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Research Article

THE COMMERCIAL AND DISCARD CATCH RATES OF THE TRAWL FISHERY IN THE İSKENDERUN BAY (NORTHEASTERN LEVANTINE SEA)

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Abstract: The management of fishery is significant due to the sustainability of marine resources. Therefore, the fishing areas should be constantly monitored. In this study, the fishery data were collected from the Iskenderun Bay (Northeastern Levantine Sea) with a rented commercial trawl vessel. The fishery-dependent data was recorded during the 2012-2013 fishing season with the help of the crew. 33 tows were achieved using a trawl net (codend diamond mesh size of 44 mm) for 26 hours. Each tow was limited with 70 min and the towing speed varied between 2.5 to 3.0 knots. The depth contour ranged from 39 to 69 m. While 32 species were evaluated as discard, 35 species were included in the landed catch. The total catch consisted of 67.2% the landed and 32.8% of the discarded fish in terms of $CPUE_W$ (catch per unit effort by weight).

Özet: Deniz kaynaklarının sürdürülebilirliği için balıkçılık yönetimi son derece önemlidir. Bu nedenle balıkçılık alanları sürekli olarak izlenmelidir. Bu çalışmada kullanılan veriler İskenderun Körfezi'nde (Kuzeydoğu Levant Denizi) avlanan bir ticari trol teknesi ile toplanmıştır. Balıkçılığa bağlı veriler, 2012-2013 balıkçılık sezonunda tekne mürettebat yardımı ile kaydedilmiştir. 26 saat süren 33 trol çekimi 44 mm rombik ağ gözü boyutuna sahip torba kullanılarak gerçekleştirilmiştir. Trol çekim hızı 2,5 ila 3,0 knot arasında değişmiş ve en fazla 70 dakika sürmüştür. İskenderun Körfezi'nde 39-69 m derinlik konturu incelenmiştir. 32 tür ıskarta olarak değerlendirilirken, 35 tür ticari av içinde yer almıştır. Buna karşın, toplam av $CPUE_W$ (birim zamanda elde edilen biyokütle) açısından değerlendirildiğinde %67,2'sinin ticari ava %32,8'inin ise ıskarta ait olduğu saptanmıştır.

Introduction

Discard is a part of the catch that is unwanted by fishers due to being too small, damaged, inedible, having a little or no economic value, or not being able to be retained with management or quota restrictions (Zeller *et al.* 2018). Data on discard rates plays a key role for understanding the energy flow of the marine ecosystem (Machias *et al.* 2001).

The bottom trawl makes the highest contribution to the 9.1 million tonnes annual discard levels worldwide with 4.2 million tonnes (Pérez Roda *et al.* 2019). Mitigation of discard catches is extremely decisive on biodiversity and ecosystem health. There are some ways like mesh size regulations, catch quotas or effort limitations, minimum landing sizes to reduce the amount of discard catch caught by trawls (Weissenberger 2014). In Turkish waters, the mesh size and minimum landing size regulations are preferred by the Ministry of Agriculture and Forestry.

Researchers performed so far in Turkish Seas have focused on discard catch in the last few decades and most of them used beam trawls (Bayhan *et al.* 2006, Demirci 2003, Gökçe & Metin 2006, Kınacıgil 1999a, b, Soykan *et al.* 2006, Yazıcı *et al.* 2006). However, conducting a long-term monitoring study to determine the discarded yield takes too much effort and it is financially compelling as well.

The present study was conducted in the Iskenderun Bay (Easternmost Levantine Sea) where a high biodiversity is present. Erythrean invasion is one of the main causes of this situation. Invasion is also the most important ecological process affecting fisheries in north-eastern Mediterranean Sea. The Red Sea immigrants are evaluated in trawl catch from the Northeastern Levantine Sea (Gücü *et al.* 1994, Gücü *et al.* 2010, Özyurt *et al.* 2018, Yemişken *et al.* 2014). Apart from this, the bay hosts many cartilaginous fishes and these fishes were previously investigated in terms of bycatch and discard. However, the majority of Elasmobranch species are threatened with extinction in the area (Yağlıoğlu *et al.* 2015, Yemişken *et al.* 2014).

This study aimed to define the catch composition and catch/discard rates of trawl fisheries in Iskenderun Bay.

Materials and Methods

Study Area

The Northeastern Levantine Sea has a wide continental shelf including the Iskenderun Bay (Fig. 1). The bay is preferred as a study area due to being an important fishing area in the Eastern Mediterranean (Yemisken *et al.* 2014). Its surface area is about 2275 km^2 with an average depth of 70 m, and its bottom is mainly covered with sand and mud. The range of sea surface water temperature was recorded between 16 and 30°C during 2012-2013 (Karpuz & Sakalli 2019) while salinity varied from 37.0 to 39.4 psu (Terbıyık Kurt 2018).

The regulations and restrictions of trawl fishery are determined by the Ministry of Agriculture and Forestry. The fishing season in the Iskenderun Bay is between September 15 and April 15 every year. Fishing in the bay is prohibited within the first 2 miles off the coast and 44 mm minimum mesh size for the diamond mesh can be used in the Turkish coasts of the Mediterranean Sea.

Sampling

Fishery dependent data were collected by the commercial trawler (Faik Baba, 22 m, 400 HP), in December 2012, February and April 2013, during the legal fishing season. 33 tows with trawl net had achieved with a codend diamond mesh size of 44 mm. Each towing duration ranged from 30 to 70 min depending on topology, bottom type and vessel speed and the towing speed varied between 2.5 to 3.0 knots.

Fieldwork included recording the characteristics of the haul, the estimation of the total catch and landed catch. When the catch reached to the board, it was sorted out as commercial and discard by the crew. After the catch was sorted by the crew, the discard portion was put in boxes. Then the number of individuals of the discard catch was counted and the total weights of each species were noted. Weight was determined to the nearest 1 g. Sub-sampling was performed for the species with a high number of individuals. Species that are difficult to identify were identified in the laboratory.

Statistical Analysis

The most reliable estimation used to determine negative or positive changes in stocks, is the CPUE (Catch Per Unit Effort) calculation (Bordalo-Machado 2006). The CPUE of the trawl was calculated and expressed as biomass/towing time or abundance/towing time (Eq. 1) (D'Onghia *et al.* 2003, Morgan & Burges 2005).

Eq. 1 $CPUE_W = Cw/t$ and $CPUE_A = C_A/t$

Cw: Biomass of the catch (g)

CA: Abundance of the catch (ind)

t: Towing time (h)

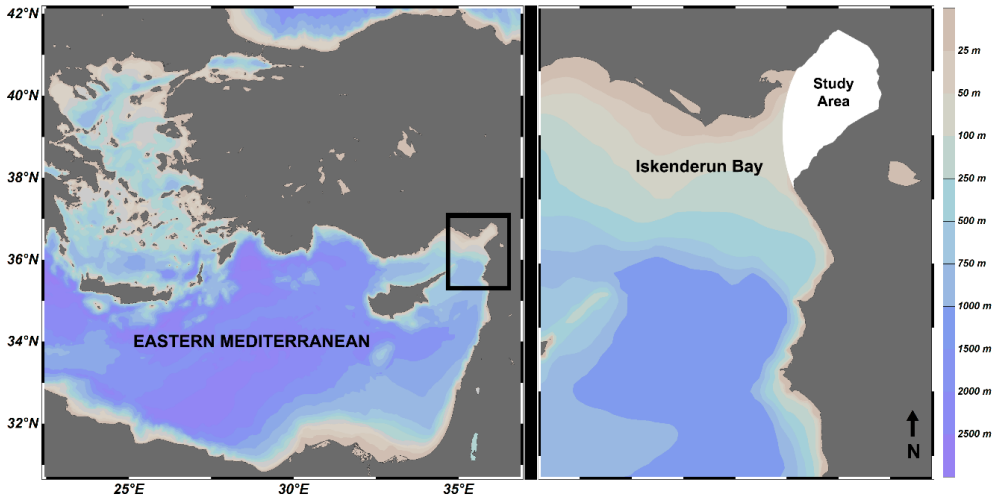

Fig. 1. Sampling area in the Iskenderun Bay, Northeastern Levantine Sea.

Results and Discussion

The tows duration lasted 26 hours in 33 tows (Table 1). The tows were performed at 39-69 m (average depths) depth contour, which is the most visited by fishermen in fishing seasons. Among the tows, the highest abundance and biomass values belonged to the haul at 39 m, which is the shallowest depth. While the discard catch per haul was estimated between 0.25 and 25.5 kg/h, total fish catch varied between 2.3 and 41 kg/h during the fishing period (Table 1).

In 2012-2013 fishing season, a total of 67 species were evaluated by the crew, of which 32 were in discard and 35 were in the landed catch. *Glaucostegus cemiculus* (Geoffroy St. Hilaire, 1817), *Mustelus mustelus* (Linnaeus, 1758) and *Zeus faber* Linnaeus, 1758 were placed in discard catch due to avoided sizes of the individuals.

A total of 332 kg of the catch was obtained during the study. The total abundance of fishes was 7738. Data refers to 10506 individuals when the number of individuals in each tow is standardized by the swept area ($CPUE_A$), 60.5% of which are discarded (Table 2). In terms of $CPUE_W$ the trawl catches mainly consisted of 67.2% landed and 32.8% discarded fish.

Table 1. The informative data of the tows achieved in the Iskenderun Bay at 2012-2013 fishing season (Tow numbers 1-12 were carried out in Dec-2012, 13-25 in Feb-2013 and 26-33 in Apr-2013).

Tows	Average Depth (m)	Towing Time (h)	Landed ($CPUE_A$)(ind/h)	Landed ($CPUE_W$) (g/h)	Discard ($CPUE_A$) (ind/h)	Discard ($CPUE_W$) (g/h)
1	61	1.17	72	12228.2	182	3031.6
2	56	1.00	173	9323.0	149	5719.3
3	39	0.33	1060	21569.7	348	19416.0
4	46	1.17	142	7898.3	142	3544.3
5	62	0.70	222	12638.6	226	1732.3
6	62	1.00	541	7669.0	102	25407.4
7	56	0.65	154	22323.1	257	2776.9
8	57	1.00	98	17385.0	206	8030.0
9	62	0.70	101	26838.6	297	2634.3
10	67	0.75	227	9097.3	113	2542.7
11	69	0.77	173	7364.9	97	5037.7
12	61	0.77	140	17002.6	223	2619.5
13	63	0.72	183	4290.3	57	6486.1
14	61	1.30	20	2314.6	35	835.0
15	59	0.93	102	4146.2	67	2695.7
16	61	0.87	128	2973.6	40	1985.1
17	62	1.00	151	3396.0	47	1233.0
18	65	1.03	277	7538.8	104	6128.2
19	62	0.72	401	16966.7	257	5101.4
20	68	1.08	112	2621.3	40	866.7
21	67	0.58	114	4619.0	81	1524.1
22	60	0.72	78	7013.9	92	695.8
23	58	0.80	19	2988.8	38	258.8
24	55	0.58	57	2462.1	43	491.4
25	68	0.82	110	4573.2	62	704.9
26	68	0.55	275	4310.9	64	3930.9
27	53	0.75	99	13820.0	215	13917.3
28	53	0.83	359	9721.7	146	1394.0
29	57	0.62	179	12537.1	240	2293.5
30	55	0.48	169	4512.5	54	2447.9
31	57	0.58	76	3520.7	57	2334.5
32	60	0.50	84	1688.0	24	618.0
33	57	0.62	265	2766.1	42	2932.3

Five species were identified as cartilaginous fishes, among those *G. cemiculus* and *M. mustelus* are of limited economic value. These fishes take part in IUCN Red List as CR and VU, respectively. All chondrichthyes was sorted as discard and they covered 11% of the total catch. Cartilaginous fish were estimated to 33% of the total discard catch biomass. *Dasyatis pastinaca* covered the largest part of the total discard catch biomass but was represented by low numbers in the total abundance. Yemişken *et al.* (2014) mentioned that the species is among the vast majority of the discard catch biomass with *Gymnura altavela* in the area. Also, Yaglioglu *et al.* (2015) estimated that *D. pastinaca* constitutes 38% of the total elasmobranch biomass.

During the study period, 21 species (31%) were determined as Red Sea immigrants. These species were estimated as 57.5% of the total teleost catch biomass and the rest of the catch consisted of the Atlanto-Mediterranean species. Özyurt *et al.* (2018) mentioned that 35% of the teleost species are Red Sea species and percentage of them is 75% in the total biomass.

Table 2. The standardized values of the landed and discard catch as $CPUE_A$ (ind./h) and $CPUE_W$ (g/h) in the Iskenderun Bay. Status of the listed fishes were determined as D (Discard) and L (Landed) (Red Sea immigrants*; Cartilaginous^{++}).

Species	Landed ($CPUE_A$)	Landed ($CPUE_W$)	Discard ($CPUE_A$)	Discard ($CPUE_W$)	Status
Apterichtus caecus (Linnaeus, 1758)	0	0	6	37	**D**
Arnoglossus grohmanni (Bonaparte, 1837)	0	0	5	13	**D**
Arnoglossus thori Kyle, 1913	0	0	149	644	**D**
Blennius ocellaris Linnaeus, 1758	0	0	5	59	**D**
Boops boops (Linnaeus, 1758)	32	870	5	108	**L**
Bregmaceros nectabanus Whitley, 1941*	0	0	1	2	**D**
Caranx rhonchus Geoffroy St. Hilaire, 1817	57	3536	43	1572	**L**
Cepola macrophthalma (Linnaeus, 1758)	0	0	9	30	**D**
Champsodon nudivittis (Ogilby, 1895)*	0	0	1478	13725	**D**
Chelidonichthys lastoviza (Bonnaterre, 1788)	2	124	22	272	**L**
Chelidonichthys lucerna (Linnaeus, 1758)	309	18396	17	3461	**L**
Chelon auratus (Risso, 1810)	1	157	0	0	**L**
Citharus linguatula (Linnaeus, 1758)	0	0	831	12368	**D**
Conger conger (Linnaeus, 1758)	1	411	0	0	**L**
Cynoglossus sinusarabici (Chabanaud, 1931)*	0	0	1	9	**D**
Dasyatis marmorata (Steindachner, 1892)$^{++}$	0	0	1	230	**D**
Dasyatis pastinaca (Linnaeus, 1758)$^{++}$	0	0	34	40168	**D**
Deltentosteus collonianus (Risso, 1820)	0	0	6	17	**D**
Deltentosteus quadrimaculatus (Valenciennes, 1837)	0	0	36	97	**D**
Diplodus annularis (Linnaeus, 1758)	38	2039	0	0	**L**
Dussumieria elopsoides Bleeker, 1849*	31	894	10	193	**L**
Echelus myrus (Linnaeus, 1758)	0	0	1	131	**D**
Echeneis naucrates Linnaeus, 1758	0	0	1	30	**D**
Engraulis encrasicolus (Linnaeus, 1758)	0	0	42	173	**D**
Epinephelus aeneus (Geoffroy St. Hilaire, 1817)	2	135	0	0	**L**
Epinephelus costae (Steindachner, 1878)	2	304	0	0	**L**
Equulites klunzingeri (Steindachner, 1898)*	0	0	1681	19312	**D**
Etrumeus golanii DiBattista, Randall & Bowen, 2012*	2	146	0	0	**L**
Glaucostegus cemiculus (Geoffroy St. Hilaire, 1817)$^{++}$	0	0	8	4951	**D**
Gobius niger Linnaeus, 1758	0	0	3	67	**D**
Gobius paganellus Linnaeus, 1758	0	0	1	8	**D**
Jaydia queketti (Gilchrist, 1903)*	0	0	26	105	**D**
Jaydia smithi Kotthaus, 1970*	0	0	49	381	**D**
Lagocephalus guentheri Miranda Ribeiro, 1915	0	0	40	1355	**D**
Lagocephalus suezensis Clark & Gohar, 1953*	0	0	35	795	**D**
Lepidotrigla cavillone (Lacepède, 1801)	0	0	17	179	**D**
Lepidotrigla dieuzeidei Blanc & Hureau, 1973	0	0	1	16	**D**
Merluccius merluccius (Linnaeus, 1758)	9	268	1	16	**L**

Table 2. Continued.

Species	Landed ($CPUE_A$)	Landed ($CPUE_W$)	Discard ($CPUE_A$)	Discard ($CPUE_W$)	Status
Mullus barbatus Linnaeus, 1758	159	10800	4	1130	**L**
Mustelus mustelus (Linnaeus, 1758)$^{++}$	0	0	2	750	**D**
Nemipterus randalli Russell, 1986*	1187	62856	1117	22317	**L**
Ostorhinchus fasciatus (Shaw, 1790)*	0	0	18	40	**D**
Oxyurichthys petersii (Klunzinger 1871)*	0	0	175	2673	**D**
Pagellus acarne (Risso, 1827)	168	5057	10	1032	**L**
Pagellus erythrinus (Linnaeus, 1758)	352	19220	13	677	**L**
Pelates quadrilineatus (Bloch, 1790)*	8	209	2	29	**L**
Pomatomus saltatrix (Linnaeus, 1766)	15	1767	0	0	**L**
Raja miraletus Linnaeus, 1758^{++}	0	0	1	191	**D**
Sardina pilchardus (Walbaum, 1792)	8	271	0	0	**L**
Saurida lessepsianus Russell, Golani & Tikochinski, 2015*	822	85731	112	7575	**L**
Scomber colias Gmelin, 1789	1	33	0	0	**L**
Serranus hepatus (Linnaeus, 1758)	0	0	100	1395	**D**
Siganus rivulatus Forsskål & Niebuhr, 1775*	2	54	0	0	**L**
Solea solea (Linnaeus, 1758)	50	6055	33	1676	**L**
Sparus aurata Linnaeus, 1758	773	65683	0	0	**L**
Sphyraena chrysotaenia Klunzinger, 1884*	1	156	0	0	**L**
Spicara smaris (Linnaeus, 1758)	0	0	4	47	**D**
Synodus saurus (Linnaeus, 1758)	2	103	0	0	**L**
Torquigener flavimaculosus Hardy & Randall, 1983*	0	0	1	27	**D**
Trachinus draco Linnaeus, 1758	0	0	6	343	**D**
Trachurus indicus Nekrasov, 1966*	28	1542	3	46	**L**
Trachurus mediterraneus (Steindachner, 1868)	2	16	0	0	**L**
Trachurus trachurus (Linnaeus, 1758)	3	40	87	294	**L**
Trichiurus lepturus Linnaeus, 1758	27	2513	3	25	**L**
Upeneus moluccensis (Bleeker, 1855)*	50	653	99	570	**L**
Upeneus pori Ben-Tuvia & Golani, 1989*	4	81	0	0	**L**
Zeus faber Linnaeus, 1758	0	0	3	6	**D**
Total	**4148**	**290120**	**6358**	**141367**	

Among Erythrean species, *Saurida lessepsianus* and *Nemipterus randalli* were the most important species that were obtained in the trawl fishery (Fig. 2). Also, these species constitute 41% of the landed catch. Gücü *et al.* (1994) estimated that about 30% of the Teleost catch from the bay belonged to *S. lessepsianus*. *Dasyatis pastinaca*, *Equulites klunzingeri* and *N. randalli* constituted 58% of the discard catch biomass while *E. klunzingeri*, *Champsodon nudivittis* and *N. randalli* were included in the abundance of discard catch with a percentage of 68%.

Conger conger, *Diplodus annularis*, *Epinephelus aeneus*, *E. costae*, *Etrumeus teres*, *Chelon auratus*, *Pomatomus saltatrix*, *Sardina pilchardus*, *Scomber colias*, *Siganus rivulatus*, *Sparus aurata*, *Sphyraena chrysotaenia*, *Synodus saurus*, *Trachurus mediterraneus* and *Upeneus pori* were not found in the discard catch. The local fishermen tend to evaluate all sizes of *E. aeneus*, *E. costae* and *S. aurata* in the landed catch. The intense trawl fisheries activity is the main threat for these fishes in the bay (Fig. 3).

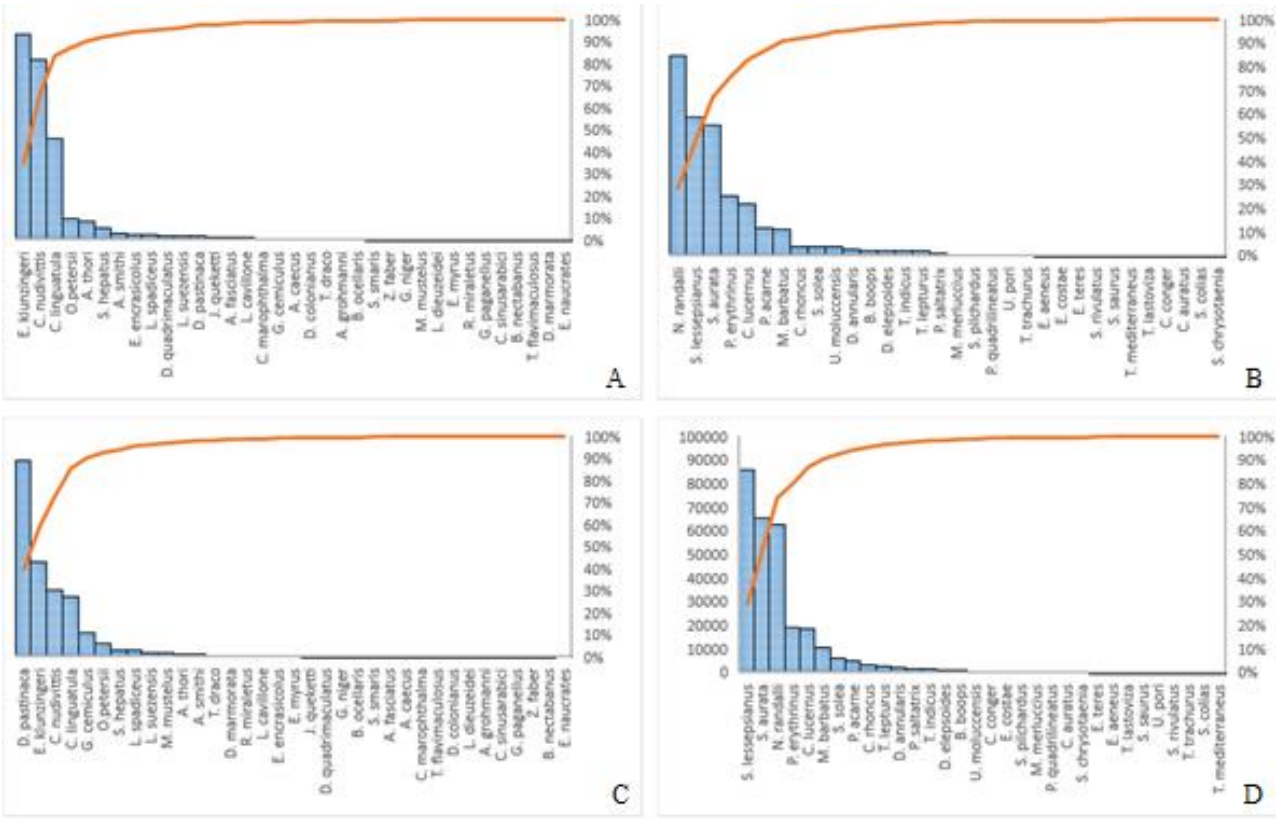

Fig. 2. The standardized values of the catch in the Iskenderun Bay; A) $CPUE_A$ of the discard catch, B) $CPUE_W$ of the discard catch, C) $CPUE_A$ of the landed catch, D) $CPUE_W$ of the landed catch.

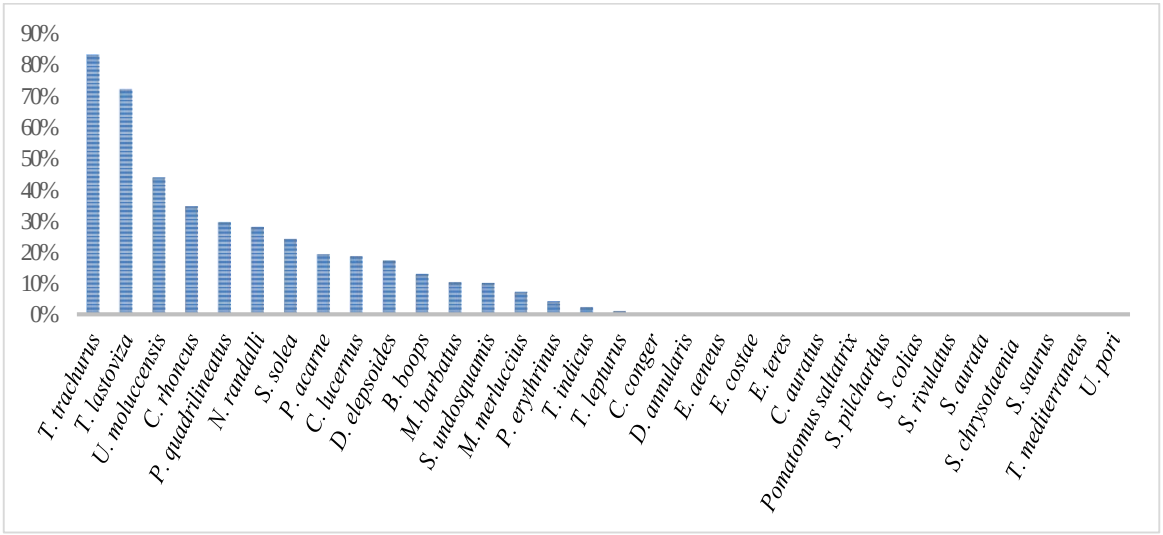

Fig. 3. The discard rates of fishes in the landed catch in the Iskenderun Bay at 2012-2013 fishing period.

In the Northeastern Levantine Sea, the catch and discard of the trawl fishery have a trend to decrease towards the end of the fishing season. The biomass value of seasonal catch declines sharply in the January-February period (Yemişken *et al.* 2014, Gökçe *et al.* 2016). The total catch biomass estimated in April was about 2 times higher than the February (Fig. 4). The depth range differences between the studies may have caused this mismatch.

Considering the values of trawl fishery of the bay, it appeared that most of the discard biomass consisted of chondrichthyes species that feed on carcasses formed as a result of intense fishing activity. Besides, two of the three species (*S. lessepsianus* and *N. randalli*) occupying the majority of the landed biomass belong to the Red Sea immigrants, indicating that the existence of these species in the region has irreversible effects. The dispersal success of the Red Sea immigrants plays a significant role

in the trawl fisheries and these species should be monitored with long-running studies.

Studies on discard catches are important in terms of fisheries management, especially for multispecies trawl fisheries. Additional comprehensive studies and long-term monitoring are needed in order to understand the population dynamics and to detect ultimate changes in the target area. Moreover, there is no study to reduce fishing pressure on the fish stocks, except Gücü (2012) who revealed that regulations of depth and fishing period had a positive effect to mitigate discard rates in the north-eastern Levantine Sea. Advanced studies should be encouraged in the area which has significant demersal resources that are under the pressure of intense fisheries activities.

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