Cah. Biol. Mar. (2017) 58 : 1-7
DOI: 10.21411/CBM.A.B3268672

Catch composition, length-weight relationship and discard ratios of commercial longline fishery in the Eastern Mediterranean

Anıl GÜLŞAHİN[1] and Ozan SOYKAN[2*]
(1) *Muğla Sıtkı Koçman University, Fisheries Faculty, 48000 Muğla, Turkey*
(2) *Ege University, Fisheries Faculty, 35100 Bornova, İzmir, Turkey*
**Corresponding author E-mail: ozansoykan@hotmail.com*

Abstract: The aim of the study is to determine the catch composition, catch per unit effort and discard ratios of demersal longline fishery which is the most important fishing method in the Gökova Bay. A total of 25 commercial fishing sets (15000 hooks) were performed between October 2014 and September 2015 with a 6 m length traditional type boat. 14 species belonging to 9 families were obtained during the fishing operations. A total of 718 individuals totally weighed 144.5 kg. CPUE values for total number of individuals and total weight were calculated as 4.8 ind.100 hooks^{-1} and 0.92 kg.100 hooks^{-1}, respectively. Discard ratio for Gökova longline fishery was found to be 24.6%.

Résumé : *Composition des captures, relations taille-poids et taux de rejet de la pêcherie à la palangre en Méditerranée orientale.* L'objectif de cette étude était de déterminer la composition des captures, le taux de capture par unité d'effort de pêche ainsi que les taux de rejet de la pêcherie à la palangre, méthode de pêche la plus utilisée dans la Baie de Gökova. Un total de 25 campagnes (15000 hameçons) a été déployé entre octobre 2014 et septembre 2015 à l'aide d'un bateau traditionnel de 6 m de long. 14 espèces appartenant à 9 familles ont été capturées au cours de ces pêches, soit 718 individus pour une biomasse totale de 144,5 kg. La CPUE a été estimée à 4,8 ind.100 hameçons^{-1} et 0,92 kg. 100 hameçons^{-1}. Le taux de rejet de la pêcherie à la palangre de Gökova a été de 24,6%.

Keywords: Gökova Bay ● Longline ● Catch composition

Introduction

Longline fishery is very common in the Aegean and Mediterranean coasts of Turkish Seas. There have been 14595 commercial fishing vessels and 32599 fishing employees (fishermen) in Turkey and 3561 of those are longline vessels creating a number of 3714 fishermen in the field of longlining (TUIK, 2014). Almost 1/4 of longline vessels have been operating in the Aegean Sea (TUIK, 2014).

Gökova Bay is located in the connection zone of the Aegean Sea and the Mediterranean Sea which has been declared as special environmental protection area (SEPA) in 1988 on account of its natural, historical and cultural significance. (GDPNA, 2014). Small scale vessels

Reçu le 3 février 2016 ; accepté après révision le 14 septembre 2016.
Received 3 February 2016; accepted in revised form 14 September 2016.

dominate fishing activity, with fishing boats averaging around 8.1 meters in length in Gökova region (Bann & Başak, 2011) and the most common coastal fishing instruments in Gökova Bay are gillnets, trammel nets, longlines and handlines (Çoker & Akyol, 2014). The fisheries of Gökova are mentioned in many studies (Akyol et al. 2007; Ceyhan et al., 2009; Ünal & Erdem, 2009; Ünal, 2010; Kıraç & Veryeri, 2010; Dereli et al., 2015). A literature survey by Kıraç & Veryeri (2010) revealed the presence of 352 fish species in the area, comprising almost 73% of all fish species in Turkey, including 24 threatened species.

Longlining is an important passive fishing technique (Løkkeborg & Bjordal, 1992). Although some studies have focused on different aspects of longline fishery for Turkey (Ulaş & Düzbastılar, 2001; Özyurt et al., 2003; Çekiç & Başusta, 2004; Erdem & Akyol, 2005; Özdemir et al., 2006; Akyol et al., 2007), information regarding the bait, catch composition, discard ratios and catch per unit effort are scarce and variable. The goal of the study is to determine the catch composition, length-weight relationship, catch per unit effort and discard ratios of demersallongline fishery which is the most important fishing method in the bay, and also to update the scientific knowledge on the mentioned subjects for the bay.

Material and Method

Gökova Bay was the study area (Fig. 1) as being one of the region's most important fishing grounds for the demersal longline fishery. A total of 25 commercial fishing sets (15000 hooks) were performed from October 2014 to September 2015 with a 6 m length traditional type boat. All hooks were baited with Mediterranean mud shrimp *Upogebia pusilla* (Petagna, 1792). Furthermore, depths of the sets ranged between 10-70 meters. Mainline and the branch lines were made of nylon monofilament. The diameter of the mainline was 0.60 mm and the snood was 0.40 mm with a snood length of 100 cm. The distance between two snoods was 250 cm. Longline was prepared with traditional J-hook model number 14 (Mustad 912 TD) which is commonly used by fishermen in Gökova Bay. Gear was deployed before sunrise and drifted after sunrise. Duration of the operations was standardized to 3 hours. All species were weighed on board to the nearest 0.1 g with a digital balance and total length (TL) was measured in the natural body position to the nearest cm (We only used fork length (FL) for *Nemipterus randalli* because of damage on their caudal filaments). . Commercial and discarded CPUE calculations were based on only the marketable or discarded part of the total catch per haul. Catch per unit effort (CPUE) were calculated according to Godøy et al. (2003):

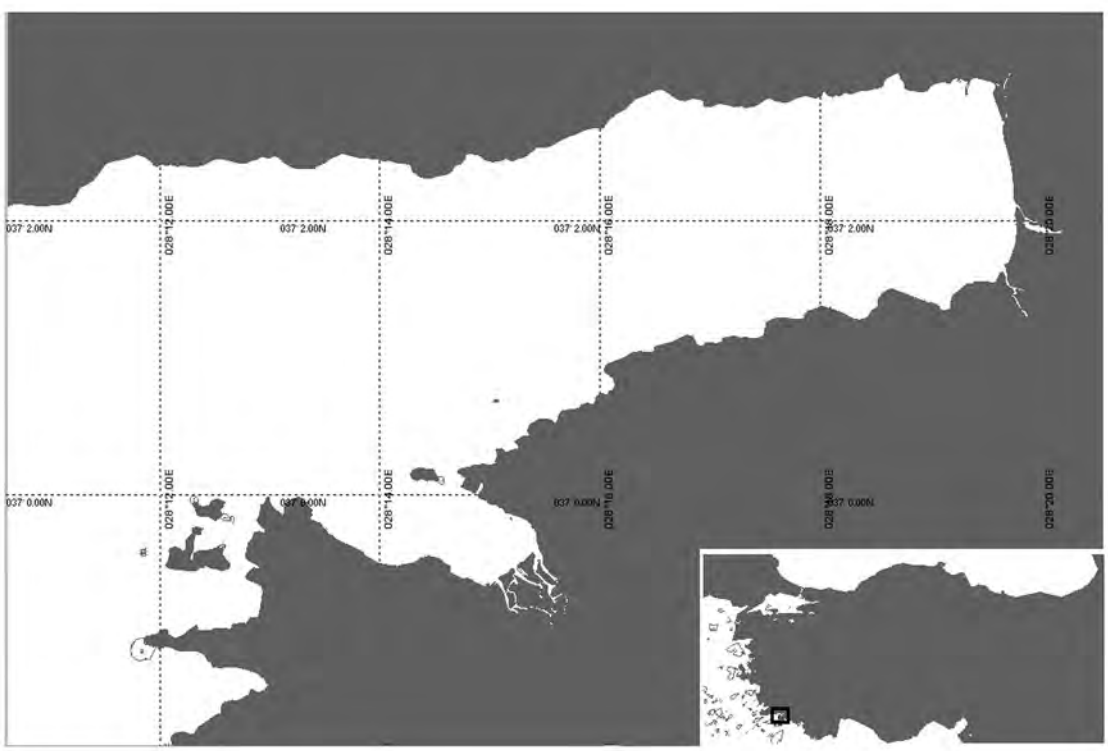

Figure 1. Study area where 25 commercial longline sets were performed between October 2014 to September 2015

$$CPUE = \frac{\sum n}{\sum h \times \sum t} \times 100 \quad (1)$$

where n is the number of individuals, h the number of hooks and t the number of operations.

Parameters of length-weight relationship (LWR) for six fish species were estimated by logarithmic transformation:

$$\log W = \log a + b \log L \quad (2)$$

with *a* and *b* determined via least-squares regression. Accuracy of the growth parameters was examined by the t-test using the Statistica 6.0 software package.

Data were evaluated by MS office Excel 2010 and Statistica 12 software. The mean lengths of main commercial species were given with standard error. Furthermore, discard ratio was calculated with the formula given below (Kelleher, 2005):

$$Dr = Discards\ Total\ catch \times 100 \quad (3)$$

Results

As a result of 15000 hook samplings (25 commercial longline deployments), 14 species belonging to 9 families were obtained. It was determined that while 9 of these species were marketed, 5 of them were always discarded regardless of their size. A total of 718 individuals totally weighed 144.5 kg and captured species of the study with relevant descriptive statistics were given in table 1. It was found that 75.4% of the total catch was marketed and among marketed part of the catch, *Pagellus erythrinus* was the leading commercial species followed by *Dentex dentex*, *Nemipterus randalli*, and *Sparus aurata* respectively (Table 2). Moreover, total ratio of the sparids in the commercial catch composition was 73% as being the dominant family.

Discard ratio for Gökova longline fishery was found to be 24.6%. *Lagocephalus sceleratus* and *Mustelus mustelus* composed more than half of the discarded part of the total catch in terms of weight (Table 2). CPUE values for total number of individuals and total weight were calculated as 4.8 ind.100 hooks^{-1} and 0.92 kg.100 hooks^{-1} respectively. Furthermore, CPUE for commercial catch was found to be 0.72 kg.100 hooks^{-1} while 0.20 kg.100 hooks^{-1} determined for discarded catch for the longline fishery in Gökova Bay.

The *a* and *b* parameters of the LWR calculated for six

Table 1. Commercial (C) and non-commercial (NC) species, their lengths, weights and descriptive statistics by longline sampling in Gökova Bay (n, number; W, weight; LT, length type; se, standard error).

				Length (cm)			Weight (g)			
	n	**W (kg)**	**LT**	**Lmin**	**Lmax**	**Lmean ± se**	**Wmin**	**Wmax**	**Wmean ± se**	**Status**
CONGRIDAE										
Conger conger (Linnaeus, 1758)	6	5.7	TL	70.0	92.0	81.2 ± 3.6	266.3	1385.0	952.3 ± 136.4	NC
DASYATIDAE										
Dasyatis pastinaca (Linnaeus, 1758)	3	5.8	TL	65.0	72.0	68.0 ± 2.1	1850.0	2040.0	1930.6 ± 56.6	NC
NEMIPTERIDAE										
Nemipterus randalli Russell, 1986	237	19.1	FL	12.5	20.2	16.6 ± 0.1	37.8	135.0	80.8 ± 1.6	C
RAJIDAE										
Raja clavata Linnaeus, 1758	3	3.7	TL	55.6	60.2	58.4 ± 1.4	1095.0	1318.0	1237.6 ± 71.5	NC
SERRANIDAE										
Epinephelus aeneus (Geoffroy Saint-Hilai*re,* 1817)	6	4.5	TL	33.2	47.2	40.4 ± 2.2	391.9	1040.2	755.3 ± 108.7	C
Serranus cabrilla (Linnaeus, 1758)	4	0.2	TL	15.0	18.0	16.9 ± 0.7	33.2	55.4	48.2 ± 5.0	C
SPARIDAE										
Dentex dentex (Linnaeus, 1758)	21	24.6	TL	46.3	54.5	48.0 ± 0.6	1047.0	1550.3	1173.8 ± 35.5	C
Diplodus sargus (Linnaeus, 1758)	7	1.0	TL	18.9	21.6	20.5 ± 0.4	118.0	170.0	146.1 ± 7.7	C
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	27	3.5	TL	19.1	26.7	21.0 ± 0.4	81.0	199.3	130.2 ± 8.0	C
Pagellus erythrinus (Linnaeus, 1758)	336	44.1	TL	12.8	43.0	21.1 ± 0.2	25.2	1192.4	131.3 ± 6.7	C
Sparus aurata Linnaeus, 1758	31	11.4	TL	24.1	38.1	29.0 ± 0.9	170.0	830.0	367.4 ± 45.6	C
SYNODONTIDAE										
Saurida lessepsianus (Russell, Golani & Tikochinski, 2015)	3	0.7	TL	30.6	34.1	32.3 ± 1.0	179.9	265.5	229.6 ± 25.6	C
TETRODONTIDAE										
Lagocephalus sceleratus (Gmelin, 1789)	28	10.0	TL	24.6	40.2	31.4 ± 0.9	185.1	657.3	359.8 ± 29.5	NC
TRIAKIDAE										
Mustelus mustelus (Linnaeus, 1758)	6	10.2	TL	52.3	62.4	57.8 ± 1.6	475.4	830.8	660.8 ± 54.3	NC
TOTAL	**718**	**144.5**								

Table 2. Weight based distribution of captured species of commercial longline fishery in Gökova Bay according to each category as commercial and discard.

Commercial		Discard	
Species	**%**	**Species**	**%**
P. erythrinus	40.4	*M. mustelus*	28.9
D. dentex	22.6	*L. sceleratus*	28.3
N. randalli	17.5	*D. pastinaca*	16.3
S. aurata	10.4	*C. conger*	16.1
E. aeneus	4.1	*R. clavata*	10.4
D. vulgaris	3.2	**Total**	**100**
D. sargus	0.9		
S. lesepsianus	0.6		
S. cabrilla	0.2		
Total	**100**		

species collected from Gökova Bay are presented in table 3. The *b* values varied from 2.14 (*D. dentex*) to 3.47 (*S. aurata*). Positive allometric growth was observed for *P.erythrinus* and *S. aurata* but negative allometric growth was detected for the other species (*t-test*, $p < 0.005$).

Discussion

In this study, 14 species belonging to 9 families were determined from longline fishery in Gökova Bay. Similar results were stated by Dereli et al. (2015) from the same area including 16 species which 5 of them are common in both studies. On the other hand 43 species were reported from Cyclades Islands in longline fishery which forms a big difference in terms of species richness. The probable reason of this difference may be due to use of different hook sizes (11, 12, 13 and 15) in Cyclades Islands. Untargeted catch during any type of fishery may cause some problems in terms of ecosystem dynamics and economic approaches. Although the dimensions of this problem vary for every type of fishery, they fundamentally have some common characteristics. Furthermore, marketing conditions, season, region with the habits and preferences of consumers are the main factors which affect the classification of the yield as commercial or discarded (Soykan et al, 2016a). Fish which are discarded are often unmarketable species, individuals which are below minimum landing sizes and catches of species which fishermen are not allowed to land, for instance due to quota restrictions. A remarkable example of this situation is the presence of *Serranus cabrilla* in the commercial catch composition in our study while it has been reported to be a discarded species in many studies (Akyol, 2003; Aydın et al., 2008; Gökçe & Metin, 2007). In the present work, although sea breams were targeted, all marketable individuals were retained by fishermen. It was also determined that no commercial species was discarded due to its size. In our

Table 3. Length-weight relationship parameters for 6 fish species in Gökova Bay captured by longline (n, number; s.e. (*b*), standard error of *b*).

Species	n	*a*	*b*	s.e. (*b*)	R^2
P. erythtinus	336	0.0075	3.15	0.028	0.95
N. randalli	237	0.0412	2.69	0.029	0.81
S. aurata	31	0.0027	3.47	0.019	0.99
D. dentex	21	0.2864	2.14	0.075	0.88
D. vulgaris	27	0.0399	2.64	0.093	0.73
L. sceleratus	28	0.0352	2.66	0.024	0.99

study discard ratio of Gökova longline fishery was found to be 24.6% and discarded catch composition composed of 5 species (*L. sceleratus, M, mustelus, C. conger, D. pastinaca, R. clavata*). Dereli et al. (2015) reported this ratio as 11.5% from the same area and 6 species (*C. conger, Diplodus annularis* (Linnaeus, 1758)*, Lithognathus mormyrus* (Risso, 1827)*, Pagellus acarne* (Risso, 1827)*, S. lessepsianus, Serranus scriba* (Risso, 1827)) were stated as discards. Stergiou et al. (2002) determined the discard ratio of longline fishery between 2 and 5% in Cyclades Islands including 6 species (*Ariosoma balearicum, Liocarcinus depurator* (Linnaeus, 1758)*, Muraena helena* (Linnaeus, 1758)*, Scyliorhinus canicula* (Linnaeus, 1758)*, Symphodus tinca* (Linnaeus, 1758)*, Trigloporus lastoviza* (Bonnaterre, 1788)). Discard ratio of our study is remarkably higher than in the mentioned studies. This high ratio is attributable to presence of *M. mustelus* and a lessepsian migrant *L. sceleratus* in the catch composition which composed almost 60% of the discard and 15% of the total catch composition. Factors such as depth, bait and hook type are also considered to make the differences in discard ratios among the mentioned studies. Soykan et al. (2016a) stated the difficulty in nominating the target species in multispecies fishery areas. Therefore the term “commercial catch” may be used instead of “target catch” to clarify the classification of the total catch for multispecies fishery areas (Soykan et al., 2016a). The quality and quantity of discards in longline fishery depend on several factors such as the region, technical features of the gear, bait type and target species. Table 4 presents the discard ratios of the longline fishery performed in the Aegean Sea ranging from 7.7 to 61.6%. The main reason for this big range is considered to be the sampling strategy, because while most of the presented studies were experimental, our results are based on commercial longline operations.

Minimum landing size (MLS) is an important measure and restriction parameter in fisheries management. MLS of *D. dentex*, *D. vulgaris* and *S. aurata* were found to be higher than the given limits for Turkey as 35 cm, 18 cm and 20 cm respectively (Anonymous, 2012). On the other hand, *E. aeneus* and *D. sargus* were below the limits for Turkish seas (45 cm for *E. aeneus* and 21cm for *D. sargus*). The mean length of *D. sargus* (20.5 cm) was very close to the

Table 4. Marketed and discarded ratios of the longline fishery from the previous studies in the Aegean Sea.

Study	Marketed (%)	Discarded (%)	Study area
Ulaş & Düzbastılar (2001)	38.4	61.6	Urla, middle Aegean Sea
Özdemir et al. (2006)	63.6	36.4	Urla, middle Aegean Sea
Maktay (2012)	89.0	11.0	Urla, middle Aegean Sea
Odabaşı (2013)	54.0	46.0	Saroz Bay, North Aegean Sea
Aydın & Bolat (2014)	81.9	18.1	Finike Bay, Mediterranean
Özgül et al. (2015)	92.3	7.7	Kuşadası Bay, middle Aegean Sea
Present study	**75.4**	**24.6**	**Gökova Bay, South Aegean Sea**

MLS. The low number of *D. sargus* and *E. aeneus* specimen obtained during the study is also bringing a difficulty to make a comprehensive evaluation in terms of the MLS restriction for these two species. MLS regulations for *P. erythrinus* which was represented with the highest number of individuals in our study is lacking for Turkey. We determined the mean length of *P. erythrinus* to be 21.1 cm. Metin et al. (2011) reported the total lengths at first maturity of females and males of *P. erythrinus* as 11.30 and 15.08 cm, respectively. Our value is dramatically higher than that of Metin et al. (2011) especially for females indicating a sustainable fishing trend for the species. Second abundant fish of our study, *N. randalli* has been reported as a Lessepsian (Bilecenoğlu & Russel, 2008) and Lessepsian invasive species (Erguden & Goksu, 2010). Although its presence in some regions of Turkish seas has been published (Bilecenoğlu & Russel, 2008; Gülşahin & Kara, 2013), information on age, growth, reproduction and fishery aspects are scarce for this Lessepsian migrant in its new habitat. The mean length of *N. randalli* in our study was 16.6 cm fork length. Erguden & Goksu (2010) reported the mean length to be 13.74 cm total length covering 379 individuals from 4.8 to 21.5 cm captured by demersal trawling. The difference in the mean length is attributable to mostly the different sampling gear and then the area. While the first record of *N. randalli* was given by Gülşahin & Kara (2013) from Gökova Bay, it was the second most dominant species in terms of number, and the third most abundant in terms of weight in the commercial catch composition even though its small size in comparison to some other commercial species. Therefore further detailed studies are required in order to monitor the dispersion and to determine the interspecific competition success of the species in the Aegean Sea.

In this study, CPUE values were calculated separately for commercial and discarded catch, and for overall data. CPUE values for total number of individuals and total weight were calculated as 4.8.100 hooks^{-1} and 0.96 kg.100 hooks^{-1} respectively. Our finding is similar to Akyol et al. (2007) which was reported as 8.43 ± 1.02 kg.day^{-1} for 1000 hooks from the same area. CPUE value was also given by Dereli et al. (2015) as 1.7 kg.100 hooks^{-1} from Gökova Bay as well. Özgül et al. (2015) compared the efficiency of circle and J style hooks in longline fishery and they reported the overall CPUE to be 4.73 fishes.100 hooks^{-1} for circle and 2.46 fishes for J-style hooks. The differences between these studies could be attributed to technical factors (hook type, bait, etc.) and operational methods (day time, operation period, etc.) of longlining. Stelzenmüller et al. (2007) reported that marine reserves such as marine protected areas and SEPA's are increasingly advocated not only as conservation but also as fisheries management tools to safeguard the decline of coastal fishing resources. Authors also stated that CPUE of total fish increased close to the integral reserve due to direct and indirect reserve effects in Medes Islands, Mediterranean. Therefore small scale fishing in Gökova which includes no take zones in the scope of SEPA, should be well monitored and under surveillance.

In longline fisheries, there are many factors that influence selectivity and catches, the most important are bait and hook (Jacobsen & Joensen, 2004). If a fish is to consider bait as food and eat it, then the bait must be more tempting than the available food in the area (Jacobsen & Joensen, 2004). There are several factors which influence the quality of bait such as smell, taste, texture and toughness/tenacity (Jacobsen & Joensen, 2004). Lokkeborg & Pina (1997) reported that the catch efficiency is high when the bait is fresh and operations more than 2 hours reduces the catch efficiency. In our research, only one bait *U. pusilla* was used due to fisherman preference and approach. The reason of this case was Mediterranean mud shrimp has low cost and easy to obtain. Neither Akyol et al. (2007) nor Dereli et al. (2015) reported the types of longline baits for Gökova Bay. Therefore, no scientific discussion can be presented regarding the baits in the longline fishery of Gökova Bay, but *U. pusilla* has been reported to be an efficient bait in the Aegean Sea (Soykan et al., 2013). Catch composition of longline fishery differs between regions of the Aegean Sea. Ulaş & Düzbastılar (2001) reported 10 fish species from longline operations from İzmir Bay, middle Aegean Sea and 6 of those fish (*S. aurata, D. dentex, P. acarne, D. vulgaris, D. sargus* and *Oblada melanura* (Linnaeus, 1758)) belonged to Sparidae family. Çekiç & Başusta (2004) determined 34 species (33

fish, 1 cephalopod) from longline samplings in İskenderun Bay, Northeast Mediterranean. All sparids of this study and *E. aeneus* were common in both studies. The other differences in the catch composition are attributable to regional and operational factors such as bait, hook type, depth and number of operations. Akyol et al. (2007) reported 25 fish species excluding *N. randalli* and *L. sceleratus* from longline samplings in Gökova Bay. Record of *N. randalli* for Gökova Bay was given by Gülşahin & Kara (2013) in 2011 from longline samplings. Our study included a considerable amount of *N. randalli* in the commercial catch composition as being the second most dominant species in terms of number. Similarly, *L. sceleratus* numerically dominated the discarded catch composition. The high abundance of these two lessepsien species in comparison to the locals is considered to be a result of successful adaptation after interspecific competitions. Soykan et al. (2013) determined 11 species belonging to 3 classes and 7 families from longline trials in Urla, middle Aegean Sea, dominated by sparids in terms of captured individuals and weight.

Length-weight relationship (LWR) is an important tool in fisheries management. However, LWR parameters of the same species vary between regions, sampling methods and the measurement accuracy of the researchers. In this study LWR were calculated for 6 fish, 5 commercial and 1 discarded (*L. sceleratus*). The *b* values varied between 2.14 (*D. dentex*) and 3.47 (*S. aurata*) with all regressions highly significant (t-test, $P < 0.005$). Reported LWR parameters by Akyol et al. (2007) and Ceyhan et al. (2009) for *P. erythrinus, S. aurata* and *D. vulgaris* showed some variations. These differences are attributable to sampling method (longline, trammel nets, etc) and other factors in longline operations (hook type, bait, duration and timing). Dulcic & Kraljevic (1996) reported that various factors may be responsible for the differences in parameters of LWRs among seasons and years, such as temperature, salinity, food (quantity, quality, and size), sex, time of year and stage of maturity. Furthermore, we believe that bait type also affects the LWR in the longline fishery as the juvenile and mature individuals of the same species may have different feeding preferences.

Longline fishing in Turkey is still being performed by traditional methods. Operational innovations such as boat, hook and bait type are needed in order to increase the longline fishery based production (Soykan et al., 2016b). This study aimed to determine the catch composition, catch per unit effort and discard ratios of demersal longline fishery which is one of the most important fishing method in the Gökova Bay. Consequently 14 species belonging to 9 families were obtained and it was found that 24.6% of the catch was discarded, 75.6% was marketed. *P. erythrinus* and *D. dentex* were found to be the most dominant commercial species while *L. sceleratus* and *M. mustelus* were the leading discarded species. Further studies about the bait and hook type, selectivity and discard reduction are required in order to develop this passive fishing gear. Furthermore monitoring the catch composition of longline fishery in the Bay where is under a high pressure of lessepsian migration is also very important in ecological contemplation.

Acknowledgements

This study has been granted by the Muğla Sıtkı Kocman University scientific research projects coordination office, project grand number 13/08. Authors would also like to thank Abdullah KÜÇÜKÇİFTÇİ, Hasan CERİM and Gökçen BİLGE for efforts during the field studies and captain of the commercial longline vessel for data gathering.

References

Akyol O. 2003. Retained and trash fish catches of beach-seining in the Aegean coast of Turkey. *Turk Journal of Veterinary and Animal Sciences.* **27**: 1111-1117.

Akyol O., Kınacıgil H.T. & Şevik R. 2007. Longline fishery and length-weight relationships for selected fish species in Gökova Bay (Aegean Sea, Turkey). *International Journal of Natural and Engineering Sciences*, **1**: 1-4.

Anonymous 2012. Fisheries regulation for marine and fresh waters for commercial fishery, 2008-2012 fishing period No: 2/1, *Ministry of Agriculture and Rural Affair of Turkey, Protect and Control General Office*, Ankara, 85 pp. (in Turkish).

Aydın C.M. & Bolat Y. 2014. The selectivity of different hook size in the bottom longline which used for catching white seabream (*Diplodus sargus* L., 1758) in Finike Bay. *Journal of FisheriesSciences.com,* **8**: 186-193.

Aydın İ., Gökçe G. & Metin C. 2008. The effects of netting twine on discard rates of commercial red mullet gillnets in Izmir Bay. *Turkish Journal of Fisheries and Aquatic Sciences,* **8**: 373-376.

Aydın İ., Gökçe G. & Metin C. 2008. The effects of netting twine on discard rates of commercial red mullet gillnets in Izmir Bay. *Turkish Journal of Fisheries and Aquatic Sciences*, **8**: 373-376.

Bann C. & Başak E. 2011. The economic analysis of Gökova Special environmental protection area. Economic analysis reports for Foça and Gökova in the framework of environmental economics principles. Project PIMS 3697: The strengthening the system of marine and coastal protected areas of Turkey. Technical Report Series 3: 80 pp.

Bilecenoglu M. & Russel B. 2008. Record of *Nemipterus randalli* Russell, 1986 (Nemipteridae) from Iskenderun Bay, Turkey. *Cybium*, **32**: 279-280.

Çekiç M. & Basusta N. 2004. Effect on the species selectivity of different bait and hook size in longline in Iskenderun Bay, Eastern Mediterranean Sea. *Ege Journal of Fisheries and Aquatic Sciences*, **21**: 73-77.

Ceyhan T., Akyol O. & Erdem M. 2009. Length-weight relationships of fishes from Gökova Bay, Turkey (Aegean Sea). *Turkish Journal of Zoology,* **33**: 69-72.

Çoker T. & Akyol O. 2014. An evaluation on the fish diversity of Gökova Bay (Aegean Sea) (Gökova Körfezi (Ege Denizi) Balık Tür Çeşitliliği Üzerine Bir Değerlendirme). *Ege Journal of Fisheries and Aquatic Sciences,* **31**: 161-166.

Dereli H., Tosunoğlu Z., Göncüoğlu H. & Ünal V. 2015. Catch per unit effort (CPUE) and catch composition of small scale fisheries in Gökova Bay. *Ege Journal of Fisheries and Aquatic Sciences,* **32**: 135-143.

Dulcic J. & Kraljevic M. 1996. Weight-length relationships for 40 fish species in the eastern Adriatic (Croatian waters). *Fisheries Research*, **28**: 243-251.

Erdem M. & Akyol O. 2005. A preliminary study on longlining of swordfish (*Xiphias gladius* L., 1758) in Fethiye Region (Mediterranean) (in Turkish). *Ege Journal of Fisheries and Aquatic Sciences*, **22**: 201-204.

Ergüden S.A. & Goksu M.Z.L. 2010. Age, growth and sex ratio of tench *Tinca tinca* (L., 1758) in Seyhan Dam Lake, Turkey. *Journal of Applied Ichthyology,* **26**: 546-549.

GDPNA (General Directorate for Protection of Natural Assets) 2014. Fethiye-Göcek, Köyceğiz Dalyan, Datça-Bozburun, Gökova, Foça special environment protection areas and Ayvalık Adaları nature guide book, PIMS 3697. The strenghtening the system of marine and coastal protected areas of Turkey Project, 64 pp. (in Turkish).

Godøy H., Furevik D. & Løkkeborg S. 2003. Reduced bycatch of red king crab (*Paralithodes camtschaticus*) in the gillnet fishery for cod (*Gadus morhua*) in northern Norway. *Fisheries Research*, **62**: 377-384.

Gökçe G. & Metin C. 2007. Landed and discarded catches from commercial prawn trammel net fishery. *Journal of Applied Ichthyology,* **23**: 543-546.

Gülşahin A. & Kara A. 2013. Record of *Nemipterus randalli* Russell, 1986 from the southern Aegean Sea (Gökova Bay, Turkey). *Journal of Applied Ichthyology*, **29**: 933-934.

Jacobsen J.H. & Joensen J. 2004. Comparison of bait in longline fishery. Doctoral dissertation, BSc. Thesis, *University of Faroe Island*, Denmark, 54 pp.

Kelleher K. 2005. Discards in the world's marine fisheries. An update. FAO Fisheries Technical Paper # 470. FAO: Rome. 131 pp.

Kıraç C.O. & Veryeri N.O. 2010. Putting PEEN to practice in marine and coastal areas; Gokova Integrated coastal and marine management Planning Project. Final Report to BBI Matra, the Netherlands.). SAD-AFAG: Ankara. 92 pp.

Løkkeborg S. & Bjordal J. 1992. Reduced bait loss and bycatch of seabirds in longlining by using a seabird scarer. *Document to Working Group FSA-92 CCAMLR*, Hobart, Australia. 5 pp.

Løkkeborg S. & Pina T. 1997. Effects of setting time, setting direction and soak time on longline catch rates. *Fisheries Research*, **32**: 213-222.

Løkkeborg S. 2000. Fish behavior and gear improvement in longlining. *Fishing gear system 2000* Scottish Exhibition and Conference Centre, Glasgow, Scotland.

Maktay C.B. 2012. Effect on catching efficency of different natural bait in Longline fisheries. Master's Thesis, Science Institute of Ege University, İzmir, Turkey. 38 pp.

Metin G., Ilkyaz A.T., Soykan O. & Kinacigil H.T. 2011. Biological characteristics of the common pandora, *Pagellus erythrinus* (Linnaeus, 1758), in the central Aegean Sea. *Turkish Journal of Zoology,* **35**: 307-315.

Odabaşı O.B. 2013. Investigation of bycatch composition in longline fisheries in Çanakkale Region. Master's Thesis, Science Institute of Onsekiz Mart University, Çanakkale, Turkey.

Özdemir S., Ayaz A., Gurbet R. & Erdem Y. 2006. Catch efficiency of bottom long-line used with different hook size and sifferent type bait at dawn and daytime. *Anadolu University Journal of Science and Technology*, **7**: 405-411.

Özgül A., Ulaş A., Lök A., Düzbastılar F.O. & Metin C. 2015. A comparison of alternative circle hook (Kahle Hook) and J style hook performance in experimental pelagic longline fishery in Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, **15**: 19-27.

Özyurt C.E., Sarıhan E. & Akar M. 2003. The possibilities of using longline at pike-perch (Sander lucioperca, Bogustkaya & Naseka, 1996) fishing at Seyhan Dam Lake. *E.U. Journal of Fisheries & Aquatic Sciences*, **20**: 43-50.

Soykan O., Akgül Ş.A. & Kınacıgil H.T. 2016a. Catch composition and some other aspects of bottom trawl fishery in Sığacık Bay, central Aegean Sea, eastern Mediterranean. *Journal of Applied Ichthyology,* **32**: 542-547.

Soykan, O., Aydın, İ. & Kınacıgil, H.T. 2016b. A preliminary study on the potential use of an alternative bait for demersal longline fishery; *Sepietta* sp. *Ege Journal of Fisheries and Aquatic Sciences,* **33**: 163-167

Soykan O., Kinacigil H.T. & Barisik T.Ö. 2013. Potential use of a new bait for longline fishery in Aegean Sea: *Sepietta* sp. *The first international fisheries symposium*, 24-27 March 2013, Girne, North Cyprus.

Stelzenmüller V., Maynou F. & Martín P. 2007. Spatial assessment of benefits of a coastal Mediterranean marine protected area. *Biological Conservation,* **136**: 571-583

Stergiou K.I., Moutopoulos D.K. & Erzini K. 2002. Gill net and longlines fisheries in Cyclades waters (Aegean Sea): species composition and gear competition, *Fisheries Research*, **57**: 25-37.

TUIK (Turkish Statistical Institute) 2014. Fishery statistics 2014, Ankara.

Ulaş A. & Düzbastılar O.F. 2001. Comparison of catch efficiency of different longlines, *E.U. Journal of Fisheries & Aquatic Sciences*, **18**: 175-186.

Ünal V. 2010. Overview of the existing definitions of "recreational fisheries". The transversal workshop on the monitoring of recreational fisheries in the GFCM area. General Fisheries Commission for the Mediterranean (GFCM), Scientific Advisory Committee, Sub-Committee on Economic and Social Sciences (SCESS): Palma de Mallorca, Spain.

Ünal V. & Erdem M. 2009. Combating illegal fishing in Gökova Bay (Aegean Sea), Turkey. In: *Proceedings of the 3rd International Symposium on Underwater Research* (B.A. Çiçek & H. ve Öniz H. eds), Eastern Mediterranean University: Famagusta, 125 pp.