean fisheries by giving damage to the endangered species not releasing back to the sea due to its commercial value. However, anchovy is the main component of the small migratory species in the Black Sea formed single schools (may mixed with sprat in negligible volumes). That's why the bycatch rate (37%) is too high in the region due to schools mixed with undersized anchovies following the bigger pioneers at the beginning of the anchovy fishing season.

In case of bottom trawl fisheries in the Black Sea, bycatch rate was found significantly higher (62%) than Saila (1983) (47%), Alverson *et al*. (1994) (4%) and Kelleher (2005) (45-50%). Ceylan (2011) calculated bycatch rate in the Western Black Sea as 42%; Soykan (2011) 38% for the Aegean Sea and Malal (2008) 56% for the Mediterranean Sea. The high bycatch rate in the Black Sea can be evaluated as a major threat for the future of exploited stocks and biodiversity (Table 5).

Hydraulic dredges are widely used to harvest baby clam in Adriatic Sea, and invasive mollusc and crustacean species in USA. Bycatch rate was reported as 11.5% in the Adriatic (Kelleher, 2005). Untargeted harvest is more than this figure (19%) in the Western Black Sea in baby clam fisheries. Daily quota and the total amount of catch taken from the sea is quite high using hydraulic dredge in Turkey. In order to reduce the impact of the hydraulic dredges on benthic ecosystem and baby clam stocks, designated areas are closed once every two years due to restoration of the stocks. However, this measure is not sufficient for the renewal of the stocks, and there is another option as to use traditional dredges instead of hydraulic ones for more selective harvesting and better protection of the bottom habitat among fishermen. This will also increase their earnings by harvesting fewer quantities.

The most striking results were found in fishing operations carried out in different depths. Bycatch rate in the coastal areas are lower than the deeper locations using trammel nets, bottom gillnets, bottom trawls and purse seine nets. Therefore, the use of trawls and purse seines should be obligatory for the deeper waters in the Black Sea ecosystem. Trawl nets should not be permitted within the 3-miles zone while purse seining needs to be permitted over 24 m depths and new decisions are needed to increase this range in order to better protection of the nursery areas and migrating young small fish species in the coastal zone. There is no effective control measures on artisanal fisheries which is allowed throughout the year although industrial fisheries conducted with some management regulations as closed season, no fishing zones, fish size and gear technical

Table 5. Comparison of the bycatch rates

Research	Areas	Gillnets				Trawl	Purse seine	Dredge
		Bottom gillnets	Pelagic gillnets	Trammel nets	Atlantic bonito nets			
Saila (1983)	World					47		
Alverson (1994)	World					4	3	
Kelleher (2005)	Mediterranean and Black Sea	15		7.4		45-50	negligible	11.5
Ceylan (2011)	A part of the Black Sea					42	2.1	
Genç vd., (2010)	East Black Sea						9.85	
Soykan (2011)	Aegean Sea					38		
Kale (2008)	Aegean Sea		17.18					
Ayyıldız (2006)	Aegean Sea						25.3	
Malal (2006)	Mediterranean Sea					56		
This study	Black Sea	30	12	58	7	62	37	19

specifications. According to the results of this study, bycatch rate was found lower in bottom gillnets in the summer season. However, it is an indication of the catch of spawning stock in the reproduction period, which reduces the rate of recruitment. Bycatch rates were found high in all types of fishing gears in the Black Sea. Therefore, it is better to increase their selectivity or find out new selective fishing gears in order to reduce bycatch. Gillnets over 1 piece of net should be prohibited for recreational fisheries in coastal areas which is very important for young stages of all species as feeding and protection for fish (10-15 m depth).

High bycatch rates affect socio-economic situation of the fishermen causing losses in salaries and employment. A total anchovy landing for 2011 was about 205243 tons and bycatch rate in weight was 37% (75.940 tons) (TSI, 2012). Considering the average weight for anchovy (8.12 g) for the same year, total bycatch in numbers can be calculated as $25x10^9$ individuals consisting of 23% undersized anchovies and this ratio equals to $5.8x10^9$ fish. According to the 2011 market prices, total value of anchovy bycatch was roughly estimated as $87x10^6$ TL (1.84 Turkish Liras/kg given for anchovy).

Growth and recruitment overfishing will heavily affect anchovy stocks near future. Also, their market value will be high comparing the young ones to be processed for fishmeal and oil. This will increase the income of the fishermen as they expected. It is also the same for the Mediterranean horse mackerel case, which has more commercial value than anchovy in the region. Total catch in the Black Sea was 14393 tons and bycatch rate was calculated as 8% (1151 tons). If weight converted to number of fish in bycatch (mean weight 20.86 g), it can be said that $2.5x10^8$ horse mackerel had been taken from the stock below the legal size. It is the loss of fishermen for the following year's income. If the same fishing strategies have been continued, the ecosystem will collapse and economic losses will fold in the next decades. The negative effects of bycatch on the ecosystem will be better understood when the decline of these two important species abundance are observed. They have significant roles in the food web to feed other fish species located at higher trophic levels such as blue fish, Atlantic bonito and Atlantic mackerel that their abundances are closely related with the abundance of anchovy and horse mackerel. So, it is better to apply selective fishing methods to save the next generations of the same species, keep as feed for the use of large fish species and all will let fishermen increase their incomes from the Black Sea.

Conclusion

In this study we aimed to determine bycatch rates in the purse seine, trawl, gill net and hydraulic dredge fisheries in order to demonstrate of effects on the living resources in the Black Sea. Another important aim of this research is to provide data for scientific community as its absence in the Black Sea was reported by FAO. Data was provided from commercial and artisanal vessels using various gill nets in order to use as indicators to estimate the damage given to the fish stocks.

It is better to conduct new studies to determine the selectivity of all types of fishing gears used in Turkish fisheries. As a next step, the re-evaluation of the minimum allowable catch size of economically important species is essential. Finally, new types of more selective catching techniques should be introduced in fisheries as mid-water trawl for pelagic, traps for shellfish and crustaceans, and redesigning of current gears not to allow catching small fish, protected fish, mammals and other marine living organisms as well as sea birds.

Acknowledgements

This article has been prepared using data obtained by a project supported by the Karadeniz Technical University Scientific Research Fund (2008.117.001.1).

References

Alverson, D. L., Freeberg, M. H., Pope, J. G. and Murawski, S. A. 1994. A global assessment on fisheries bycatch and discards. FAO Fisheries Technical Paper, No 339, Rome, 136 pp.

Ayyildiz, H. 2006. Investigation of purse seine bycatch composition in North Aegean Sea. MSc. thesis. Çanakkale: Çanakkale Onsekiz Mart University.

Ceylan, Y. 2011. Determination of non-target species and discard rate of bottom trawl and purse seine used in Black Sea. MSc. thesis. Rize: Recep Tayyip Erdoğan University.

Genc, Y., Ak, O., Bascinar, N. S., Dagtekin, M., Erbay, M. and Atilgan, E. 2010. Population parameters and bycatch rates of anchovy (*Engraulis encrasicolus* (L., 1758)) caught from Southern Black Sea in 2009-2010 fishing season. I. Anchovy Workshop, June 2010. Trabzon, Turkey, 58-64.

Kale, S. 2008. Catch composition, size selectivity and discard rates of commercial gill nets for bogue on The North Aegean Sea. MSc. thesis. Çanakkale: Çanakkale Onsekiz Mart University.

Kelleher, K. 2005. Discards in the world's marine fisheries. FAO Technical Paper No 470, Rome, 131 pp.

Malal, S. 2006. Determination of by-catch and discard catch rates on trawl fishing in Mersin-Anamur fishing ground. MSc thesis. Ankara: Ankara University.

Matsuoka, T. 1999. Sampling estimation of discards in mu1ti-species fisheries. The International Conference on Integrated Fisheries Monitoring. February 1999, Australia, 197-209.

Phiri, H. and Shirakihara, K. 1999. Distribution and seasonal movement of pelagic fish in southern Lake Tanganyika. Fisheries Research. 41: 63-71. doi:10.1016/S0165-7836(99)00008-9.

Saila, S. 1983. Importance and assessment of discards in commercial fisheries, FAO Technical Paper No 765,

Rome, 72 pp.

Soykan, O. 2011. Seasonal distribution of by-Catch species in Sigacik Bay by demersal trawl. PhD. thesis. İzmir: Ege University.

Sparre, P. and Venema, S.C. 1998. Introduction to tropical fish stock assessment part 1: Manual, FAO Fisheries Technical Paper No 306/1, Rome, 376 pp.

Turkis Statistical Institute (TSI). 2012. Fisheries Statistics. https://www.tuik.gov.tr (accessed December 25, 2012)