Research Article
Turkish Journal of Maritime and Marine Sciences

DOI: 10.52998/trjmms.1677532
Volume: XX Issue: XX (20XX) XX-XX

Spatial and Temporal Variation of Catch per Unit Effort (CPUE) in Small-Scale Fisheries Along the Turkish Coast

Türkiye Kıyılarındaki Küçük Ölçekli Balıkçılıkta Birim Çaba Başına Düşen Av Miktarının (CPUE) Mekansal ve Zamansal Değişimi

Türk Denizcilik ve Deniz Bilimleri Dergisi

Cilt: XX Sayı: XX (20XX) XXX-XXX

Hakkı DERELİ[1,*], Erdal ÜSTÜNDAĞ[2], Hüseyin AKBAŞ[3], Mustafa Agah TEKİNDAL[4]

[1]*Department of Fisheries and Seafood Processing Technology, Faculty of Fisheries, İzmir Katip Çelebi University, Türkiye*
[2]*Department of Statistics and Information Systems, General Directorate of Fisheries and Aquaculture, Türkiye*
[3]*Department of Fisheries, Institute of Science, İzmir Katip Çelebi University, Türkiye*
[4]*Department of Biostatistics, Faculty of Medicine, İzmir Katip Çelebi University, Türkiye*

ABSTRACT

Fishery-dependent catch per unit effort (CPUE) values are an important indicator for assessing stock abundance due to the high cost of fishery-independent research. In this study, it was aimed to determine the spatial (Black Sea, Sea of Marmara, Aegean Sea and Mediterranean Sea) and temporal (2016-2022) changes in the fishing effort and CPUE values of small-scale fisheries (SSF) along the Turkish coast. Records collected by the Ministry of Agriculture and Forestry between 2017 and 2023 within the scope of the support implemented for SSF were retrospectively examined and analyzed. The fishing effort (fishing days per year) and CPUE (kg/vessel/day and kg/kW/day) values were calculated for the whole sea and segments (year and sea), and statistical comparisons were made with one-way analysis of variance (ANOVA). This study was the first to include engine power (kW) in the calculation of CPUE in Turkish SSF. The fishing days decreased by 32 days from 2016 to 2022 and the differences between the years and between the seas were statistically significant ($p < 0.001$). While higher CPUE (kg/vessel/day) values were obtained in 2022 compared to 2016 in all seas ($p < 0.05$). The highest CPUE (kg/vessel/day) values in all years were in the Black Sea, and the lowest values were in the Aegean Sea ($p < 0.001$). The CPUE (kg/kW/day) for the whole sea decreased by 7% in 2022 compared to 2016. Fishing days per year was lower and the CPUE (kg/vessel/day) were higher compared to the previous periods.

Keywords: Small-scale fisheries, CPUE, Black Sea, Aegean Sea, Mediterranean Sea, Sea of Marmara

Article Info
Received: 16 April 2025
Revised: 16 May 2025
Accepted: 21 May 2025

[*](corresponding author)
E-mail: hakkidereli@gmail.com

To cite this article: Dereli, H., Üstündağ, E., Akbaş, H., Tekindal, M.A., (20XX). Spatial and Temporal Variation of Catch per Unit Effort (CPUE) in Small-Scale Fisheries Along the Turkish Coast, *Turkish Journal of Maritime and Marine Sciences*, XX (XX): XX-XX. doi: 10.52998/trjmms.1677532.

ÖZET

Balıkçılığa bağlı birim çaba başına düşen av miktarı (CPUE) değerleri, balıkçılıktan bağımsız araştırmaların yüksek maliyeti nedeniyle stok bolluğunun değerlendirilmesinde önemli bir göstergedir. Bu çalışmada, Türkiye kıyılarındaki küçük ölçekli balıkçılığın (SSF) balıkçılık çabası ve CPUE değerlerindeki mekansal (Karadeniz, Marmara Denizi, Ege Denizi ve Akdeniz) ve zamansal (2016-2022) değişimlerin belirlenmesi amaçlanmıştır. SSF'ye yönelik uygulanan destek kapsamında Tarım ve Orman Bakanlığı'nın 2017-2023 yılları arasında tuttuğu kayıtlar retrospektif olarak incelenmiş ve analiz edilmiştir. Balıkçılık çabası (yılda balıkçılık gün sayısı) ve CPUE (kg/gemi/gün ve kg/kW/gün) değerleri tüm deniz ve segmentler (yıl ve deniz) için hesaplanmış ve istatistiksel karşılaştırmalar tek yönlü varyans analizi (ANOVA) ile yapılmıştır. Bu çalışma, Türkiye küçük ölçekli balıkçılığında CPUE hesaplamasına motor gücünü (kW) dahil eden ilk çalışmadır. Balıkçılık gün sayısında 2016-2022 yılları arasında 32 gün azalma olmuş, yıllar ve denizler arası farklar istatistiksel olarak anlamlı bulunmuştur ($p < 0,001$). 2022 yılında tüm denizlerde 2016 yılına göre daha yüksek CPUE (kg/tekne/gün) değerleri elde edilmiştir ($p < 0,05$). Tüm yıllarda en yüksek CPUE (kg/gemi/gün) değerleri Karadeniz'de, en düşük değerler ise Ege Denizi'nde elde edilmiştir ($p < 0,001$). Tüm denizler birlikte değerlendirildiğinde CPUE (kg/kW/gün) 2016 yılına göre 2022 yılında %7 azalmıştır. Balıkçılık gün sayısı önceki dönemlere göre daha düşük, CPUE (kg/gemi/gün) ise daha yüksektir.

Anahtar sözcükler: Küçük ölçekli balıkçılık, CPUE, Karadeniz, Ege Denizi, Akdeniz, Marmara Denizi

1. INTRODUCTION

Small-scale fisheries, which provide about half of the world's seafood production, contribute to nutrition, food security, sustainable livelihoods, poverty reduction and employment, especially in developing countries (Berkes *et al.*, 2001; Birkan and Öndes, 2020; FAO, 2022a). These goals/contributions are also included in the United Nations' 17 Sustainable Development Goals (United Nations, 2023).

Small-scale fisheries in the Mediterranean and Black Sea are characterized by the use of small-sized vessels and by very heterogeneous landing locations, different types of fishing gears (e.g. gillnets, trammel nets, combined nets, longlines, handlines) a variety of target species and fishing strategies (FAO, 2022b).

Türkiye has a very large marine fishing fleet in terms of number and capacity. Within this fleet, small-scale fishing can be defined as "fishing carried out by fishing vessels smaller than 12 meters, which accept the coastal area as fishing grounds, use passive fishing gear (gillnets, longlines, traps, etc.) for daily fishing, and sell their catch commercially" (Ünal, 2003; Ünal and Ulman, 2020). As of 2023, 90% (13,609 vessels) of the 15,219 marine fishing vessels licensed are smaller than 12 meters (GDFA, 2023).

Despite their importance, issues related to small-scale fisheries in many developing countries are poorly documented and not well understood (Farrugio, 2015; Gianelli *et al.*, 2018). In order to properly manage this type of fishery, it is necessary to know the status of the stocks in addition to information on the fishery. Knowing only the fishing effort or only the amount of catch does not give enough information about the stocks. At this point, catch per unit effort (CPUE) data gains importance. When long year series are constructed, CPUE data can be used to have an idea about whether the stocks are getting better or worse.

Catch per unit effort (CPUE) provides a relative index of fish stock abundance in the presence of successive landings, especially for closed populations (Nishida and Chen, 2004; Skalski *et al.*, 2005). CPUE is an important indicator of fish density in the sampling area when standardized nets are used (Naesje *et al.*, 2007). However, due to the high cost, unavailability or inadequacy of fishery-independent surveys, "fishery-dependent CPUE" will remain a common and informative indicator for fishery stock assessments

(Ducharme-Barth *et al.*, 2022).

For this important indicator, first of all, basic reliable data on the relevant fisheries are needed. Due to the lack of reliable basic data for small scale fisheries (SSF) in Turkish coast this indicator could not be calculated (Göktürk and Deniz, 2017), or it could be only for a limited region (Dereli *et al.*, 2015; Akyol *et al.*, 2024). In this study though, the records kept by the Ministry of Agriculture and Forestry between 2017 and 2023 within the scope of the support implemented for SSF were retrospectively examined and analyzed. The aim of this study is to determine the spatial (Black Sea, Sea of Marmara, Aegean Sea and Mediterranean Sea) and temporal (2016-2022) changes in the fishing effort and CPUE values of small-scale fisheries along the Turkish coast

2. MATERIAL AND METHOD

The material of this study consisted of the records kept by the Ministry of Agriculture and Forestry between 2017 and 2023 within the scope of the support applied to the SSF (Table 1). The Ministry recorded information on the effort and catches of the previous year based on the declarations of the fishers who applied under the support programme implemented within the framework of the Communiqués on Recording and Supporting Traditional Coastal Fisheries between 2017 and 2023 and the Communiqué on Supporting Small Scale Fisheries (Communiqué No: 2022/56) from 2023 (Anonymous, 2023a). However, in the first support year (2017), fishers were not required to declare catches from the previous year (2016). The data provided by the Ministry was retrospectively reviewed and analysed.

Table 1. Number of small-scale vessels in the fishing fleet, number of supported vessels and their ratios within the fleet in the years 2016-2022

Years	Number of Vessels in the Marine Fishing Fleet	Number of Vessels Supported	The Support Participation Rate	The Support Scope
2016	13282	7525	56.7%	The vessel's overall length < 10 m
2017	13119	8537	65.1%	
2018	13021	9805	75.3%	
2019	12926	10208	79.0%	
2020	13701	11701	85.4%	The vessel's overall length < 12 m
2021	13670	11586	84.8%	
2022	13613	12093	88.8%	

Fishing effort was calculated separately as "number of fishing days per year" and "kW*day/year". CPUE was calculated separately as "kg/kW/day" (a) and "kg/vessel/day" (b), as explained below. The formulas in Ulman and Pauly (2016) were used to calculate fishing effort (kW*day/year) and catch per unit effort (CPUE) (kg/kW/day). In these calculations, unlike Ulman and Pauly (2016), the data on the number of vessels in the fleet and engine power (kW) were taken into account in the General Directorate of Fisheries and Aquaculture (GDFA) databases instead of the Turkish Statistical Institute (TUIK).

(a) For the calculation of catch per unit effort (CPUE) (kg/kW/day), first the mean of catch was calculated from the survey data as "kg/vessel/year". The total catch was determined by multiplying this value by the number of small-scale vessels in the fishing fleet for the relevant year obtained from GDFA. The total catch was divided by the fishing effort (kW*day/year). For fishing effort (kW*day/year), the mean of the "number of fishing days in a year" was calculated from the data. This value was multiplied by the number of small-scale vessels in the fishing fleet and kW per vessel values obtained from GDFA for the relevant year.

(b) The catch per unit effort (CPUE) (kg/vessel/day) was calculated from the data by dividing "the amount of catch of the vessel in a year" by "the number of fishing days of vessel during the year".

Data were analyzed using the statistical package program IBM SPSS Statistics Standard Concurrent User V 26 (IBM Corp., Armonk,

New York, USA). In order to reduce the effects of outliers in the data set and to make the analyses more accurate, the Trimmed Mean (5%) method was used to prune the data. Descriptive statistics were given as number of units (n), percentage (%), mean ± standard deviation ($\bar{x}$±sd), median (M), minimum (min) and maximum (max) values. The normal distribution of the data was evaluated by Shapiro Wilk normality test. Comparisons by sea and year were analyzed using One-Way Analysis of Variance. A value of $p<0.05$ and $p<0.001$ was considered statistically significant.

3. RESULTS

3.1. Number of fishing days

The total number of fishing days at sea in a year decreased from 151 ± 68.8 in 2016 to 119 ± 70.6 in 2022. There was a statistically significant difference between the years ($p < 0.001$) (Table 2). The highest fishing days in all seas was in 2016 and then a decline was observed. When the number of fishing days at sea was analyzed, the highest values were in the Mediterranean Sea in all years except 2020. It was followed by the Aegean Sea, Sea of Marmara and Black Sea, respectively. Descriptive statistics for the number of days fished and comparison by years and seas are presented in Table 2. Statistically significant differences were found between seas in all years and between years in all seas ($p < 0.001$) (Table 2).

3.2. Total Fishing Effort (kW*day/year)

The total fishing effort (kW*day/year) of the small-scale marine fishing fleet by sea is presented in Table 3. Fishing effort of the total small-scale fleet increased by 37% from 57.6 million kW*day/year in 2016 to 78.7 million kW*day/year in 2022. Similar increases are seen in all seas, with higher values in the last 2 years (2021-2022) compared to previous years. In all years, the Black Sea has the highest and the Mediterranean the lowest kW*day/year values (Table 3).

3.3. Catch per unit effort (CPUE) (kg/kW/day)

The total CPUE in all seas has shown positive and negative breakdowns since 2016, with the highest value (0.65 kg/kW/day) in 2017. In 2022 (0.52 kg/kW/day), 7% lower value was obtained compared to 2016 (0.55 kg/kW/day). When the CPUE values in the seas are analyzed, in 2022, values very close to those of 2016 were obtained in the Black Sea and Sea of Marmara, while lower values were obtained in the Aegean Sea and the Mediterranean Sea (Figure 1). In all years between 2016 and 2022, the highest values are in the Black Sea and the lowest values are in the Aegean Sea. Except for 2016 and 2019, the Sea of Marmara ranked second in all other years (Table 4).

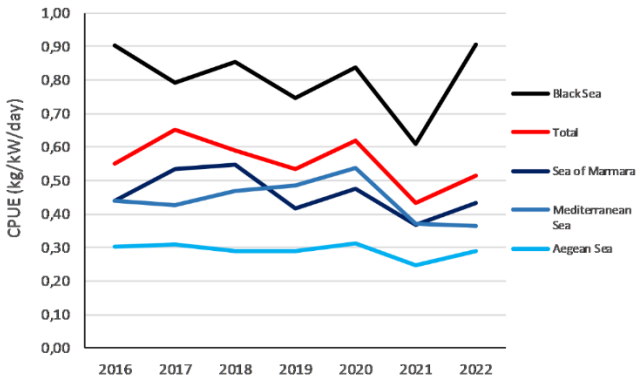

Figure 1. CPUE (kg/kW/day)

Table 2. Descriptive statistics for the number of fishing days and comparison by years and seas (*n*: number; *Mean*: arithmetic mean; *SD*: standard deviation; *CI*: 95% confidence interval; *L*: lower limit; *U*: upper limit)

Seas		Years							ANOVA	
		2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	***F***	***p***
Black Sea	*n*	3236	3779	4218	4282	4819	4780	4874	132.42	0.001
	Mean	141	121	117	114	108	100	107		
	SD	70.3	71	71.8	72.7	69.6	70.1	71		
	CI-L	139	119	115	112	106	98	105		
	CL-U	144	123	119	116	110	102	109		
Sea of Marmara	*n*	1276	1527	1773	1812	2263	2170	2305	89.978	0.001
	Mean	151	127	129	122	104	107	114		
	SD	68.6	68.2	69.2	68.6	65.1	67.5	65.5		
	CI-L	147	123	126	118	102	104	111		
	CL-U	155	130	133	125	107	110	117		
Aegean Sea	*n*	1843	1922	2354	2590	2888	2826	3029	44.637	0.001
	Mean	160	146	149	144	135	134	133		
	SD	66.2	69.4	70.3	67.7	69.9	67.9	70.1		
	CI-L	157	143	146	141	133	131	131		
	CL-U	163	150	151	147	138	136	136		
Mediterranean	*n*	1036	1133	1179	1149	1249	1259	1247	19.291	0.001
	Mean	165	146	147	146	143	138	139		
	SD	64.1	66.7	70	68.3	68.3	69	68.5		
	CI-L	162	142	143	142	139	134	136		
	CL-U	169	150	151	150	147	142	143		
Total	*n*	7391	8361	9524	9833	11219	11035	11455	260.435	0.001
	Mean	151	131	131	127	118	114	119		
	SD	68.8	70.5	72.1	71.5	70.3	70.8	70.6		
	CI-L	149	130	129	125	117	113	117		
	CL-U	152	133	132	128	119	116	120		
ANOVA	*F*	48.05	77.754	122.828	133.296	184.584	202.479	133.429		
	p	0.001	0.001	0.001	0.001	0.001	0.001	0.001		

Table 3. Total fishing effort (kW*day/year)

Years	Black Sea	Sea of Marmara	Aegean Sea	Mediterranean	Total
2016	21000248	14389052	13986664	8178115	57554079
2017	22168654	15391809	14726468	651180	52938111
2018	20222724	13750077	14227506	7346773	55547080
2019	20964982	14437642	15152208	6079977	56634809
2020	21241436	14302622	15915903	4309052	55769013
2021	25457728	19285372	19635999	8601877	72980976
2022	24358887	21215097	20115262	13017879	78707125

Table 4. Catch per unit effort (CPUE) (kg/kW/day)

Years	Black Sea	Sea of Marmara	Aegean Sea	Mediterranean	Total
2016	0.902	0.439	0.302	0.438	0.551
2017	0.792	0.533	0.308	0.426	0.651
2018	0.855	0.547	0.289	0.468	0.590
2019	0.747	0.417	0.289	0.486	0.533
2020	0.838	0.474	0.311	0.538	0.618
2021	0.611	0.369	0.248	0.370	0.433
2022	0.905	0.433	0.289	0.365	0.515

3.4. Catch per unit effort (CPUE) (kg/vessel/day)

Descriptive statistics for catch per unit effort (CPUE) (kg/vessel/day) and comparison by years and seas are presented in Table 5. The CPUE in all seas increased from 2016 and reached its highest value in 2022 (45 ± 207.2 kg/vessel/day). A statistically significant difference was found between the years ($p < 0.001$). When the change in CPUE in each sea over the years is analyzed, it is seen that the values in 2022 are higher than 2016 in all seas. The highest values were obtained in 2022 for the Black Sea, Sea of Marmara and Aegean Sea and in 2020 for the Mediterranean Sea. Statistically significant differences were found between years in all seas ($p < 0.05$) (Table 5). The highest values in all years were in the Black Sea, followed by the Sea of Marmara, when CPUE values were analyzed by seas. The lowest values were obtained from the Aegean Sea in all years. There was a statistically significant difference between the seas in all years ($p < 0.001$) (Table 5).

Table 5. Descriptive statistics for catch per unit effort (CPUE) (kg/vessel/day) and comparison by year and sea (*n*: number; *Mean*: arithmetic mean; *SD*: standard deviation; *CI*: 95% confidence interval; *L*: lower limit; *U*: upper limit)

		Years							ANOVA	
	Seas	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	***F***	***p***
Black Sea	*n*	835	3704	4113	4120	4616	4401	4624		
	Mean	37	46	51	54	61	59	72		
	SD	95.2	162.2	207.3	250	357	290.6	297.3	4.79	0.001
	CI-L	30	41	45	46	51	51	63		
	CL-U	43	51	57	62	71	68	80		
Sea of Marmara	*n*	473	1799	2192	2395	2751	2703	2698		
	Mean	20	33	28	26	37	38	42		
	SD	70.7	112.3	67.8	66.7	134.9	154.4	178.3	9.42	0.001
	CI-L	14	28	25	23	32	32	35		
	CL-U	26	39	31	29	42	43	49		
Aegean Sea	*n*	724	2006	2466	2697	2989	2903	3094		
	Mean	10	13	13	13	18	18	21		
	SD	21.4	38.7	39.4	32.9	70.3	65.9	75.8	10.323	0.001
	CI-L	8	11	12	12	15	15	19		
	CL-U	11	15	15	15	20	20	24		

Table 5. (Continued)

Mediterranean	*n*	220	1536	1714	1698	1800	1833	1875		
	Mean	14	20	24	26	28	26	25		
	SD	20.8	40.6	81.8	84.7	65.2	82.7	72	2.779	0.011
	CI-L	11	18	20	22	25	23	22		
	CL-U	17	22	28	30	31	30	29		
Total	*n*	2252	9045	10485	10910	12156	11840	12291		
	Mean	22	32	33	33	40	39	45		
	SD	68.8	118.6	139.7	162	233.8	198.1	207.2	11.586	0.001
	CI-L	20	29	30	30	36	35	42		
	CL-U	25	34	36	36	44	43	49		
ANOVA	*F*	22.017	39.441	43.535	39.214	23.16	29.603	45.244		
	p	0.001	0.001	0.001	0.001	0.001	0.001	0.001		

4. DISCUSSIONS

The mean fishing days of the small-scale marine fishing fleet decreased by 32 days from 151 days in 2016 to 119 days in 2022. In the Communiqués regulating commercial fisheries (Communiqués No. 4/1 for the period 2016-2020 and Communiqués No. 5/1 for the period 2020-2024), there is no time ban for small-scale fishing gears (gillnets, encircling gillnets, handlines, fyke nets/traps and longlines) at sea. Small-scale fishermen can fish with these fishing gears on all days of the year if they wish, provided that they comply with other prohibitions (Anonymous, 2016 and 2020). Although there are no legal restrictions, it is thought that the pandemic restrictions that started in March 2020 and continued at various levels until mid-2021 and the mucilage experienced in the Sea of Marmara in 2021 were effective in the decrease in the number of fishing days. It was also emphasized by Karakulak *et al.* (2023) that mucilage in the Sea of Marmara causes a decrease in fishing effort in the region. In addition, it is thought that the fishermen may have voluntarily reduced their fishing effort due to the decrease in fishing incomes (in dollars and euros) and the increase in fuel costs as identified in the report published by Dereli and Tekindal (2023). In addition, in recent years, especially in the southern Aegean Sea, fishermen have reduced their fishing days due to the low amount of fish landing in small-scale fishing gears (Ünal *et al.*, 2022).

It is also seen that the number of fishing days is in a downward trend compared to previous years, when the literature is examined. In a study conducted in 6 different fishing areas (Karaburun, Foça, Mordoğan, Akyaka, Akçapınar and Marmaris) for the Aegean Sea small-scale fisheries in the 2002-2003 fishing seasons, the number of days at sea was determined as 184.7 ± 75 (Foça), 192.1 ± 84 (Karaburun), 219 ± 73 (Mordoğan), 224.2 ± 58 (Akyaka), 185.6 ± 46 (Akçapınar) and 147.8 ± 64 (Marmaris) (Ünal and Franquesa, 2010). Ünal (2003) found that part-time small-scale fishermen in the Aegean Sea (Foça) in the 1999-2000 fishing season had an average of 136 days/year of sea work days and had lower sea work days than full-time fishermen. In this study, it is seen that the value obtained for full-time small-scale fisheries in 2022 (133 ± 70.1 days/year) is below the values of part-time fisheries 22 years ago.

This is the first study to include engine power (kW) in the calculation of effort and CPUE in small-scale fisheries. While total fishing effort (kW*day/year) of the small-scale fishing fleet increased in all seas, CPUE (kg/kw/day) for the whole fleet decreased in the last 2 years (2021-2022) compared to previous years (2016-2020 period). In the only other study in the literature where engine power (kW) was included (Ulman and Pauly, 2016), calculations were made by sea based on TUIK statistics for the total marine fleet including large-scale fisheries.

In contrast to the decrease in the number of fishing days, the increase in fishing effort including vessel engine power (kW) is noteworthy. In the support communiqués published in the last 3 years (2021-2023), vessels in the range of 10-12 meters were included in the scope of support. It is thought that the increase in engine power depending on vessel length has led to an increase in fishing effort (kW*day/year) values and subsequently a decrease in CPUEs (kg/kw/day), especially in the last 2 years.

For CPUE (kg/vessel/day), Berkes (1986) reported a value of 20 kg/vessel/day for small-scale fisheries (for vessels with 2 people) in the Turkish seas. In this study, it was observed that the CPUE value determined in 2016 (22.4± 68.8 kg/vessel/day) for the Turkish seas (all) was close to Berkes (1986). In the following years, CPUE increased with a statistical difference ($p<0.05$) and reached 45.5 ± 207.2 kg/vessel/day in 2022.

It is thought that the high values in the last 2 years are attributed to the inclusion of the vessel group in the 10-12 m range, including the beam trawl gear, in the support. This opinion is confirmed by Dereli and Tekindal (2023) in which the highest values in all years among the fishing gears in the seas were observed in the beam trawl/dredges. As an active fishing gear, beam trawl/dredges, which are included in the drift gears group, have higher daily catches than passive fishing gears such as gillnets, fyke nets/traps and longlines.

In the study conducted in the Aegean Sea during the 2002-2003 fishing season, CPUE was found in the range of 2.0-7.2 kg/vessel/day (Ünal and Franquesa, 2010). In this study, it was determined that the CPUE values calculated for the Aegean Sea in the 2016-2022 period were higher than Ünal and Franquesa (2010) and statistically, it has been on a continuous increase trend since 2016 (9.9 ± 21.5 kg/vessel/day) and reached 22.7 ± 87.4 kg/vessel/day in 2022. In another study conducted in the Aegean Sea (Gökova Bay) between 2009 and 2011 (Dereli *et al*., 2015), CPUE values of 10.8 ± 11.0 kg/vessel/day were reported for vessels using gillnets and 5.2 ± 4.3 kg/vessel/day for longlines, and it was determined that the CPUE values in this study calculated for the Aegean Sea between 2016 and 2022 were higher.

5. CONCLUSION

Fishing effort (fishing days) decreased significantly both in the period under study (from 2016 to 2022) and in comparison with previous periods (1999-2000 and 2002-2003) in the literature. In contrast to the decrease in the number of fishing days, fishing effort (kW*days/year), including vessel engine power (kW), increased from 2016 to 2022. It is thought that these increases are not due to the replacement of boat engines with larger engines, but to the inclusion of boats in the range of 10-12 meters in the scope of support in the last 3 years. CPUE (kg/vessel/day) has reached higher values in 2022 compared to 2016 with an increasing trend and is higher than the previous periods (1986 and 2002-2003). CPUE (kg/kw/day) is lower in the last 2 years (2021-2022) compared to the previous years (2016-2020 period).

This is the first study to evaluate the CPUE values of small-scale fisheries in Türkiye for all seas and year series. The first requirement for the sustainable development of SSF is the establishment and utilization of a system to collect SSF-related data reliably and regularly. Following the installation of the system, data on daily catches should be collected regularly from the SSF vessels and recorded statistically using logbooks containing discard and bycatch data (Göktürk and Deniz, 2017). Similarly, Birkan and Öndes (2020) suggested that fishing effort and catch quantities should be monitored using mandatory logbooks for sustainable management of the sector.

AUTHORSHIP CONTRIBUTION STATEMENT

Hakkı DERELİ: Conceptualization, Formal Analysis, Investigation, Writing - Original Draft, Writing - Review and Editing. **Erdal ÜSTÜNDAĞ:** Conceptualization, Writing - Review and Editing. **Hüseyin AKBAŞ:** Conceptualization, Writing - Review and Editing. **Mustafa Agah TEKİNDAL:** Conceptualization, Formal Analysis, Writing - Review and Editing.

CONFLICT OF INTERESTS

The authors declare that for this article they have no actual, potential or perceived conflict of interests.

ETHICS COMMITTEE PERMISSION

The authors declare that this study was conducted in accordance with ethics committee procedures of human or animal experiments.

FUNDING

No funding was received from institutions or agencies for the execution of this research.

ORCID IDs

Hakkı DERELİ:
https://orcid.org/0000-0002-1240-8922
Erdal ÜSTÜNDAĞ:
https://orcid.org/0000-0002-9240-5165
Hüseyin AKBAŞ:
https://orcid.org/0009-0001-4586-9661
Mustafa Agah TEKİNDAL:
https://orcid.org/0000-0002-4060-7048

6. REFERENCES

Akyol, O., Ceyhan, T., Düzbastılar, F.O., Ertosluk, O. (2024). Catch Composition and Catch Per Unit Effort of Small-scale Fisheries on the Coasts of the Bodrum Region (Güllük Bay, South-eastern Aegean Sea). *Turkish Journal of Fisheries and Aquatic Sciences*, 24 (9): TRJFAS25819. doi: 10.4194/TRJFAS25819

Anonymous, (2016). Communiqué No. 4/1 on the Regulation of Commercial Fisheries (Communiqué No: 2016/35). Ministry of Agriculture and Forestry. *Resmi Gazete*, (No. 29800 and dated 13 August 2016). https://www.resmigazete.gov.tr/eskiler/2016/08/20160813-17.pdf (in Turkish)

Anonymous, (2020). Communiqué No. 5/1 on the Regulation of Commercial Fisheries (Communiqué No: 2020/20). Ministry of Agriculture and Forestry. *Resmi Gazete*, (No. 31221 dated 22 August 2020). https://www.resmigazete.gov.tr/eskiler/2020/08/20200822-8.pdf (in Turkish)

Anonymous, (2023). Communiqué on Support for Small-Scale Fisheries (Communiqué No: 2022/56). Ministry of Agriculture and Forestry. Resmi *Gazete*, (No. 32072 dated 13 January 2023). https://www.resmigazete.gov.tr/eskiler/2023/01/20230113-4.htm (in Turkish)

Berkes, F. (1986). Local-Level Management and the Commons Problem. A Comparative Study of Turkish Coastal Fisheries. *Marine Policy*, 10 (3): 215–229. doi: 10.1016/0308-597X(86)90054-0.

Berkes, F., Mahon, R., McConney, P., Pollnac, R., Pomeroy, R. (2001). *Managing small-scale fisheries. Alternative directions and methods*. Ottawa: IDRC.

Birkan, R., Öndes, F. (2020). Socio-economic characteristics of small-scale fisheries in the Aegean Sea, Turkey (eastern Mediterranean). *Acta Ichthyologica et Piscatoria*, 50 (3): 257–268.

GDFA (2023). *Fisheries Statistics.* Ministry of Agriculture and Forestry, General Directorate of Fisheries and Aquaculture, Ankara. (in Turkish)

Dereli, H., Tekindal, M.A. (2023). *Evaluation and reporting of data obtained within the scope of small-scale fishing support,* Ministry of Agriculture and Forestry, General Directorate of Fisheries and Aquaculture, Ankara. 290 s. (in Turkish)

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 Aquaculture Science*, 32(3): 135-143. doi: 10.12714/egejfas.2015.32.3.03

Ducharme-Barth N.D., Grüss, A., Vincent, M.T., Kiyofuji, H., Aoki, Y., Pilling, G., Hampton, J., Thorson, J.T. (2022). Impacts of fisheries-dependent spatial sampling patterns on catch-per-unit-effort standardization: a simulation study and fishery application. *Fisheries Research*, 246, 106169.

FAO (2022a). *The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation*. Rome, FAO. doi: 10.4060/cc0461en

FAO (2022b). *The State of Mediterranean and Black Sea Fisheries 2022*. General Fisheries Commission for the Mediterranean. Rome. doi: 10.4060/cc3370en

Farrugio, H. (2015). Current situation of small-scale fisheries in the Mediterranean and Black Sea: Strategies and methodologies for an effective analysis of the sector. Pp. 15–43. In: Srour, A., Ferri, N., Bourdenet, D., Fezzardi, D. & Nastasi, A. (eds.) *First regional symposium on sustainable small-scale fisheries in the Mediterranean and Black Sea*, 27–30 November 2013, Saint Julian's, Malta. FAO Fisheries and Aquaculture Proceedings No. 39.

Gianelli, I., Horta, S., Martínez, G., de la Rosa, A., Defeo, O. (2018). Operationalizing an ecosystem approach to small-scale fisheries in developing countries: The case of Uru-guay. *Marine Policy*, 95: 180–188. doi: 10.1016/j.marpol.2018.03.020

Göktürk, D., Deniz, T. (2017). Development of sustainable small-scale fisheries management in Turkey. *Journal of Aquaculture and Marine Biology*, 6(1): 00142. doi: 10.15406/jamb.2017.06.00142

Karakulak, F.S., Kahraman, A.E., Uzer, U., Gül, B., Doğu, S. (2023). Effects of mucilage on the fisheries in the Sea of Marmara. In: Mucilage Problem in the Sea of Marmara. Albay, M. (ed.). Istanbul, Istanbul University Press, pp. 1-9.

Naesje, T.F., Hay, C.J., Nickanor, N., Koekemoer, J., Strand, R., Thorstad, E.B. (2007). *Fish populations, gillnet catches and gillnet selectivity in the lower Orange River, Namibia, from 1995 to 2001*. NINA Report No: 231.

Nishida, T., Chen, D.G. (2004). Incorporating spatial autocorrelation into the general linear model with an application to the yellowfin tuna (*Thunnus albacares*) longline CPUE data. *Fisheries Research*, 70, 265–274.

Skalski, J.R., Ryding, K.E., Millspaugh, J.J. (2005). Analysis of population indices. In John RS, Kristen E.R. & Joshua, J.M. (eds), *Wildlife Demography*. Cambridge, MA: Academic Press, pp. 359–433.

Ulman, A., Pauly, D. (2016). Making history count: The shifting baselines of Turkish fisheries. *Fisheries Research*, 183, 74-79.

United Nations (2023). *Sustainable Development Goals*. United Nations. https://www.un.org/sustainabledevelopment/sustainable-development-goals/

Ünal, V. (2003). Socio-Economic Analysis of Part-Time Small-Scale Fishing, Foça (Aegean Sea). *Su Ürünleri Dergisi*, 20(1-2): 165-172. (in Turkish)

Ünal, V., Franquesa, R. (2010). A comparative study on socio-economic indicators and viability in small-scale fisheries of six districts along the Turkish coast. *Journal of Applied Ichthyology*, 26(1): 26-34.

Ünal, V., Tıraşın, E.M., Tosunoğlu, Z. (2022). An ecosystem approach to fisheries management for small-scale fisheries in Gökova marine protected area, Turkey: Challenges encountered during the transition process. In: Transition towards an ecosystem approach to fisheries in the Mediterranean Sea - Lessons learned through selected case studies. Vasconcellos, M. & Ünal, V. (eds.). Rome, FAO Fisheries and Aquaculture Technical Paper No. 681. pp. 117-136.

Ünal, V., Ulman, A. (2020). The Current Status and Challenges Facing the Small-Scale Fisheries of Turkey. p. 83-103. In: *Small-Scale Fisheries in Europe: Status, Resilience and Governance*, J. J. Pascual-Fernández et al. (eds.), MARE Publication Series 23, Switzerland. doi: 10.1007/978-3-030-37371-9_5