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Striped venus clam (*Chamelea gallina* Linnaeus, 1758) fishery in the southern Black Sea coast: What does a fisherman's logbook tell?

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Abstract

Striped venus clam fishing has been carried out in the Black Sea coasts of Türkiye for a long time about 30 fishing vessel. In this fishery, which is maintained with hydraulic dredges, it cannot be said that administrative legislation has been fully developed. It is not entirely clear on what basis the fishing quota is in the fishery bans that change and develop day by day. Further standardization is required for selectivity of sieves. In this study, data covering 4 fishing seasons of a fishing vessel were standardized and processed. Catch per unit effort (CPUE) in terms of kilogram/minutes was calculated. Fishing activities according to season were carried out at Şile stations in 2017-2018, and in Sakarya in 2018-2019 and 2019-2020, at Şile in the last season of 2020-2021. It was found out that the CPUE data was in a continuous downward trend within each season and in the following seasons. This situation reveals the necessity of questioning and rethinking the current daily catch quota (10 tons per day). In addition, the high proportion of waste and small-sized individuals in marketed catch is a sign of a selectivity problem. Therefore, stock determination, selectivity and daily catch quota applications of striped venus clam fishery should be rearranged.

Keywords: Striped venus clam, Size selectivity, Hydraulic dredge, Fishery quota, Black Sea

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1. Introduction

The striped clam (*Chamelea gallina* L. 1758), which is distributed in the area from the coasts of Norway to the coasts of Africa and in the Mediterranean, Marmara and Black Seas, is mostly found in sandy areas where the depth varies between 5-25 m (Gaspar et al. 2003). As income from fishery decreases, fishermen's interest in different fishing activities increases. Thus, fishing of striped venus has also become an unaccustomed source of income for fishermen in Türkiye after the 1980s. At the beginning of striped venus clam fishing, it was preferred only in the spring and summer (until 15 July), when the fishing income decreased or after the fishing season. Later on, fishing vessels that carried out their activities only with this fishery emerged. Today, it is possible to come across many fishing vessels in different parts of the Black Sea, which continue their commercial activities only by clam fishery with hydraulic dredges.

The beginning of the striped venus clam fishery in the Black Sea brought along some fisheries regulations about it. These are regulations such as location and time prohibitions, size of fishing gear used, minimum landing size, daily (10 tons per fishing vessel), and seasonal (30,000 tons in total) fishing quotas. Fishing boats that will catch clam during the year have to get permission from the provincial directorates of the Ministry of Agriculture and Forestry, and the origin certificate is issued at the landing points (Anonymous, 2022; Türkmenoğlu, 2019). Therefore, it can be said that some regulations have been developed and put into practice over time for the management of clam fishing. Clams caught in the Black Sea are not consumed in Türkiye, but they are processed in processing factories established in different regions and

exported to European Union countries, especially Italy (Dalgıç, 2006). Previous studies indicated that 26-39 fishing vessels have been carried out fishing activities during the season (Dalgıç 2006; Türkmenoğlu, 2019). In addition, various problems for this fishing were mentioned in the studies. In particular, it has been stated that it is necessary to determine the stock and the population characteristics, set the fishery quota accordingly, limit the number of vessels, and reduce the rates of bycatch (Çolakoğlu & Tokaç 2010, 2014, 2017; Dalgıç, 2006; Dalgıç et al., 2005, 2009). Researchers reported that the ratio of small-sized individuals in the marketed catch varies between 19% and 38.10%, and that spiral sieves do not provide sufficient selectivity, which is an extremely important problem for striped venus clam stocks in the Black sea (Dalgıç & Ceylan 2012; Ceylan, 2022).

This study aimed to obtain inferences about whether the applied management policy and inspections were sufficient by examining the long-term catch data of a striped venus clam fishing vessel's activities.

2. Material and Methods

The data processed in the study were collected between 2017 and 2021. During this period, the ship logbooks in which the fishing vessel (LOA: 15 m, 380 hp main engine, 240 hp secondary engine) fishing for striped venus clams with hydraulic dredge recorded daily fishing data was examined (Due to the captain's legal fears, the ship's name and related images will not be published). The hydraulic dredge was 3.5 m long and 2.4 m wide. The spiral sieve was used until January 2020, then the it was changed to as vibrating sieve in the vessel. The logbooks where all seasons are recorded separately are digitized and standardized as CPUE (catch per unit effort).

While evaluating the daily catch data, the following standardizations have been applied:

- CPUE: Total catch obtained in duration from the start of hauls to the end of hauls,
- Total catch (Tc): Recorded daily from the fisherman's year-end documents (kg),
- Navigation time (Nt): Departure and return times of the ship to the fishing area (minute),
- Total haul duration (hD): Daily hauling of dredge time (minute),
- Waste: Amount of other than striped venus clam in the marketed catch (%),
- Fishing time (Ft): Total time spent per day for fishing (minute).

The fisherman's departure and return times, navigation time, fishing area, the start and end times of each haul, the target catch amount obtained in each operation (kg), the daily waste ratio in the target catch (organisms other than clam, empty clams shells, etc.) amount was recorded by the vessel's captain. The vessel fished at Şile in the 2017-2018 season, Sakarya in the 2018-2019 and 2019-20120 season, and lastly at the Şile station in the 2020-2021 season, in the legal fishing areas (Figure 1).

Statistical comparison of the data (CPUE, Tc, Nt, hD, Waste and Ft) obtained from seasonal and fishing areas was analyzed with one-way ANOVA in SigmaPlot 14 program.

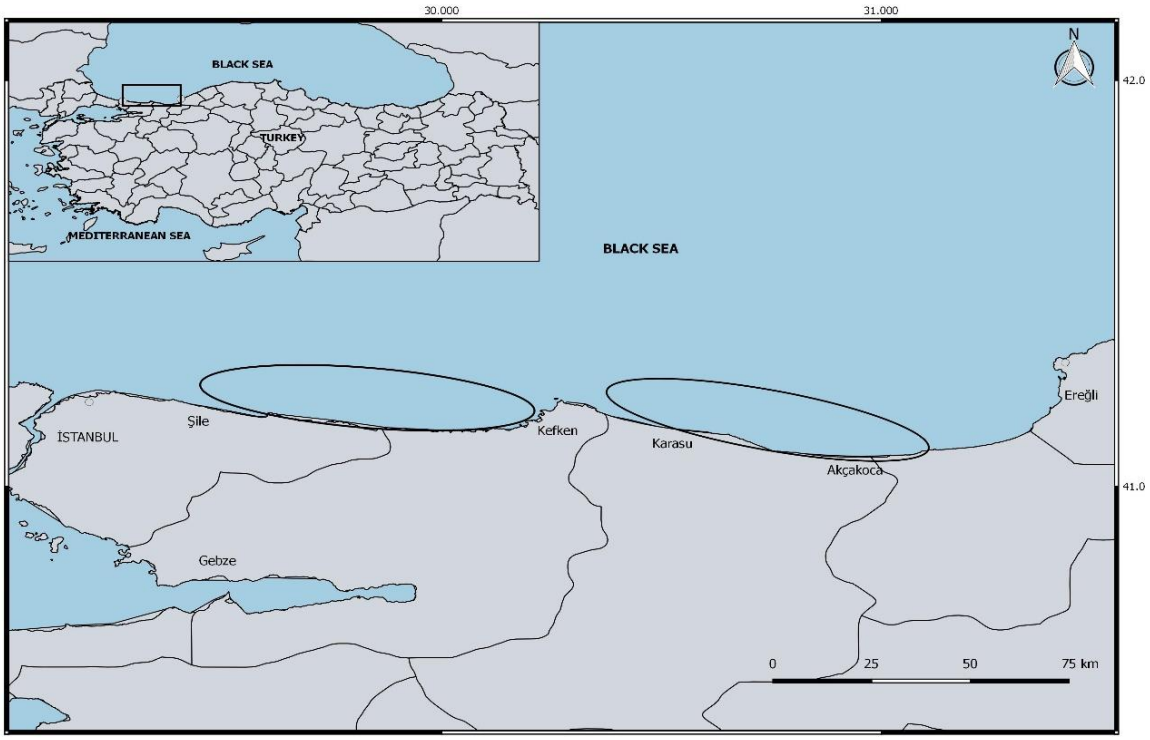

Figure 1. Map of the fishing regions

3. Results

The data obtained from the 4-years activities of the fishing vessel engaged in striped venus clam fishing were first processed and standardized separately for each season.

The fishing vessel, whose fishing data we evaluated, carried out its activities in the Şile station in the 2017-2018 season. It organized 105 days of fishing trials during the season on the 40 km coastline and marketed 1445 tons of total catch. The daily catch quota was 10 tons/day and fisherman has caught more than it. The 2017-2018 season is the second fishing year of Şile station and the following year, it was declared as the area closed to striped venus calm fishing as required by law. The data obtained in this season are presented in Table 1. When CPUE values are taken into account monthly, it is seen that there is a decrease of more than 50% at the end of the season. Due to the decrease in CPUE, fishing time the captain spends at sea to obtain the daily quota increased. Especially in April, it is seen that it landed products below its daily quota (Table 1-2, Figure 2). The seasonal and monthly CPUE values and the total daily fishing time spent data indicate that as the season progresses, the catch decreases, and the corresponding fishing effort increases (p<0.05) (Table 2, Figure 3).

Table 1. Striped venus clam fishery data in the 2017-2018 season

Months	Day	ΣTc (kg)	$\bar{T}c \pm s^*$ (kg)	CPUE ± s*	$\bar{N}t \pm s^*$ (minute)	$\bar{h}D \pm s^*$ (minute)	Waste
October	20	250690	12534.50 ± 2796.21	28.56 ± 9.53	59.65 ± 31.34	353.54 ± 73.00	10%
November	24	390775	16282.29 ± 2542.26	41.16 ± 10.49	43.08 ± 23.28	320.80 ± 71.72	10%
December	20	262013.5	13100.68 ± 5067.57	29.53 ± 12.57	36.00 ± 15.39	314.06 ± 100.16	12%
January	13	142805.5	10985.04 ± 4741.73	21.70 ± 8.02	33.92 ± 17.54	389.18 ± 114.15	15%
February	6	71983.5	11997.25 ± 1965.49	23.22 ± 4.63	38.83 ± 9.79	418.23 ± 90.21	14%
March	19	215950.5	11365.82 ± 5001.90	21.09 ± 7.72	38.68 ± 6.11	407.91 ± 142.41	16%
April	11	109335	9939.55 ± 2495.09	17.77 ± 3.40	42.09 ± 23.36	409.70 ± 104.97	13%

**refer to statistical differences in each column (p<0,05). ΣTc: total catch, $\bar{C}PUE$: mean catch per unit effort, $\bar{N}t$: mean navigation time per day, $\bar{h}D$: mean duration per day, s: standard deviation.*

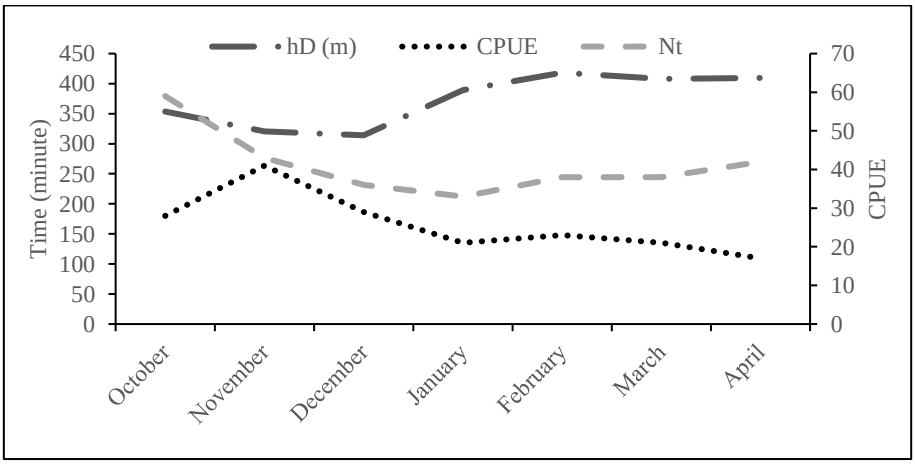

Figure 2. Monthly variation of catch per unit effort (CPUE), navigation time (Nt), and haul duration (hD) values in the 2017-2018 fishing period

Table 2. Seasonal values of average CPUE and fishing time in the 2017-2018 fishing period

Season	Sea trial	$\bar{C}PUE \pm s^*$	$\bar{F}t \pm s^*$ (minute)
Autumn	43	35.43 ± 11.79	434.11 ± 96.76
Winter	45	25.95 ± 10.78	488.15 ± 129.00
Spring	17	19.87 ± 6.61	536.73 ± 133.99

**refer to statistical differences in each column (p<0.05). $\bar{C}PUE$: mean catch per unit effort, $\bar{F}t$: mean fishing time per day.*

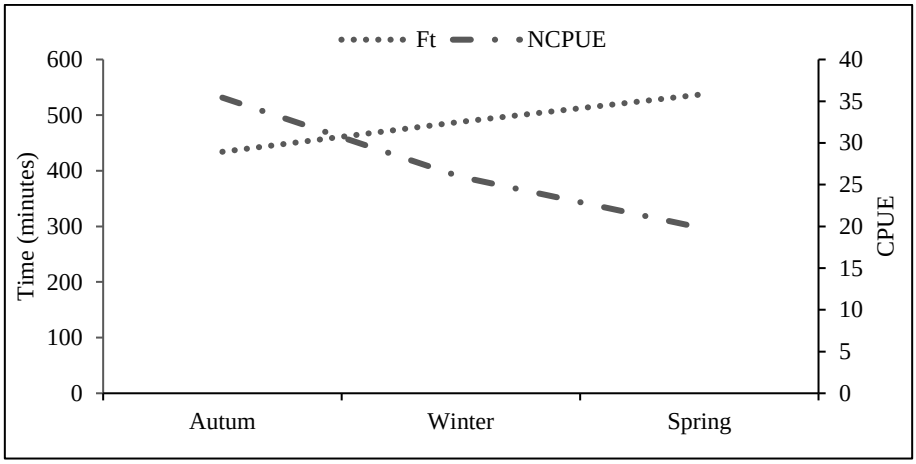

Figure 3. Seasonal variation of mean CPUE and daily fishing time in the 2017-2018 fishing period

The area where fishing was conducted is Sakarya station in the 2018-2019 season. The coastal length of this station is about 80 km. The area, which was closed for former two years, has been opened to striped venus clam fishery for the 2018-2019 and 2019-2020 seasons. The fishing vessel sailed for a total of 120 days in this season and marketed a total of 1470 tons of target species. It was seen that every month it landed products above the daily fishery quota and the CPUE value at the beginning of the season significantly decreased (p<0.05) by about 1/3 at the end of the season (Table 3, Figure 4). While the CPUE values decrease seasonally and monthly, a rise is seen in the daily total fishing time data. The statistical significance of these changes was demonstrated by the analysis (p<0.05) (Table 4, Figure 5).

Table 3. Striped venus clam fishery data in 2018-2019 season

Months	Day	ΣTc (kg)	$\bar{T}c \pm s^*$ (kg)	CPUE ± s*	$\bar{N}t \pm s^*$ (minute)	$\bar{h}D \pm s^*$ (minute)	Waste
October	21	265817.25	12657.96 ± 1105.21	63.99 ± 12.03	58.67 ± 26.88	159.19 ± 33.47	9%
November	21	255244.5	12154.50 ± 2488.42	52.87 ± 10.00	89.29 ± 37.26	169.35 ± 42.10	10%
December	18	236041.5	13113.42 ± 528.17	50.18 ± 23.61	97.11 ± 26.43	259.42 ± 88.02	10%
January	20	245754	12287.70 ± 2802.46	51.74 ± 15.52	90.35 ± 30.87	184.19 ± 41.47	14%
February	13	148629	11433.00 ± 1714.67	41.66 ± 7.19	105.38 ± 22.73	223.95 ± 47.71	14%
March	20	227938.5	11396.93 ± 3315.47	42.50 ± 12.91	77.50 ± 20.37	197.91 ± 51.08	13%
April	7	110722.5	15817.50 ± 2506.94	49.55 ± 6.44	71.86 ± 11.42	270.81 ± 45.95	12%

**refer to statistical differences in each column (p<0,05). $\bar{T}c$: total catch, $\bar{C}PUE$: mean catch per unit effort, $\bar{N}t$: mean navigation time per day, $\bar{h}D$: mean duration per day, s: standard deviation.*

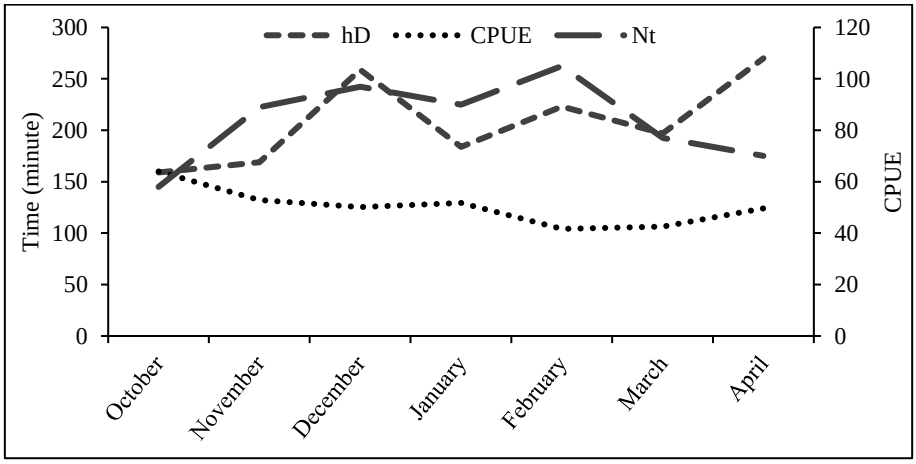

Figure 4. Monthly variation of catch per unit effort (CPUE), navigation time (Nt), and haul duration (hD) values in the 2018-2019 fishing period

Table 4. Seasonal values of average CPUE and fishing time in the 2018-2019 fishing period

Season	Sea trial	$\bar{C}$PUE ± s*	$\bar{F}$t ± s* (minute)
Autumn	49	58.43±12.29	219.95±59.03
Winter	47	48.62±17.62	274.12±82.39
Spring	19	44.32±11.89	276.19±66.44

**refer to statistical differences in each column ($p<0.05$). $\bar{C}$PUE: mean catch per unit effort, $\bar{F}$t: mean fishing time per day.*

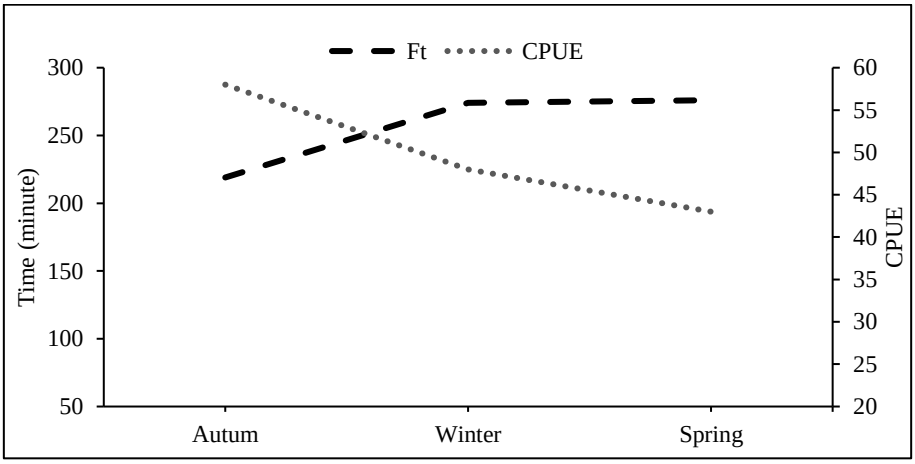

Figure 5. Seasonal variation of mean CPUE and daily fishing time in the 2018-2019 fishing period

The 2019-2020 season is the second year of Sakarya station, and the fishing vessel has sailed for 115 days this season. A total of 1150 tons of clam was caught, which was lower than the first year. The CPUE value at the beginning of the season (October) was almost equal to the CPUE value in the last month of the previous season (Table 5, Figure 6). It was observed that the wastage rate of the ship, which has been tested for vibrating sieve middle of the season, has decreased up to 0% since February. Standardized data for this period are presented in Table 5. The average CPUE values calculated both seasonally and monthly showed a significant decrease at the end of the season ($p<0.05$). Average daily fishing time data doubled in spring (Table 6, Figure 7).

Table 5. Striped venus clam fishery data in 2019-2020 season

Months	Day	ΣTc (kg)	$\bar{T}$c ± s* (kg)	CPUE ± s*	$\bar{N}$t ± s* (minute)	$\bar{h}$D ± s* (minute)	Waste
October	25	250708	10028.32 ± 346.99	49.30 ± 14.50	97.52 ± 32.35	219.24 ± 59.54	12%
November	24	253320	10555.00 ± 426.96	56.01 ± 15.52	74.38 ± 30.80	202.83 ± 60.22	14%
December	17	182487	10734.53 ± 878.68	45.49 ± 18.39	97.12 ± 33.00	269.88 ± 98.08	15%
January	11	123212	11201.09 ± 3226.72	36.20 ± 16.68	77.00 ± 30.85	342.09 ± 90.39	6%
February	19	145936	7680.84 ± 3075.72	22.03 ± 6.16	81.47 ± 25.15	354.05 ± 122.57	0%
March	15	150554	10036.93 ± 2658.42	26.31 ± 7.03	77.53 ± 26.82	385.60 ± 79.81	0%
April	4	44007	11001.75 ± 1551.56	30.06 ± 7.43	86.25 ± 28.69	377.00 ± 74.53	0.5%

**refer to statistical differences in each column ($p<0,05$). $\bar{T}$c: total catch, $\bar{C}$PUE: mean catch per unit effort, $\bar{N}$t: mean navigation time per day, $\bar{h}$D: mean duration per day, s: standard deviation.*

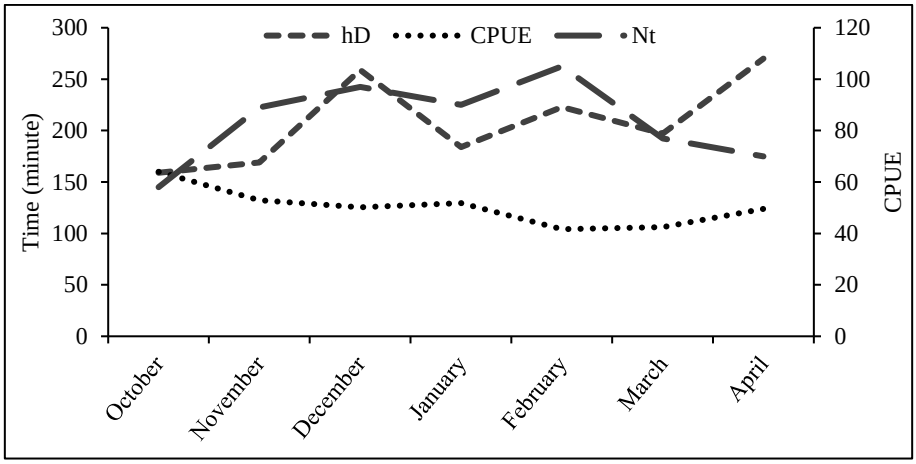

Figure 6. Monthly variation of catch per unit effort (CPUE), navigation time (Nt), and haul duration (hD) values in the 2019-2020 fishing period

Table 6. Seasonal values of average CPUE and fishing time in the 2019-2020 fishing period

Season	Sea trial	$\bar{C}$PUE ± s*	$\bar{F}$t ± s* (minute)
Autumn	49	52.59 ± 15.23	253.85 ± 69.63
Winter	47	33.83 ± 17.37	411.36 ± 132.32
Spring	19	27.11 ± 7.07	509.57 ± 110.16

**refer to statistical differences in each column ($p<0.05$). $\bar{C}$PUE: mean catch per unit effort, $\bar{F}$t: mean fishing time per day.*

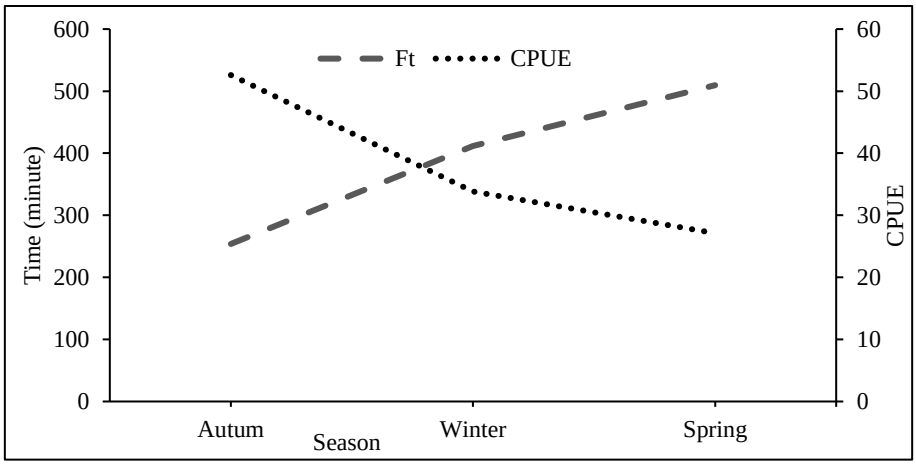

Figure 7. Seasonal variation of mean CPUE and daily fishing time in the 2019-2020 fishing period

The 2020-2021 season was conducted in the Şile area, which was closed to striped venus clam fishing previous two years. Although no clam fishery has been done in the past 2 years, CPUE values were lower at the beginning of the season compared to all other seasons (13.83 kg/min). The vessel has 105 days of fishing trips this season and marketed a total of 635 tons of clams. The data obtained in the 2020-2021 season are presented in Table 7 and Figure 8. It could not market 39.6% of its daily catch quota. The seasonal mean CPUE value was not found to be the lowest among the other seasons. It is seen that a very high value has been reached in terms of fishing time (Table 8, Figure 9).

When compared in terms of CPUE and fishing time obtained from all seasons and stations, the Şile area was found to be more inefficient in terms of fishing compared to the Sakarya station (Table 9). Decreases in CPUE values, accordingly, increases in the daily fishing time spent by the fisherman appeared as a common situation observed in every season.

Table 7. Striped venus clam fishery data in 2020-2021 season

Months	Day	ΣTc (kg)	$\bar{T}c \pm s^*$ (kg)	CPUE ± s*	$\bar{N}t \pm s^*$ (minute)	$\bar{h}D \pm s^*$ (minute)	Waste
October	12	88023	7335.25 ± 2471.39	13.83 ± 3.25	144.3 ± 370.15	398.41 ± 126.30	0%
November	20	79476	3973.80 ± 1783.41	8.99 ± 3.42	46.85 ± 29.89	367.51 ± 127.75	0.5%
December	11	53224.5	4838.59 ± 2569.45	9.64 ± 3.97	39.55 ± 11.18	412.12 ± 185.97	0.4%
January	13	75036	5772.00 ± 2757.09	12.44 ± 4.15	136.08 ± 79.68	378.58 ± 132.77	0%
February	15	94072.5	6271.50 ± 3133.52	14.60 ± 9.12	94.07 ± 48.67	408.55 ± 153.44	0%
March	17	94183.5	5540.21 ± 2937.98	10.96 ± 6.07	89.47 ± 49.97	428.96 ± 174.17	0.2%
April	13	107282.5	8252.50 ± 5904.77	16.78 ± 9.43	78.77 ± 60.34	387.72 ± 186.68	0.3%

**refer to statistical differences in each column (p<0,05). $\bar{T}c$: total catch, $\bar{C}PUE$: mean catch per unit effort, $\bar{N}t$: mean navigation time per day, $\bar{h}D$: mean duration per day, s: standard deviation.*

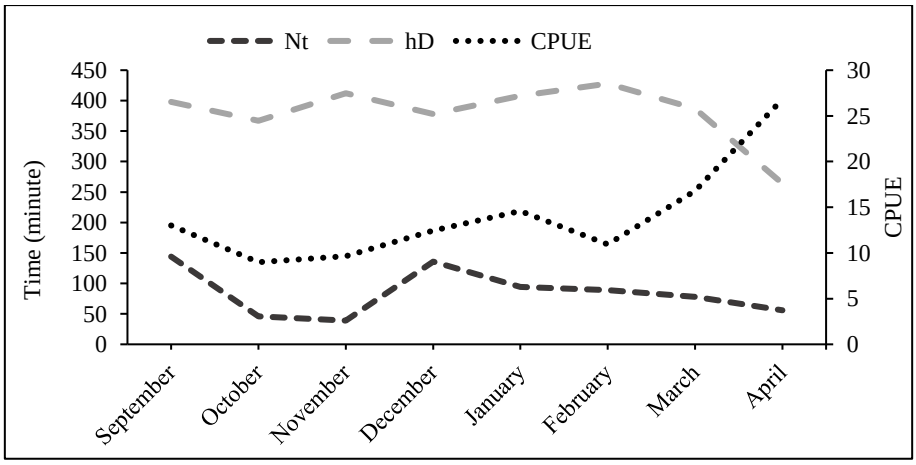

Figure 8. Monthly variation of catch per unit effort (CPUE), navigation time (Nt), and haul duration (hD) values in the 2020-2021 fishing period

Table 8. Seasonal values of average CPUE and fishing time in the 2020-2021 fishing period

Season	Sea trial	$\bar{C}PUE \pm s^*$	$\bar{F}t \pm s^*$ (minute)
Autumn	43	10.50 ± 4.02	475.25 ± 151.19
Winter	45	12.63 ± 8.26	479.08 ± 166.59
Spring	17	19.15 ± 9.72	456.17 ± 204.45

**refer to statistical differences in each column (p<0.05). $\bar{C}PUE$: mean catch per unit effort, $\bar{F}t$: mean fishing time per day.*

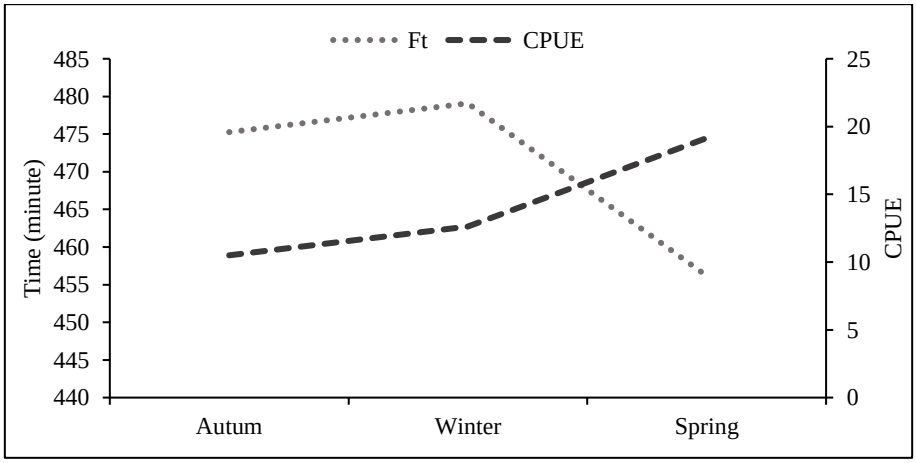

Figure 9. Seasonal variation of mean CPUE and daily fishing time in the 2020-2021 fishing period

Table 8. Seasonal values of average CPUE and fishing time in the 2020-2021 fishing period

Period	Region	CPUE	Ft
2017-2018	Şile	28.03	480.01
2018-2019	Sakarya	51.09	255.63
2019-2020	Sakarya	40.71	360.48
2020-2021	Şile	12.81	473.81

4. Discussion

Sustainable fishery of striped venus clam with hydraulic dredge is very important for both the ecosystem and the fisherman. This fishing, which has a yearly export capacity of approximately 11 million euros, is a sector that cannot be ignored for both Turkish fisheries and the economy (Türkmenoğlu, 2019). Hydraulic dredge fishery is managed by a number of administrative regulations as well as the technical features of the fishing gear. The most important ones in terms of sustainability are the fishery quota and the closure of the areas to fishing for two years.

However, the stocks in Şile region, which was opened for fishing two years later, cannot rehabilitated itself. The CPUE value of 2020-2021 season is the lowest value with 12.81. It is very worrying that there has been no improvement in the productivity of the stocks despite being closed for two years. This may be the biggest sign that the striped venus clam stock has collapsed. In addition, the fishing ban from April 15 to September 1 in the Sakarya region at the end of the first year has no contribution to the CPUE value. Because, at the end of the 2018-2019 fishing season, the CPUE value was calculated as 49.55 in the Sakarya region (April 2019), and at the beginning of the next season (October 2019) the CPUE was calculated as 49.30. The monthly decreasing trend in CPUE values and the continuous increase in fishing effort in both seasons (Sakarya) were indications that the quota application is not sufficient. In addition, the high rate of small-sized individuals in landed catch is another negative factor that increases the pressure on stocks (Dalgıç & Ceylan, 2012). The L_{50} value of the sieves used and the ratio of small-sized individuals in the landed catch (minimum landing size: 17 cm) at the same period of the study were 15.2 cm and 38.1%, respectively (Ceylan, 2022). This situation can be seen as the main reason for the decrease in CPUE values in each season and the collapse at Şile station. If a fisherman is working 12 hours per day and 38.1% of his quota consists of small-sized individuals, it is inevitable that the number of individuals above MLS in the ecosystem is quite low.

In a study conducted on two years in open and closed areas, it was reported that the stocks decreased approximately 5 times (Türkmenoğlu, 2019). It can be said that similar results were obtained with the aforementioned study due to the decrease in CPUE values of the exploited areas. The selectivity of the hydraulic dredge used in clam fishery is quite low. For this reason, the focus of researchers and fisheries management organizations must be on the sieves on the deck, where the selectivity takes place. Since spiral sieves cannot provide the sufficient selectivity, it is known that vibrating sieves with flat area are more effective (Sala et al., 2017; Patetta et al., 2021). For this reason, the use of this type of sieve must be urgently required for hydraulic dredge fishery maintained in the Black Sea. Care should be taken to implement fishing quotas. As revealed from the results of this study, quota controls are not carried out sufficiently. In addition, it is unclear which results of scientific research is taken into account when determining the quota. It is urgently necessary to determine the operated stocks and to re-determine the total allowable catch (TAC) amount as a result of these studies. If the total allowable catch is stably sustainable, fishing yield will increase (Pourtois et al., 2021). As the catch efficiency decreases, the time spent by the fisherman increases, which reduces the economic profitability of fishing activities. For this reason, a sustainable quota application will benefit the fishermen with this aspect.

5. Conclusion

Rules and practices managing striped venus clam fisheries should be reconsidered. Fishermen can catch clams above their daily quota, and they know who market this product. This situation reveals the fact that there are not enough inspections or that the fishermen can bypass these controls. In addition, it is necessary to eliminate some selectivity problems. The cause of this problem should be defined as the inadequacy of spiral type sieves with 8.5mm bar opening. An urgent regulation should be legislated for the using of vibrating sieve. In addition, it is necessary to determine the stocks, biology, reproduction and increments of the striped venus clam, and to re-determine the daily catch quota depending on all these. In this context, the institutions responsible for fisheries management should achieve the most accurate management plan.

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Conflict of interest

The authors declare that there is no conflict of interest.

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