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RESEARCH ARTICLE

Serranus species in the trawl catches of the Gulf of Antalya, Turkey (Eastern Mediterranean Sea)

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Abstract

A total of 116 hauls were carried out, between August 2009 and April 2010, seasonally in the Gulf of Antalya, at six stations and six depth levels (25, 50, 75, 100, 150, 200 m), using a commercial bottom trawl net and 1494 individuals of *Serranus cabrilla* (Linnaeus, 1758), 1022 individuals of *Serranus hepatus* (Linnaeus, 1758) and 17 individuals of *Serranus scriba* (Linnaeus, 1758) were sampled. The present paper reports the spatio-temporal patterns of abundance and biomass of these three *Serranus* species. The frequency of occurrence was 70.69% for *S. cabrilla*, 68.97% for *S. hepatus* and 6.03% for *S. scriba*. The overall mean abundance and biomass were 221.11 ind./km^2 and 6.93 kg/km^2 for *S. cabrilla*; 163.47 ind./km^2 and 1.84 kg/km^2 for *S. hepatus*, and 3.10 ind./km^2 and 0.15 kg/km^2 for *S. scriba.* This study provides information on the spatio-temporal distribution of these species in the region.

Keywords: Trawl survey, abundance, biomass, spatio-temporal distribution, Serranidae

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Introduction

The predatory marine fishes of the family Serranidae vary in size that can be from 4 cm to 3 m in length and have been the focus of studies because of their ecological role as top predators and commercial importance (Randall 1998; Nelson 2006). Previously, many studies from Turkey have reported the presence of the Serranidae species in trawl hauls (Başusta and Erdem 2000; Başusta *et al*. 2002; Türker Çakır and Torcu Koç 2002; Çiçek *et al*. 2004; Torcu Koç *et al.* 2004; İşmen *et al*. 2007; Leblebici *et al.* 2007; İlkyaz *et al.* 2008; Türker Çakır *et al.*

2008; Bilecenoğlu 2009; Düzbastılar *et al.* 2010; Keskin *et al*. 2011; Yapıcı *et al.* 2012; Gurbet *et al.* 2013; Yemişken *et al.* 2014; Akalın *et al.* 2015; Erdoğan and Torcu Koç 2016). However the CPUE and CPUA data of these species are quite limited (JICA 1993; Gücü and Bingel 1994; Salihoğlu and Mutlu 2000; Doğanyılmaz Özbilgin *et al.* 2006; Gücü 2012). The present paper reports the spatio-temporal patterns of abundance and biomass of the three species of *Serranus* from the Gulf of Antalya.

Materials and Methods

Study Area

The Gulf of Antalya is located in the northeastern Levantine Basin and is characterized by high temperature and salinity. The geographical coordinates of the trawling areas at six stations varied between N36° 52’ 485 - 36° 23’ 000 - E31° 32’ 322 - 30° 29’ 488 (Figure 1). Samplings were carried out at six depth levels (25, 50, 75, 100, 150, 200 m) at stations A and B. Because of the narrow and steep continental shelf, trawling at 150 and 200 m depth levels, however, could not be realized at stations C, D and E and 200 m at station F. The research was conducted seasonally, both in “closed fishing” season (August, 2009) and “open fishing” seasons (November, 2009; February, 2010 and April, 2010) and both in the no-trawl zones and open areas.

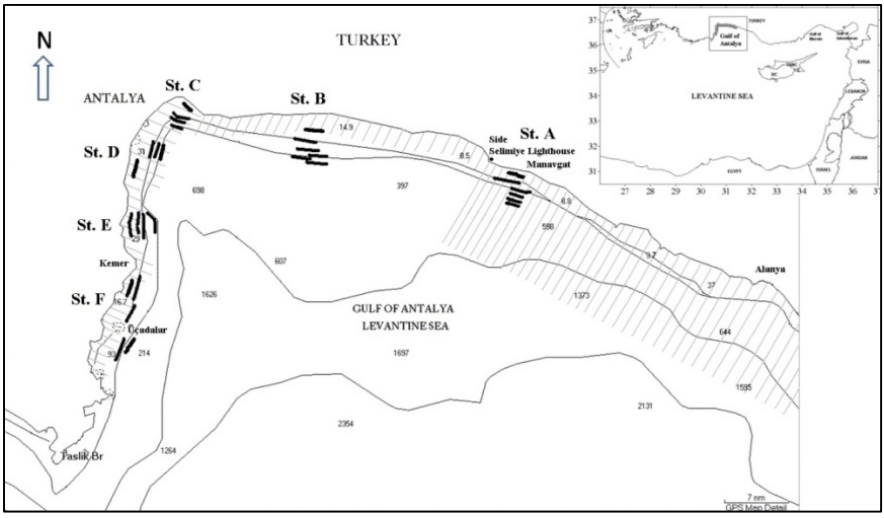

Figure 1. Map of the Gulf of Antalya- Turkey (NE Mediterranean Sea) showing the six sampling stations (named A, B, C, D, E, F from east to west) and the location and depth levels of 29 trawl hauls. The areas marked with gray lines showing “no-trawl zones”.

Turkish national regulation on commercial fisheries covers a complex scheme of open/closed (permitted/forbidden) zones and seasons for trawl fisheries (Anonymous 2016). Bottom trawling is prohibited during the fishing year within 2 NM off the coast and between 15 April and 15 September in territorial waters where trawling is permitted. Since 2005 till today, all sorts of trawling activities are also prohibited in territorial waters off Antalya Province, Side District, Selimiye Lighthouse (36º45,928' N- 31º 23,092' E) and Alanya, Gazipaşa District, Kesik Cape (36º 09,964' N- 32º23,418' E) where there is station A and also the mouth of the Manavgat River (covers the area marked with long lines in Figure 1). The main commercial trawl area in the Gulf of Antalya is represented by station B where two main streams reach the sea. Stations C and D are located off the yacht marina and great harbor of Antalya, respectively, and both are closed zones for trawling. The depth levels of 25 and 50 m in stations E and F are located within 2 NM off the coast, thus closed for trawling, but it is permitted in deeper areas.

Sampling Methods

A total of 116 hauls were conducted during the daytime. The duration of each haul was limited to one hour. Trawling was carried out by a commercial fishing vessel "Akyarlar" which was 24.80 m long with 450 HP engine. The cod-end mesh size was 22 mm (knot to knot) and the average towing speed was 2.5 NM/h. *Serranus* individuals were identified, counted, and the total catch weight (Wet Weight, WW: ±1.0 g) were recorded on board immediately after capture.

Data Analyses

The total catch from each haul was identified to species, counted, weighed and the stock amount was calculated according to the swept area method; the abundance and catch weight (Cw) divided by the swept area (a) for each species and for each haul (Sparre and Venema 1992). The coordinates of the trawl operation were recorded by 30 seconds intervals by GPS and the cover of distance was calculated by summing the distances between the recorded coordinates. The swept area (a) for each haul was estimated as $a = D.h.X$ (h: length of the head-rope, *D:* cover of distance, *X:* fraction of the headrope length which was equal to the width of the path swept by the trawl (accepted as 0.5). Abundance (number of individuals per km^2) and biomass (kg per km^2) per sampling were calculated, and the mean values were computed according to seasons, stations and depth levels. Euclidean distance dissimilarity matrix, based on the log-transformed abundance and biomass was tested by 3-way orthogonal nonparametric (permutation-based) MANOVA (PERMANOVA) for assessing differences at seasons, stations and depth levels under a model in which all of them are fixed factors using PRIMER 6+ PERMANOVA software package (Anderson *et al.* 2008). All the statistical analyses were considered at a significance level of 5% ($P<0.05$).

Results

During the study in which 116 hauls were carried out, 1494 individuals of *Serranus cabrilla* (Linnaeus, 1758), 1022 individuals of *Serranus hepatus* (Linnaeus, 1758) and 17 individuals of *Serranus scriba* (Linnaeus, 1758) were sampled. The frequency of occurrence was 70.69% for *S. cabrilla*, 68.97% for *S. hepatus* and 6.03% for *S. scriba*. The abundance and biomass data of these species and the PERMANOVA results for assessing the differences according to seasons, stations and depth levels are shown in Tables 1-6. Seasonal differences were only found in the abundance and biomass of *S. cabrilla*. The differences among stations were statistically significant in the abundance and biomass of *S. cabrilla* and *S. hepatus*, especially apparent between the stations in the eastern and western part of the gulf. Bathymetric variation was also found in the abundance and biomass of the three *Serranus* species.

Discussion

The studies reporting the CPUE/CPUA values of the three *Serranus* species in trawl hauls compared to the present results are given in Tables 7-9. For comparison, the overall average abundance and biomass of the species were calculated according to the CPUA (ind./km^2; kg/km^2) and CPUE (ind./h; kg/h) for each and overall depth levels.

The highest biomass values for *S. cabrilla* were reported from the Gulf of Mersin (Northeast Med. Sea) (Salihoğlu and Mutlu 2000) and the South Aegean Sea (JICA 1993); for *S. hepatus* from the South Aegean Sea (JICA 1993) and the Gulf of İzmir (Aegean Sea) (Doğanyılmaz Özbilgin *et al.* 2006), and for *S. scriba* from the North Aegean Sea (JICA 1993) and the Gulf of İzmir (Doğanyılmaz Özbilgin *et al.* 2006). Although there are no big differences among the results of different studies for the frequent species, *S. cabrilla* and *S. hepatus,* the long intervals between the studies complicate the interpretation of the main reasons of the differences. However, this study showed that the low mean abundance, biomass and frequency of occurrence values of these species in station B, which is the main commercial trawl area of the gulf, can be interpreted as a possible fishing effect. Slightly higher abundance and biomass in station A compared to station B may also be explained as the recovery of the "no-trawl zone". Similar distribution patterns were also previously reported for different species in the Gulf of Antalya (Ozgur Ozbek *et al.* 2013; 2015; 2016). Previous studies have well documented that demersal stocks, particularly in high-latitude regions, suffer from over-fishing and as a result, there is a decreasing trend in abundance, biomass and size composition toward a relative decline in larger fish (Jennings and Kaiser 1998; Jennings *et al.* 1999; Bianchi *et al.* 2000; Myers and Worm 2003; Rochet and Trenkel 2003; Quetglas *et al.* 2013 and references therein).

Table 1. The mean abundance (ind./km^2) and biomass (kg/km^2) of *Serranus cabr illa* caught in the Gulf of Antalya according to seasons, stations and depth levels (Mean abundance (ind./km^2(±se)), percentage of total sum of individuals (ind.%), mean biomass (kg/km^2(±se)), percentage of total sum of biomass (bio.%), frequency of occurrence (F%)).

		No. of hauls	ind./km^2 (±se)	ind./hour (±se)	ind. %	kg/km^2 (±se)	kg/hour (±se)	bio. %	F%
Season	Summer	29	182.78±48.01	12.60±3.28	20.7	7.28±2.17	0.50±0.15	26.2	86.21
	Autumn	29	441.76±143.08	29.80±9.83	49.9	11.63±3.50	0.77±0.23	41.9	75.86
	Winter	29	159.46±51.42	11.19±3.57	18.0	5.29±1.85	0.37±0.13	19.1	62.07
	Spring	29	100.43±33.75	7.29±2.47	11.4	3.54±1.03	0.26±0.08	12.8	62.07
Station	A	24	255.74±151.71	17.65±10.58	23.9	4.00±1.38	0.27±0.09	11.9	58.33
	B	24	120.63±80.27	7.83±5.09	11.3	4.38±3.23	0.28±0.20	13.1	50.00
	C	16	131.16±18.66	9.45±1.37	8.2	4.36±0.63	0.31±0.05	8.7	100.00
	D	16	191.98±50.08	12.77±3.35	12.0	7.25±1.65	0.47±0.11	14.4	87.50
	E	16	494.16±122.13	34.35±8.46	30.8	19.52±5.21	1.35±0.36	38.8	100.00
	F	20	176.92±60.28	12.45±4.21	13.8	5.26±1.88	0.37±0.13	13.1	55.00
Depth(m)	25	24	108.41±36.93	7.65±2.61	10.1	4.79±2.24	0.34±0.16	14.3	66.67
	50	24	401.03±94.97	27.82±6.59	37.5	13.72±3.44	0.94±0.24	40.9	91.67
	75	24	159.54±35.79	10.92±2.38	14.9	6.31±1.54	0.43±0.10	18.8	79.17
	100	24	374.12±162.27	25.44±11.12	35.0	8.36±3.22	0.55±0.20	24.9	79.17
	150	12	23.61±14.94	1.63±1.06	1.1	0.58±0.32	0.04±0.02	0.9	41.67
	200	8	41.32±39.69	2.77±2.66	1.3	0.14±0.10	0.01±0.01	0.1	25.00
Total		**116**	**221.11±42.02**	**15.22±2.89**	**100**	**6.93±1.18**	**0.47±0.08**	**100**	**71.55**

Table 2. Results of PERMANOVA for abundance (individuals per km^2) and biomass (kg per km^2) of *Serranus cabrilla* with seasons, stations and depth levels as fixed factors: bold number shows that P-value is less than 0.05 (df: degree of freedom, SS: sum of squares, MS: mean square, F: F-value, P (perm): calculated probability value; number of iterations = 1000)

		Abundance				Biomass			
Source	**df**	**SS**	**MS**	**F**	**P (perm)**	**SS**	**MS**	**F**	**P (perm)**
Season	3	36.650	12.217	4.057	**0.011**	92.251	30.750	3.699	**0.016**
Station	5	94.000	18.800	6.243	**0.001**	263.590	52.719	6.341	**0.001**
Depth	5	86.591	17.318	5.751	**0.001**	213.180	42.636	5.129	**0.003**
Seas. x St.	15	34.166	2.278	0.756	0.710	69.805	4.654	0.560	0.888
Seas. x Depth	15	64.330	4.289	1.424	0.175	164.150	10.943	1.316	0.243
St. x Depth	18	144.960	8.053	2.674	**0.008**	333.900	18.550	2.231	**0.017**
Residual	54	162.610	3.011			448.930	8.313		
Total	**115**	**709.24**				**1815.600**			

Table 3. The mean abundance (ind./km^2) and biomass (kg/km^2) of *Serranus hepatus* caught in the Gulf of Antalya according to seasons, stations and depth levels (Mean abundance (ind./km^2(±se)), percentage of total sum of individuals (ind.%), mean biomass (kg/km^2(±se)), percentage of total sum of biomass (bio.%), frequency of occurrence (F%)).

		No. of hauls	ind./km^2 (±se)	ind./hour (±se)	ind. %	kg/km^2 (±se)	kg/hour (±se)	bio. %	F%
Season	Summer	29	205.10±82.46	13.69±5.50	31.4	1.88±0.71	0.12±0.05	25.5	62.07
	Autumn	29	218.37±74.22	14.87±5.43	33.4	2.25±0.64	0.15±0.05	30.6	79.31
	Winter	29	123.59±29.71	8.72±2.10	18.9	1.99±0.52	0.14±0.04	27.1	65.52
	Spring	29	106.84±25.99	7.61±1.87	16.3	1.24±0.31	0.09±0.02	16.8	72.41
Station	A	24	62.34±22.14	4.17±1.48	7.9	0.92±0.40	0.06±0.03	10.3	50.00
	B	24	77.95±29.72	5.29±2.07	9.9	0.92±0.39	0.06±0.03	10.3	54.17
	C	16	296.68±124.50	21.87±9.39	25.0	2.95±1.04	0.22±0.08	22.1	81.25
	D	16	327.25±85.21	20.92±5.27	27.6	3.68±0.97	0.24±0.06	27.6	81.25
	E	16	257.65±125.55	17.81±8.51	21.7	2.80±0.98	0.19±0.07	21.0	81.25
	F	20	74.54±16.04	5.25±1.14	7.9	0.92±0.21	0.06±0.01	8.6	85.00
Depth(m)	25	24	29.30±12.51	2.10±0.91	3.7	0.39±0.16	0.03±0.01	4.4	29.17
	50	24	233.65±90.11	15.71±5.99	29.6	2.65±0.75	0.18±0.05	29.7	83.33
	75	24	214.34±55.21	14.94±3.91	27.1	2.14±0.59	0.15±0.04	24.1	87.50
	100	24	277.02±85.03	19.13±6.20	35.1	3.27±0.81	0.23±0.06	36.8	91.67
	150	12	59.86±21.35	3.96±1.41	3.8	0.82±0.32	0.05±0.02	4.6	75.00
	200	8	17.67±14.93	1.14±0.96	0.7	0.11±0.09	0.01±0.01	0.4	25.00
Total		**116**	**163.47±29.41**	**11.22±2.05**	**100**	**1.84±0.28**	**0.13±0.02**	**100**	**69.83**

Table 4. Results of PERMANOVA for abundance (individuals per km^2) and biomass (kg per km^2) of *Serranus hepatus* with seasons, stations and depth levels as fixed factors: bold number shows that P-value is less than 0.05 (df: degree of freedom, SS: sum of squares, MS: mean square, F: F-value, P (perm): calculated probability value; number of iterations = 1000)

		Abundance				Biomass			
Source	**df**	**SS**	**MS**	**F**	**P (perm)**	**SS**	**MS**	**F**	**P (perm)**
Season	3	9.554	3.185	1.182	0.332	19.557	6.519	0.959	0.428
Station	5	64.978	12.996	4.821	**0.001**	121.390	24.278	3.571	**0.012**
Depth	5	187.500	37.499	13.912	**0.001**	396.020	79.205	11.649	**0.001**
Seas. x St.	15	95.878	6.392	2.371	**0.009**	153.820	10.255	1.508	0.136
Seas. x Depth	15	72.266	4.818	1.787	0.053	152.110	10.140	1.491	0.138
St. x Depth	18	54.468	3.026	1.123	0.342	105.900	5.883	0.865	0.652
Residual	54	145.550	2.695			367.170	6.800		
Total	**115**	**663.010**				**1384.700**			

Table 5. The mean abundance (ind./km^2) and biomass (kg/km^2) of *Serranus scriba* caught in the Gulf of Antalya according to seasons, stations and depth levels (Mean abundance (ind./km^2(±se)), percentage of total sum of individuals (ind.%), mean biomass (kg/km^2(±se)), percentage of total sum of biomass (bio.%), frequency of occurrence (F%)).

		No. of hauls	ind./km^2 (±se)	ind./hour (±se)	ind.%	kg/km^2 (±se)	kg/hour (±se)	bio.%	F%
Season	Summer	29	-	-	-	-	-	-	-
	Autumn	29	3.93±2.73	0.25±0.18	31.7	0.18±0.12	0.01±0.01	30.0	6.90
	Winter	29	4.91±3.12	0.34±0.22	39.6	0.24±0.16	0.02±0.01	41.0	10.34
	Spring	29	3.55±2.92	0.24±0.19	28.7	0.17±0.14	0.01±0.01	29.0	6.90
Station	A	24	3.16±3.16	0.22±0.22	21.1	0.17±0.17	0.01±0.01	24.5	4.17
	B	24	8.20±4.61	0.53±0.30	54.8	0.39±0.22	0.02±0.01	54.3	12.50
	C	16	-	-	-	-	-	-	-
	D	16	-	-	-	-	-	-	-
	E	16	-	-	-	-	-	-	-
	F	20	4.33±2.74	0.31±0.20	24.1	0.18±0.11	0.01±0.01	21.2	15.00
Depth(m)	25	24	11.10±5.30	0.74±0.35	74.1	0.53±0.26	0.04±0.02	73.9	16.67
	50	24	3.04±2.44	0.20±0.16	20.3	0.15±0.12	0.01±0.01	21.3	8.33
	75	24	0.84±0.84	0.06±0.06	5.6	0.03±0.03	0.00±0.00	4.7	4.17
	100	24	-	-	-	-	-	-	-
	150	12	-	-	-	-	-	-	-
	200	8	-	-	-	-	-	-	-
	Total	**116**	**3.10±1.26**	**0.21±0.08**	**100**	**0.15±0.06**	**0.01±0.00**	**100**	**6.03**
Total									

Table 6. Results of PERMANOVA for abundance (individuals per km^2) and biomass (kg per km^2) of *Serranus scriba* with seasons, stations and depth levels as fixed factors: bold number shows that P-value is less than 0.05 (df: degree of freedom, SS: sum of squares, MS: mean square, F: F-value, P (perm): calculated probability value; number of iterations = 1000)

		Abundance				Biomass			
Source	**df**	**SS**	**MS**	**F**	**P (perm)**	**SS**	**MS**	**F**	**P (perm)**
Season	3	0.472	0.157	0.189	0.903	2.066	0.689	0.208	0.879
Station	5	8.898	1.780	2.132	0.077	35.526	7.105	2.148	0.075
Depth	5	10.819	2.164	2.592	**0.039**	40.069	8.014	2.423	**0.047**
Seas. x St.	15	15.137	1.009	1.209	0.302	60.267	4.018	1.215	0.279
Seas. x Depth	15	7.878	0.525	0.629	0.840	31.129	2.075	0.627	0.832
St. x Depth	18	12.074	0.671	0.803	0.692	45.511	2.528	0.764	0.740
Residual	54	45.087	0.835			178.620	3.308		
Total	115	98.138				384.780			

Table 7. Comparison of the mean abundance and biomass of *S. cabrilla* to the previous studies (CPUA= Catch per Unit Trawling Area (ind./km^2, kg/km^2); CPUE= Catch per Unit Trawling Effort (ind./time, kg/time))

Location	Date	Depth (m)	CPUA-	CPUE	Source
N Aegean Sea- Turkey	all seasons 1991/92	20-100 m	9.48 kg/km^2	-	1
N Aegean Sea- Turkey	all seasons 1991/92	101-200 m	7.78 kg/km^2	-	1
S Aegean Sea- Turkey	all seasons 1991/92	20-100 m	36.95 kg/km^2	-	1
S Aegean Sea- Turkey	all seasons 1991/92	101-200 m	6.95 kg/km^2	-	1
W Mediterranean Sea- Turkey	all seasons 1991/92	20-100 m	1.13 kg/km^2	-	1
W Mediterranean Sea- Turkey	all seasons 1991/92	101-200 m	5.63 kg/km^2	-	1
E Mediterranean Sea- Turkey	all seasons 1991/92	20-100 m	2.4 kg/km^2	-	1
E Mediterranean Sea- Turkey	all seasons 1991/92	101-200 m	0.7 kg/km^2	-	1
All areas surveyed- Turkey	all seasons 1991/92	20-100 m	8.83 kg/km^2	-	1
All areas surveyed- Turkey	all seasons 1991/92	101-200 m	5.23 kg/km^2	-	1
Mersin Bay- Turkey (NE Med. Sea)	May 1984	13-56	2824 g/h	-	2
Mersin Bay- Turkey (NE Med. Sea)	Oct.1984	25-45	600 g/h	-	2
Mersin Bay- Turkey (NE Med. Sea)	May 1984	infralittoral	4900 g/30 min	-	3
Mersin Bay- Turkey (NE Med. Sea)	May 1984	circalittoral	750 g/30 min	-	3
Mersin Bay- Turkey (NE Med. Sea)	May 1999	infralittoral	116 g/30 min	-	3
Mersin Bay- Turkey (NE Med. Sea)	May 1999	circalittoral	554 g/30 min	-	3
Mersin Bay- Turkey (NE Med. Sea)	22 June 1999	0-25	1 g/30 min	-	3
Mersin Bay- Turkey (NE Med. Sea)	17 June 1998	25-50	67 g/30 min	-	3
Mersin Bay- Turkey (NE Med. Sea)	10 Dec.1996	50-100	50 g/30 min	-	3
Average of 4 hauls in Mersin Bay- Turkey	July-Dec.1996	50-100	13 g/30 min	-	3
Average of 14 hauls in Mersin Bay- Turkey	July- Dec.1996	0-100	4 g/h	-	3
Average of 20 hauls in Mersin Bay- Turkey	April- Oct.1998	0-100	4 g/h	-	3
N Cyprus (NE Med. Sea)	Nov. 1996	70-76	1100 g/30 min	-	3
N Cyprus (NE Med. Sea)	Nov. 1996	83-90	50 g/30 min	-	3
Average of 14 hauls in İskenderun and Mersin Bays and North Cyprus (NE Med. Sea)	Nov. 1996	14-90	96 g/h	-	3
Catalan coast, Spain (NW Med. Sea)	July 1995 -June 1996	14-35	0.52 kg/h	-	4
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	25	108.41 ind/km^2 7.65 ind/h	4.79 kg/km^2 337.3 g/h	5 5
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	50	401.03 ind/km^2 27.82 ind/h	13.72 kg/km^2 943.8 g/h	5 5
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	75	159.54 ind/km^2 10.92 ind/h	6.31 kg/km^2 430.7 g/h	5 5
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	100	374.12 ind/km^2 25.44 ind/h	8.36 kg/km^2 553.7 g/h	5 5
Average of 12 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	150	23.61 ind/km^2 1.63 ind/h	0.58 kg/km^2 39.8 g/h	5 5
Average of 8 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	200	41.32 ind/km^2 2.77 ind/h	0.14 kg/km^2 9.5 g/h	5 5
Average of 116 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	25-200	221.11 ind/km^2- 15.22 ind/h	6.93 kg/km^2 473.5 g/h	5 5

Source: 1) JICA (1993), 2) Gücü and Bingel (1994), 3) Salihoğlu and Mutlu (2000), 4) Sánchez *et al.* (2004), 5) Present study

Table 8. Comparison of the mean abundance and biomass of *S. hepatus* to the previous studies (CPUA= Catch per Unit Trawling Area (ind./km^2, kg/km^2); CPUE= Catch per Unit Trawling Effort (ind./time, kg/time))

Location	Date	Depth (m)	CPUA-CPUE	Source
All areas surveyed-Turkey	Winter 1991/92	20-100 m	21.4 kg/km^2	1
Sea of Marmara-Turkey	Autumn 1992	20-100 m	42.5 kg/km^2	1
Sea of Marmara-Turkey	Winter 1991/92	20-100 m	41.3 kg/km^2	1
N Aegean Sea-Turkey	Autumn 1992	20-100 m	15.1 kg/km^2	1
S Aegean Sea-Turkey	Summer 1991	20-100 m	42.1 kg/km^2	1
S Aegean Sea-Turkey	Winter 1991/92	20-100 m	46.3 kg/km^2	1
Mersin Bay- Turkey (NE Med. Sea)	May 1984	infralittoral	700 g/30 min	2
Mersin Bay- Turkey (NE Med. Sea)	May 1984	circalittoral	370 g/30 min	2
Mersin Bay- Turkey (NE Med. Sea)	May 1999	infralittoral	28 g/30 min	2
Mersin Bay- Turkey (NE Med. Sea)	May 1999	circalittoral	145.5 g/30 min	2
Average of 14 hauls in Mersin Bay- Turkey	July- Dec.1996	0-100	13 g/h	2
Average of 4 hauls in Mersin Bay- Turkey	July- Dec.1996	50-100	15 g/30 min	2
Average of 5 hauls in Mersin Bay- Turkey	July- Dec.1996	0-25	20 g/30 min	2
Average of 5 hauls in Mersin Bay- Turkey	July- Dec.1996	25-50	4 g/30 min	2
Average of 20 hauls in Mersin Bay- Turkey	April- Oct.1998	0-100	6 g/h	2
Average of 12 hauls in Mersin Bay- Turkey	March-June 1999	0-100	6 g/h	2
İskenderun Bay- Turkey (NE Med. Sea)	Nov. 1996	49-38	3 g/30 min	2
İskenderun Bay- Turkey (NE Med. Sea)	Nov. 1996	63-61	10 g/30 min	2
Average of 14 hauls in İskenderun and Mersin Bays and North Cyprus (NE Med. Sea)	Nov. 1996	14-90	102 g/h	2
N Cyprus (NE Med. Sea)	Nov. 1996	70-76	700 g/30 min	2
N Cyprus (NE Med. Sea)	Nov. 1996	83-90	490 g/30 min	2

Table 8. Continued

Location	Date	Depth (m)	CPUA-CPUE	Source
Average of 6 hauls in İzmir- Turkey (Aegean Sea)	9 Aug.- 4 Sep. 2002	35-55	6 kg/45 min	3
Average of 12 hauls in Gulf of Thermaikos, Macedonia (Aegean Sea)	Jan.-Aug. 2009	31-65	475 ind/h- 6678 g/h	4
Average of 10 hauls in Gulf of Argolikos, Greece (Aegean Sea)	Jan.-Aug. 2009	31-65	151 ind/h- 1220 g/h	4
Average of monthly hauls in Mersin - Turkey	1980s	0->50	36 g/h	5
Average of monthly hauls in Mersin - Turkey	May 2007- March 2010	0-25	5 g/h	5
Average of monthly hauls in Mersin - Turkey	May 2007- March 2010	25-50	64 g/h	5
Average of monthly hauls in Mersin - Turkey	May 2007- March 2010	50-100	923 g/h	5
Average of monthly hauls in Mersin - Turkey	May 2007- March 2010	100-250	13 g/h	5
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	25	29.30 ind/km^2- 0.39 kg/km^2 2.10 ind/h- 27.6 g/h	6 6
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	50	233.65 ind/km^2- 2.65 kg/km^2 15.71 ind/h- 178.3 g/h	6 6
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	75	214.34 ind/km^2- 2.14 kg/km^2 14.94 ind/h- 149.2 g/h	6 6
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	100	277.02 ind/km^2- 3.27 kg/km^2 19.13 ind/h- 225.1 g/h	6 6
Average of 12 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	150	59.86 ind/km^2- 0.82 kg/km^2 3.96 ind/h- 54.6 g/h	6 6
Average of 8 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	200	17.67 ind/km^2- 0.11 kg/km^2 1.14 ind/h- 7.3 g/h	6 6
Average of 116 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	25-200	163.47 ind/km^2- 1.84 kg/km^2 11.22 ind/h- 126.2 g/h	6 6

Source: 1) JICA (1993), 2) Salihoğlu & Mutlu (2000), 3) Doğanyılmaz Özbilgin *et al.* (2006), 4) Klaoudatos *et al.* (2010), 5) Gücü (2012), 6) Present study

Table 9. Comparison of the mean abundance and biomass of *S. scriba* to the previous studies (CPUA= Catch per Unit Trawling Area (ind./km^2, kg/km^2); CPUE= Catch per Unit Trawling Effort (ind./time, kg/time))

Location	Date	Depth (m)	CPUA-CPUE	Source
N Aegean Sea	all seasons, 1991/92	20-100 m	1.8 kg/km^2	1
Average of 6 hauls in İzmir- Turkey (Aegean Sea)	9 Aug.- 4 Sep. 2002	35-55	1.65 kg/45 min	2
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	25	11.10 ind/km^2- 0.53 kg/km^2	3
			0.74 ind/h- 35.1 g/h	3
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	50	3.04 ind/km^2- 0.15 kg/km^2	3
			0.20 ind/h- 10.0 g/h	3
Average of 24 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	75	0.84 ind/km^2- 0.03 kg/km^2	3
			0.06 ind/h- 2.6 g/h	3
Average of 116 hauls in Gulf of Antalya - Turkey	Aug. 2009- April 2010	25-200	3.10 ind/km^2- 0.15 kg/km^2	3
			0.21 ind/h- 9.9 g/h	3

Source: 1) JICA (1993), 2) Doğanyılmaz Özbilgin *et al.* (2006), 3) Present study

It is essential to determine the spawning and nursery grounds of the demersal species and declare these areas "No Take Zones" which is going to affect positively not only the species but also the whole ecosystem they live in. The values presented in this study are the first detailed information on the spatial and temporal distributions of these species from the region.

Special attention and more implementation are necessary for monitoring the biodiversity of the areas open and closed to bottom trawling in the "pre & post fishing seasons". Thus long-term approaches are required to determine the distribution and status of the stocks if the lack of relevant literature from this region is concerned.

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Antalya Körfezi'nde trolle yakalanan *Serranus* türleri (Doğu Akdeniz, Türkiye)

Öz

Antalya Körfezi'nde, Ağustos 2009 ile Nisan 2010 dönemi arasında mevsimsel olarak, altı istasyonda ve altı farklı derinlikte (25, 50, 75, 100, 150, 200 m), gerçekleştirilen toplam 116 trol çekiminde 1494 birey *Serranus cabrilla* (Linnaeus, 1758), 1022 birey *Serranus hepatus* (Linnaeus, 1758) ve 17 birey *Serranus scriba* (Linnaeus, 1758) örneklenmiştir. Bu çalışmada belirtilen üç *Serranus* türünün mevsim, istasyon ve derinliklere göre bolluk ve biyokütlesi bildirilmektedir. Görülme sıklığı *S. cabrilla* için %70,69, *S. hepatus* için %68,97 ve *S. scriba* için %6,03'dür. Ortalama bolluk ve biyokütle *S. cabrilla* için 221,11 birey/km^2 ile 6,93 kg/km^2; *S. hepatus* için 163,47 birey/km^2 ile 1,84 kg/km^2 ve *S. scriba* için 3,10 birey/km^2 ile 0,15 kg/km^2 olarak hesaplanmıştır. Bu çalışma bu türlerin mevsimsel ve mekansal dağılımlarıyla ilgili bölgede yapılmış en ayrıntılı çalışmadır.

Anahtar Kelimeler: Trol, bolluk, biyokütle, mevsimsel ve mekansal dağılım, Serranidae.

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