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FULL PAPER **TAM MAKALE**

RAPA WHELK (*Rapana venosa* Valenciennes, 1846) FISHERY ALONG THE TURKISH COAST OF THE BLACK SEA

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Abstract:

In this study, the current situation of an invasive gastropod rapa whelk fishery with dredges and hookah systems were comparatively evaluated. On the other hand, a socio-economic analysis was conducted to evaluate the hookah (diving) system via face to face interviews. There were 207 vessels legally operating in the research area for whelk fisheries 108 of which were using the hookah system. Mean length and engine power of the hookah vessels were 8.8 m and 65 HP, respectively. It was also found that the average CPUE was 1050 kg/day and income rate was 79%, suggesting that whelk fishing had a high economic gain. Each of the hookah vessels provided an employment to average 3 individuals. According to the results, mean lengths of whelks harvested with dredges and hookah vessels were 5.61 cm and 5.83 cm, respectively. Length-weight relationship of the total production was determined as $W=0.0223L^{2.965}$ ($R^2=0.85$). It was concluded that the hookah system is more environmentally friendly method for the ecosystem than dredges.

Keywords: *Rapana venosa*, Black Sea, Dredging, Hookah systems

Introduction

Veined rapa whelk (*Rapana venosa,* Valenciennes, 1846) is an lessepsian invader that was first reported in the Black Sea in Novorossiysk Bay in 1946 (Daskalov & Rätz, 2011). The species originates from the Pacific Ocean and belongs to the *Muricidae* family. It was estimated that this species had been carried by ballast water tanks of commercial ships to the Black Sea and colonized in the coastal waters of the Marmara and the Black Sea (Bilecik, 1990; Cesari & Pellizzato, 1985; Rinaldi, 1985; Koutsoubas & Voultsiadou-Koukoura, 1990; Bombace *et al.,* 1994; Erdoğan-Sağlam *et al.,* 2015). Rapa whelk is an important invasive species that may have ecological and economic impacts on Mediterranean mussel (*Mytilus galloprovincialis*) stocks. The increase in rapa whelk abundance has triggered a commercial fishery since the early 1980s using dredge and hookah systems. Although the total whelk capture is well known, there are no data separated by fishing gear.

Dredges are known as beam trawls. This fishing gear consists of net and frame. Frame has been used to fix vertical and horizontal openings (Aydın *et al*., 2005). Dredges are easy to operate and are commonly used in coastal waters of Turkey and in areas that are close to the trawl fisheries. However, since the method in the Black Sea are generally operated by towing and digging at the bottom, it is considered as a harmful activity for the ecosystem (Düzgüneş, *et al.,* 1997; Düzgüneş, 2001; Daskalov & Rätz, 2011), benthic habitats and juvenile fish populations (Çelik & Samsun, 1996; Altınağaç *et al.*, 2004). The hookah system, in which rapa whelks are collected by hand, is supposed to have less ecological impact as compared to dredges (Artüz, 1989; Altınağaç *et al.*, 2004; Daskalov & Rätz, 2011). Yet, the possibility of the diving diseases can be high when the diving instructions are neglected (Altınağaç *et al.*, 2004).

The objective of this study was to compare the catch per unit effort (CPUE) and the productivity of the two harvesting methods (dredging and diving) intensively used in the Black Sea. Both fishing methods are described briefly and the structure of the fishing fleet and the trends in landings are reported. Finally, we discussed the potential ecosystem impacts of the fishing methods and evaluate whether the hookah system may be an alternative fishing method for sustainable harvesting of rapa whelks from an ecological point of view as well as by the socio-economic perspective.

Materials and Methods

This study was carried out in the Central Black Sea Region, a location closed for trawl fishing but open for the dredges and hookah systems in 2011 (Figure 1) (41°.18’ N, 37°.02’ E -41°.02’ N, 38°.01’ E).

In the Black Sea region fishing license is necessary to harvest rapa whelk from April 30th to 1st September. Rapa whelk fishing must be conducted at more than 500 m from the shoreline, from sunrise to sunset.

Legal maximum width, maximum height, maximum codend length and codend mesh size of dredges are 300 cm, 40 cm, 1 m and 72 mm, respectively.

Biological sampling

To determine catch composition by dredge fishing, a total of 1000 whelk were sampled from 5 different stations as shown in Figure 1 (Terme, Ünye, Fatsa, Perşembe and Ordu). 952 specimens were also sampled from vessels using the hookah system. Total shell length (L) was measured to the nearest 1 mm as depicted in Figure 2.

Total weights (W) of the specimens were determined at 0.01 g sensitivity after drying with tissue paper. The L–W relationships were determined using the equations: $W = a\ L^b$ (Le Cren, 1951; Pauly, 1980; Erkoyuncu, 1995). Relationship between L and W was examined by the simple linear regression analysis. The coefficients were analyzed using ANOVA (Zar, 1996). Fulton’s condition factor was calculated by $C=(W/L^3) \times 100$, where L is the total shell length (cm) and W is the body weight (g) (Le Cren, 1951; Bagenal, 1978; Sparre & Venema, 1992; Erkoyuncu, 1995).

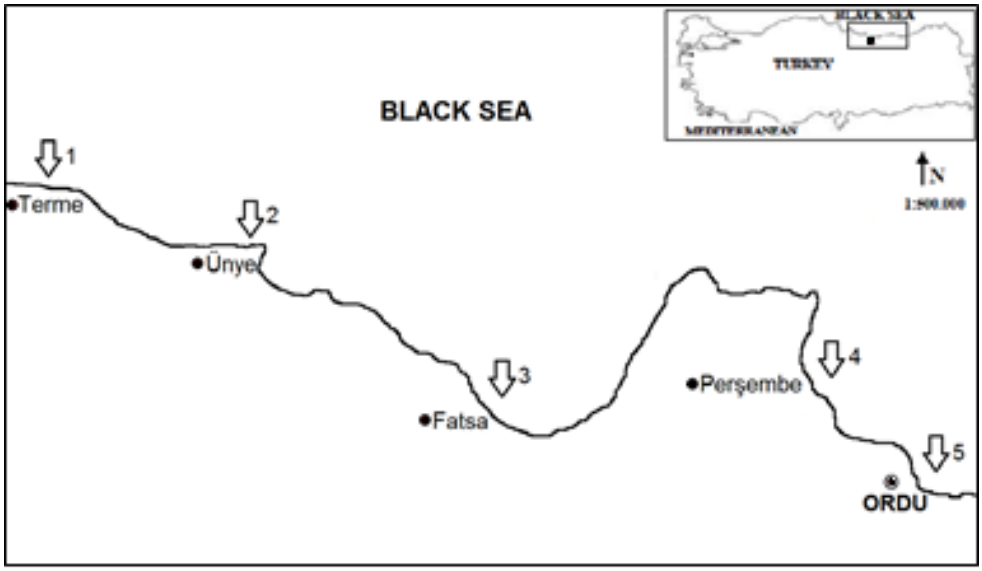

Figure 1. The study area. Sampling stations are indicated with white arrows (1-5).

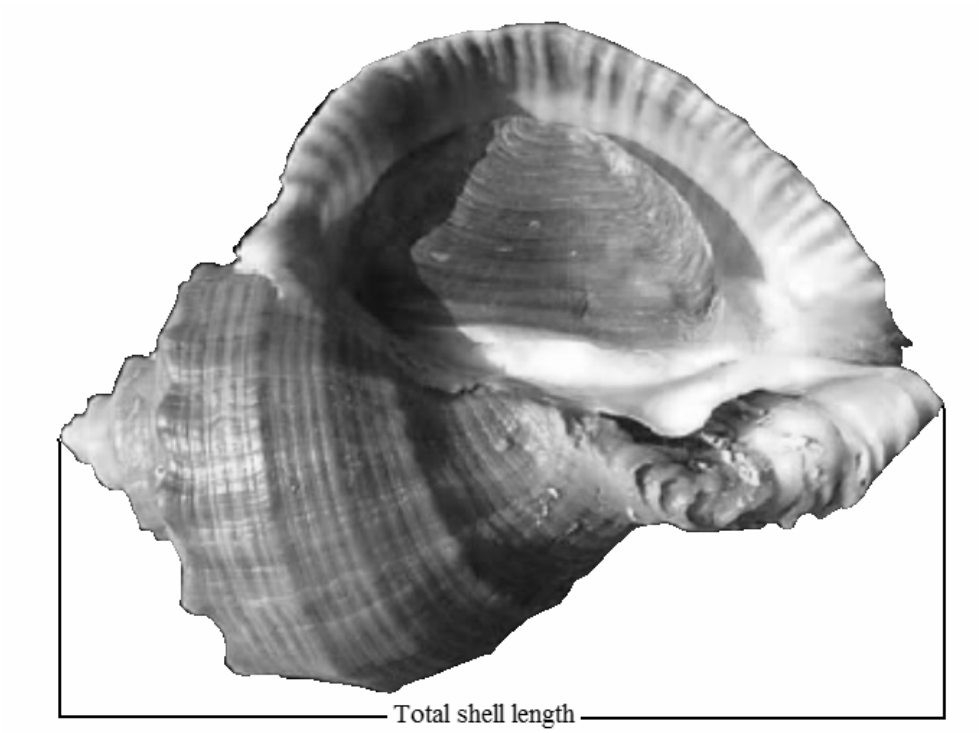

Figure 2. Total shell length (L) of rapa whelk.

Fishing fleet

Technical dimensions (mouth width, mouth depth, and codend length and mesh size) of the dredges were determined by evaluating the data provided from commercial vessels either using the existing data from Fisheries Information System (FIS) or face to face interviews. The FIS includes any data regarding the fisheries including production amount by species, number of vessels, and their specifications, fishing permissions by vessels and fishermen.

The interviews were conducted with 15 hookah system vessel owners to assess the system. A questionnaire form contained:

registry number, vessel length and width, and engine power, current value of vessel, average daily production of vessel (kg or piece), number of staff on vessel, staff education level, insurance, levels and experience of divers, daily diving duration, average diving depth, seasonal working days, current value of hookah system, daily fuel consumption of vessel, daily operational costs of vessel (excluding fuel), seasonal maintenance cost of vessel and price of product (kg or piece).

Results and Discussion

Whelk Fishing and Fishing Fleet

Commercial capture of rapa whelk has continued since early 1980s in the Black Sea (Figure 3) (TUIK, 2011). From 1995 to 2004, quantity of landings showed an increasing trend, then a decrease occurred till 2009 after a stabilization period. A fair recovery in the capture was seen in 2010.

According to FIS database, there were 207 registered whelk fishing vessels in the Black Sea region (FIS, 2012). The number of vessels within the survey area constitute over 50% of the total number of vessels in the Black Sea region; 52 (25.1%) of which were registered in Ordu Port whereas 57 (27.5%) in Samsun Port. Table 1 shows the distribution of vessels having license for whelk fishing by regions in Turkey. It is thought that commercial fishing vessels from the Aegean and the Mediterranean regions access whelk fishing in the Black Sea. Major provinces with the permitted vessels were as follow: Samsun (%14.95), Ordu (%13.59), Istanbul (%9.42), Balıkesir (%7.18) and Zonguldak (%6.51).

Dredges (beam trawl) fishing and its technical dimensions

According to fisheries regulations, dredges must have a 3 m of mouth width, 40 cm of mouth depth, 1 m of maximum cod end length and 72 mm of minimum mesh size (FIS, 2012). The results collected from the field studies showed that the length of dredge varied between 220 cm and 300 cm while the mouth heights and net mesh sizes of were 30-50 cm and 70-120 mm, respectively. Fishing was conducted in 10-30 m depth interval. The operation was performed by releasing a rope 2 to 3 times longer than the depth from the stern of the vessel at a 0.5 knot towing speed for 20-25 minutes.

Although dredges have single and double-sided towing characteristics, generally the latter is preferred. Drawings of two types of dredges used are presented in Figure 4.

Single-sided types can lose their fishing ability when they are not properly released on the bottom. On the other hand, double-sided trawls will always catch whelks in any positions. Each vessel in the region legally had only 1 dredge and capture operations had to be done between sunrise and sunset. Average length of fishing vessels was 8.4 m. About 90% of dredges used double-sided dredge in the region.

Hookah (diving) system and its technical characteristics

The hookah system was generally preferred in the periods when the dredge fishing was prohibited. It was also preferred in places where bottom surface is not good for dredging. The system could be used in locations with a distance of 500 m from the shore and a hard bottom structure when water temperature increases and whelks started reproduction. This method is allowed for all year around in the whole Black Sea of Turkish waters except the entrance of Bosporus.

According to the fishery statistics of 2011 (FIS, 2012), a total of 108 vessels are using the hookah system in the Black Sea, mostly operating from the ports of İstanbul (%19.47), Zonguldak (%16.15), Balıkesir (%10.62), Sakarya (%9.29) and Ordu (%8.63). During the present study 21 and 14 vessels using the hookah system were recorded in the Ordu and Samsun area, respectively.

Average length, GRT and engine power of the vessels in the study sites were determined as 7.48 m, 4.75 and 52.08 HP, respectively. Of all vessels in Ordu and Samsun provinces, 42.8 % were directly interviewed using the questionnaire form.

An ordinary vessel using the hookah had a compressor, air reservoir, air hose, air regulator, bags used for filling captured whelks and barrels for carrying the production in the water easily (Figure 5).

The vessels using the hookah system might use one or two divers for rapa whelk collection. When two divers were used, the lines were divided by a "Y" line connection on the hose and the divers used individual air regulators to breath.

Fishing operations could be done with or without anchoring the vessel. When anchored, effective

diving depth is limited by the length of the air hoses. If the weather was good, the vessels were not anchored, allowing divers to collect whelks from a wider area. The collected whelks were put in bags which were strictly tied up to the barrels, and the air was filled in the barrels via an air regulator to keep the barrel's neutral buoyancy in the water column as the harvest weight increases. This enabled the divers to carry the barrels in the underwater. When the bag was filled, the air was fully compressed into the barrels to take out the surface. Fishing with the hookah system vessel was conducted in the daytime, and generally, a diver stayed at underwater for 3-5 hours depending on the depth.

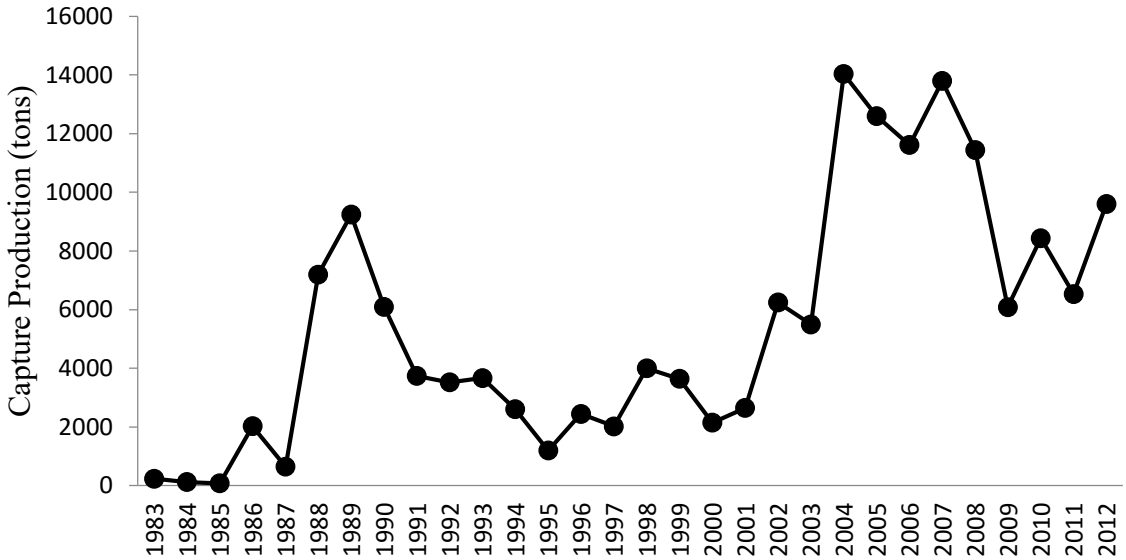

Figure 3. Total whelk capture quantity in Turkish coastal waters of the Black Sea in 1983-2012 (TUIK, 2012).

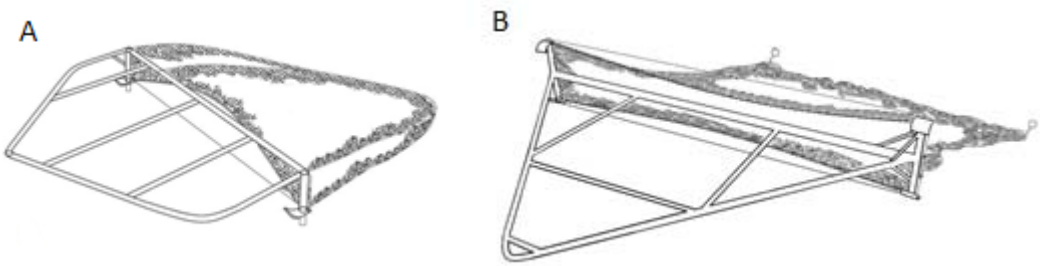

Figure 4. Depictions of dredges used in the region A) single sided, B) double sided (orginal).

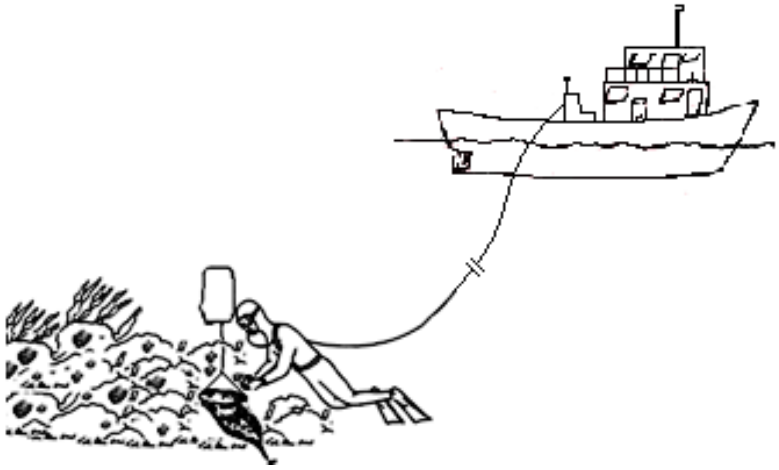

Figure 5. Operation with hookah system (orginal).

Table 1. Number of whelk fishing vessels by regions and years (FIS, 2012).

Regions	Years			
	2008	**2009**	**2010**	**2011**
Black Sea	262	302	176	207
Marmara	103	115	60	59
Aegean	10	17	5	11
Mediterranean	8	8	2	0
Total	383	442	243	277

Table 2. Distribution and main technical specifications of vessels using the hookah system by regions

Region	Number of Vessels	Average overall length m	Average GRT	Average HP
Black Sea	108	7.52	5.77	58.7
Marmara	119	8.83	14.42	63.95
Aegean	16	8.02	4.32	51.87
Mediterranean	0	-	-	-

Table 3. Main characteristics of the hookah vessels.

Mean length of vessels (m) (min-max)	Mean width of vessels (m) (min-max)	Mean engine power of vessels (HP) (min-max)	Mean diving time (Hour) (min-max)	Mean diving depth (m) (min-max)	Mean number of employees (min-max)
8.85 ±1.1 (7.0-10.6)	3.1 ±0.4 (2.1-3.8)	65 ±28.0 (26-105)	5.5 ±1.8 (2.5-9)	6.7 ±1.2 (5-10)	3 ±0.5 (2-4)

Results from questionnaires

The results of interviews with fishermen using the hookah system (15 vessels) are shown in Table 3. The average diving time was 60 minutes and duration of the operations decreased as the diving depth increased. The average operation day of the hookah vessels was 70 days per year.

Income and expense shares of the hookah vessels based on the economic analysis are shown in Figure 6.

Average seasonal income of a vessel was 55613 Turkish lira (TL) and the expense 12483 TL, resulting in a 43.132 TL net average profit.

The net profit of a vessel was generally shared by the vessel owner (50%) and the divers (50%). Average daily fuel, daily food, seasonal maintenance and repairs, present value of a vessel and present value of a hookah system are given in Table 4.

The average daily catch was 1050 kg (SE: 122) per vessel. The value of the kilogram of rapana seemed to change little between 0.85 and 1 TL.

Of divers, 50% had 1 Star, 25% 2 Stars and 10.7% 3 Stars diving certificates. Remaining 14.7% on the other hand did not have any diving certificates. Additionally, 56 % of the divers had a high school education (Figure 7).

Catch composition

During the present study 1952 individuals of rapa whelks were collected (1000 from vessels using dredges and the rest from hookah systems).

In this study, mean lengths, mean weight of the captured whelks by dredges and hookah systems were 5.61 cm, 40.34 g and 5.83 cm, 48.59g, respectively. Analysis of independent T-test detected significant differences ($p<0.001$) in mean lengths of captured whelks, but the differences in mean weight of captured whelks not significant ($p>0.05$) between dredges and hookah systems.

Length-weight measurements of individuals are given in Table 5.

Majority of the population (70.9%) was composed by the individuals having 5-6 cm total length. Length frequencies of the samples according to the size classes are given in Figure 8.

Length-weight relationship was found as $W= 0.223L^{2.965}$ ($R^2 = 0.85$) for all individuals (Figure 9).

The Fulton's coefficient of condition factor (C) was calculated between 1.41 and 62.62, and average C of population was 22.16 ±4.9.

Despite an increase in the whelk stock in the Black Sea, there is a significant decrease in average length of captured individuals by time (Daskalov and Rätz, 2011). For example, the mean length was recorded as 11.0 cm in 1986 (Ünsal, 1989), 6.7 cm in 1991, 6.5 cm in 1992 (Düzgüneş *et al.*, 1992), 5.4 cm in 1999 (Emiral, 2003), 4.5 cm in 2003 (Zengin, 2006) and 44.6 mm in 2004 (Şahin *et al*., 2005). In this study, minimum, maximum and mean lengths were determined as 1.4 cm, 10.7 cm and 5.7 cm, respectively. It is a fact that recently there has been a decrease in the lengths of harvested whelks (Daskalov & Rätz, 2011). Average length of captured whelks by dredges in this study is higher than that of previous study conducted by Sağlam *et al.* (2008), which is due to bigger mesh size (72 mm) compared to previous study (40 mm). In addition, it is known that there is an increase in the length of the captured whelks from the east to west in the Black Sea. For example, the reported mean lengths are 4.7 cm (1.1-10.7 cm), 6.4 cm (2.5-11.7 cm) and 6.9 cm (3.5-11.9 cm) from the eastern, Samsun and the western stocks, respectively (Knudsen & Zengin, 2006).

In a study conducted by Şahin, *et al.* (2005), length-weight relationship of whelk was determined as $W=0.000091\ L^{3.15}$ ($R = 0.98$) whereas it was $W= 0.223L^{2.965}$ ($R = 0.85$) in the present study.

During a survey carried out by Alparslan *et al.* (2006), the authors reported 23 whelk fishing vessels in the Black Sea. In the last years the number of fishing vessels increased to 382 vessels in 2008 and 442 in 2009, but then the number decreased to 243 in 2010 and 277 in 2011.

According to 2010 fishery statistics, 207 out of 277 whelk fishing vessels were present in the Black Sea and 108 of them were operated using the hookah system (FIS, 2012). It appears that there is a steady increase in the number of the vessels using the hookah system. Alparslan *et al.* (2006) stated that mean market price per 1 kg of whelk was 1 TL and average daily whelk harvest is 300-400 kg per vessel. In this study, it was determined that mean market price per 1 kg whelk was 0.85-1 TL and average daily harvest of a vessel using the hookah system (with two divers) was 1050 kg.

Table 4. Various expenses and values of a vessel and hookah system.

Average fuel consumption (lt/day)	Average food expense (TL/day)	Mean seasonal maintenance and reparation expense (TL)	Average value of a vessel (TL)	Average value of a hookah system (TL)
25 ±2.5 (10-45)	70 ±14.1 (20-200)	2.500 ±255.8 (1.000-4.000)	30.000 ±1980 (10.000-40.000)	3.500 ±568 2.000-10.000

Table 5. Average weight and length of whelk (±SD)

	Length (cm)			Weight (g)		
	Average±STD	Minimum	Maximum	Average ±STD	Minimum	Maximum
General	5.72 ±1.06	1.4	10.7	44.37 ±26.11	0.49	251.96
Hookah	5.83 ±0.95	1.4	10.0	48.59 ±24.1	0.49	236.90
Dredges	5.61 ±1.14	2.6	10.7	40.34 ±27.3	3.23	251.96

In the present study, it was found that average daily harvest of the dredges vessels was 1200 kg. Considering that productivity of the hookah was 1050 kg per vessel/day, the hookah system can be a good alternative to the dredges. Moreover, if the fishery statistics of whelk production is considered (9596 tons) (TUIK, 2012), it seems hookah system have a harvest capacity higher than the total production of Turkey. This figure also reveals that there is an urgent need for the improvement of collection of fisheries statistics.

As it is explained above, there is an increase in the vessel number of the hookah system in the region. This study showed that there is a serious deficiency in diver training. Moreover, it was also observed that the divers stay underwater longer than a normal diving duration, and they can be exposed to diving diseases. Therefore, it appears to be necessary to give diving instructions for the hookah system divers. It is also equally necessary to establish a diving disease treatment unit as soon as possible.

There are other alternative methods to the dredges other than the hookah system such as traps and pots, which are allowed to fish all year around (Sağlam *et al.,* 2008). Of the 277 vessels licensed for whelk fisheries in 2011, 215 were licensed to use the traps and pots. However, the present study showed that no vessel used these alternative methods. Similar reports were made in the Black Sea for whelk fishing by Daskalov & Rätz (2011). On the other hand, interestingly it was observed that some vessels were illegally active with the dredges by violating the year around permission for the trap and pot fisheries. This finding led us to suggest that either new trap and pot fishing methods should be developed or the present type of trap and pot fishing should be removed from the legislation regulating national commercial fisheries.

Whelk is predator of the Mediterranean mussel (*Mytilus galloprovincialis*) and striped venus clam (*Chamelea gallina*) stocks and that's why it must be captured with an appropriate fishing method that is not harmful to the ecosystem (Iotov, 2011). Therefore, dissemination and support of the hookah system is strongly suggested as done by Iotov (2011).

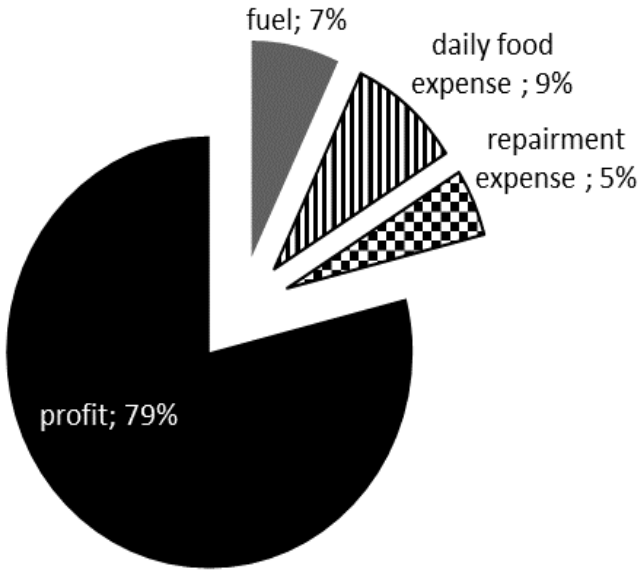

Figure 6. Income and expense shares of the vessels using the hookah system.

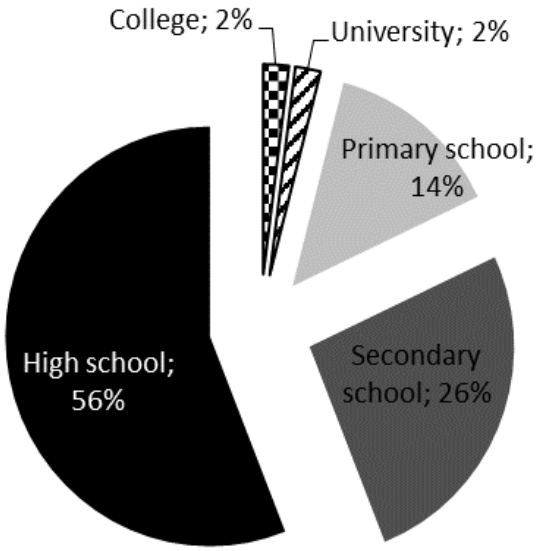

Figure 7. Education level of the crew in the vessels using the hookah system.

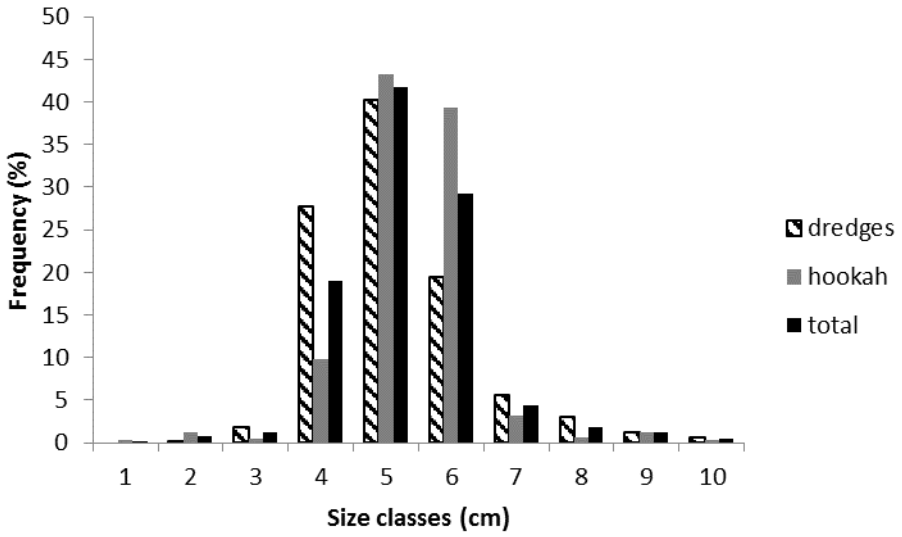

Figure 8. Length frequency distribution of whelks according to different harvesting methods

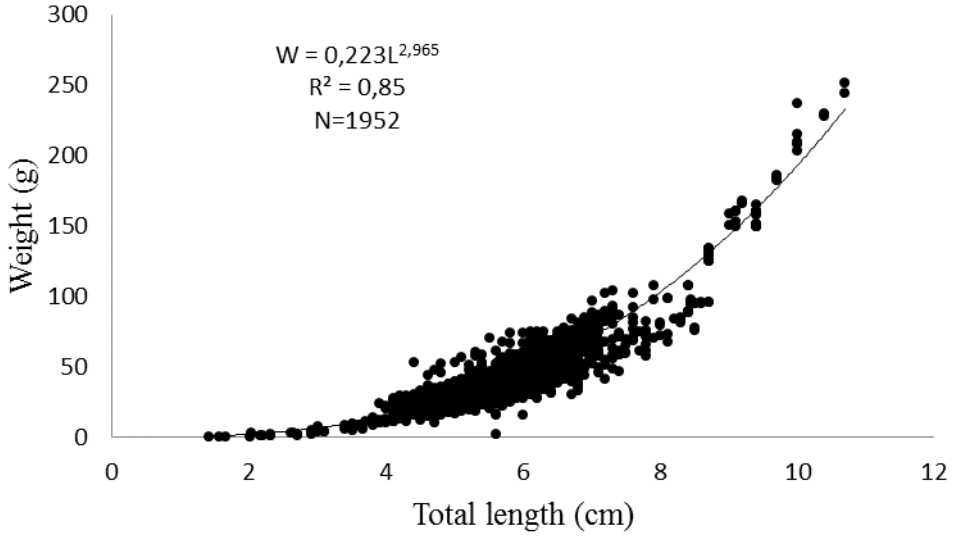

Figure 9. The length-weight relationship of whelks

Conclusion

Consequently, the rapa whelk *Rapana venosa* represents an important input for the economy of Turkey. The species was traditionally captured by dredges, but during recent years the fishery seems to be changing to the hookah systems because of its fishing efficiency and the high market value. The fishing effort is steadily increasing year after year and the average size of the individuals fished are dropping, suggesting a tendency to overexploitation of the fishery. Therefore, an urgent monitoring system for the whelk stocks are needed to determine the impacts upon the rapa whelk fishery and to keep a sustainable fishery in the Black Sea ecosystem.

Acknowledgement

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References

Alparslan, M., Ozalp, H.B., & Sagır-Odabasi, S., (2006). An invader-economical gastropod *Rapana venosa* (Valenciennes, 1846) in Canakkale and adjacent regions, *Ege University Journal of Fisheries and Aquatic Sciences,* 23(3-4), 485-487.

Altınagac, U., Ayaz, A., & Kara, A., (2004). A preliminary study on the whelk fisheries (*Rapana venosa* (Valenciennes, 1846)) using lift nets of various sizes, *Ege University Journal of Fisheries and Aquatic Sciences,* 21, 295-299.

Artuz, M.I., (1989). "Rapana" The Last Invader. *Cumhuriyet science and technology*. No:147.

Aydın, C., Gurbe, R., & Ulaş, A., (2005). Catch composition and effects on fishing area of beam trawl, *Ege University Journal of Fisheries and Aquatic Sciences,* 22(1-2), 39-42.

Bagenal, T.B., (1978). *Methods for Assessment of Fish Production in Fresh Waters*. 3rd Ed., Handbook No:3. Blackwell Scientific Publication. Oxford. 365 pp.

Bilecik, N., (1990). *Distribution of rapa whelk (Rapana venosa) in the Black Sea coastal of Turkey and effect on Black Sea fisheries.* Bodrum Fisheries Institute publication (In Turkish).

Bombace, G., Fabi, G., Fiorentini, L., & Speranza, S., (1994). Analysis of the Efficacy of Artificial Reefs Located in Five Different Areas of the Adriatic Sea. Fifth International Conference on Aquatic Habitat Enhancement, *Bulletin of Marine Science,* **55**: 559-580.

Cesari, P., & Pellizzato, M., (1985). Insediamento Nella Laguna di Venezia e Distribuzione Adriatica di *Rapana venosa* (Valenciennes) (Gastropoda, Thaididae). *Lavori, Societa Veneziana di Scienze Naturale,* 10, 3-16.

Celik, O., & Samsun O., (1996). Investigation of the catch amount and the catch composition of dredges with various design features, *Ege University Journal of Fisheries and Aquatic Sciences,* 13, 259-272.

Daskalov, G., & Rätz, H.J., (2011). *Assessment of Black Sea Stocks.* JRC Scientific, Technical and Economic Committee for Fisheries (STECF), Italy, 216pp.

Duzgunes, E., Sahin, C., Bascinar, N.S., & Emiral, H., (1997). Sea snail fishing and its effects on the coastal ecosystem of the Black Sea, Turkey. *1. National Conference on Turkish Coasts*, 24-27 June 1997.

Duzgunes, E., (2001). *Rapa Whelk fisheries with dredges in the Eastern Black Sea.* Technological advances in fisheries, 19-21 June, 106 pp.

Duzgunes, E., Unsal, S., & Feyzioglu, M., (1992). *Stock Assessment of veined whelk Rapana thomasiana (Gross, 1861) in Eastern Black Sea.* Project number. DEBAG 143/G. p.55, Karadeniz Technical University, Sürmene Marine Sciences Faculty.

Emiral, H., (2003). *Bio-ecology of Rapa Whelk (Rapana thomasiana) in the Black sea.* PhD Thesis. Karadeniz Technical University Institute of Science, 88pp.

Erdoğan Sağlam, N., Sağlam, C., & Sağlam Demir, Y., (2015). Determination of some population parameters of the veined rapa whelk (*Rapana venosa*) in the Central Black Sea. *Journal of the Marine Biological Association of the United Kingdom*, *95*(1), 123-129.

Erkoyuncu, I., (1995). *Fisheries Biology and Population Dynamics.* Ondokuz Mayıs University publication, 265 pp.

FIS., (2012). *General Directorate of Fisheries and Aquaculture.* Fisheries Information System.

Iotov, I.M., (2011). Report on current and future management of Black Sea fisheries Committee on Fisheries Rapporteur: Iliana Malinova Iotov, Plenary sitting, A7-0236/2011, 17.6.2011, (2010/2113(INI)) European Parliament, 2009-2014.

Knudsen, S., & Zengin, M., (2006). *Multidisciplinary Modeling of Black Sea Fisheries: A case study from Samsun, Turkey.* Black Sea Ecosystem 2005 and Beyond 1st Biannual Scientific Conference BSERP/BSC, 8-10 May 2006 Istanbul, Turkey.

Koutsoubas, D., & Voultsiadou-Koukoura, E., (1990). The Occurrence of *Rapana venosa* (Valenciennes, 1846) (Gastropoda, Thai-

dide) in the Aegean Sea, Boll. *Malacologico,* 26, 201-204.

Le Cren, E.D., (1951). The length-weight relationships and seasonal cycle in gonad weight and condition in perch (*Perca fluviatilis*), *Journal of Animal Ecology,* 20, 210-219.

Pauly, D., (1980). *A selection of simple methods for the assessment of tropical fish stocks*. FOA Fish Circular. No. 729. Rome. 54 pp.

Rinaldi, E., (1985). *Rapana venosa* (Valenciennes) Spiaggiata in Notevole quantita Sulla Spiaggia di Rimini (FO). *Bollettino Malacologico,* 16, 9-17.

Saglam, H., Kutlu, S., Dagtekin, M., Bascınar, N. S., Selen, H., & Sahin, A., (2008). *Development of different trap models as alternative dredges for rapa whelk fisheries.* Technical final report. Trabzon Fisheries Research Institute, 94 pp.

Sparre, P., & Venema, S.C., (1992). *Introduction to Tropical Fish Stock Assessment, Part I.* FAO Fisheries Technical Paper, 306/1, Rome, 376 pp.

Sahin, C., Duzgunes, E., Engin, S., Mutlu, C., & Hacimurtazaoglu, N., (2005). Analysis of Age and Growth Parameters of Rapa Whelk (*Rapana thomasiana*), *Turkish Journal of Aquatic Life,* 4, 34-38.

TUIK., (2012). Year Book of Turkish Fisheries Statistics (1983-2012). *Turkish Statistics Association, Prime Ministry*. Ankara.

Unsal, S., (1989). *Evaluation of biological characteristics, nutritional value and diet for Rapana thomasiana in the Eastern Black Sea region*. Karadeniz Technical University Surmene Marine Science High School, Technical Report, 47pp. (In Turkish).

Zar, J.H., (1996). Biostatistical Analysis, 3rd ed. Prentice-Hall, Englewood Cliffs, NJ, USA.

Zengin, M., (2006). *Effects of the Trawl and Snail Fisheries on the Resources of Benthic Macro Fauna in the Middle Black Sea Coast, Samsun, Turkey.* 1st Biannual Scientific Conference. Black Sea Ecosystem 2005 and Beyond 1st Biannual Scientific Conference BSERP/BSC, 8-10 May 2006 Istanbul, Turkey.