Acta Biologica Turcica, 35(2), A1:1-12, 2022 Received 25 Jan. 2022; Accepted 25 Feb. 2021; Published Online 08 Mar. 2022

ACTA BIOLOGICA TURCICA

E-ISSN: 2458-7893, http://www.actabiologicaturcica.com

Research article

Identification of critical demersal fish habitats in the Northeast Mediterranean - with an emphasis on *Mullus barbatus*

Ali Cemal GÜCÜ*, Ferit BİNGEL (passed away on May 12, 2021)

Middle East Technical University Institute of Marine Sciences, P.O. Box 28 Erdemli 33731, Turkey

*Corresponding author e-mail: gucu@ims.metu.edu.tr

Abstract: The study determines the spawning and the nursery grounds of the important demersal fishes evaluating the fisheries data collected in 1983-1984. For this purpose, the spatial distribution of mean size, abundance, and biomass of fish communities on the northeastern corner of the Mediterranean Sea was evaluated. The emphasis has been given to red mullet, *Mullus barbatus*. During the spawning season, it was not possible to draw a clear-cut boundaries for the spawning ground; rather, the stocks were distributed along the basin on an offshore band around 50 – 80 m depth. After the spawning season, the fishes were aggregated on the shallow waters (5-15 m). Among them, the most important nursery sites were found near the rivers, where the highest biomass and abundance values were recorded throughout the study. The paper also discusses the impact of Lessepsian species on critical habitats.

Keywords: Spawning and nursery grounds, demersal fish stocks, Lessepsian migration, south coast of Turkey.

Citation: Gücü, A. C., & Bingel, F. (2022). Identification of critical demersal fish habitats in the Northeast Mediterranean - with an emphasis on *Mullus barbatus*. *Acta Biologica Turcica,* 35(2), A1:1-12.

Introduction

Due to its wide continental shelf area, the Northeast (NE) Mediterranean is one of Turkey's most important trawling grounds. The history of the industrial fishery goes back to the early 1940s when only two boats were operated in the Gulf of İskenderun. Later, in the 1950s, when the number of trawlers attained 14, a sudden drop in the CPUE called the attention of the local authorities, and a fisheries survey was carried out in the Gulf of İskenderun (Aasen and Akyuz, 1956; Akyuz, 1957). This survey revealed the first symptoms of over-fishing. The scientists involved suggested freezing existing fishing efforts. The advice proposed by the scientist has been disregarded; on the contrary, the growth of the fishing fleet in number, vessel size, and power was encouraged in the 1980s (Figure 1).

The Middle East Technical University has carried out a series of fisheries surveys in the area. During these studies, various aspects of the fish stocks and fisheries were evaluated by Bingel (1987), Bingel et al. (1993); Gücü (1995), Gücü (1997), Gücü and Bingel (1994a, 1994b). These studies point out a decrease in the CPUE and an increase in Lessepsian species. Various mitigation measures have been applied in the area to recover the over-fished demersal stocks (Annonymous, 2008). However, the attempts such as mesh size regulations seasonal closure of trawling have not proven fruitful due to the multispecies nature of the fish assemblages. Protecting sensitive habitats, such as spawning and nursery grounds, which might be helpful, has never been considered seriously due to lack of information. Moreover, it is not easy to get such information today because the demersal fish stocks in the region have been exploited heavily (Çiçek, 2015).

Moreover, the opportunistic Lessepsian species have irreversibly altered the ecosystem structure. Consequently, the CPUE is so low that the trawl surveys carried out in the region can hardly get enough samples to evaluate the behavior of the native stocks. Therefore, we used the data collected in the 1980s when the stocks were under a moderate level of fishing pressure. We also aimed to identify essential demersal fish habitats, such as

important nursery and spawning grounds of major commercial species of the NE Mediterranean Sea.

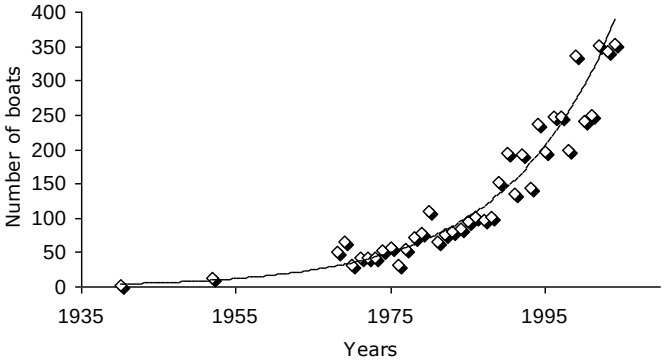

Figure 1. Development of Turkish demersal trawl fishery on the NE Mediterranean Sea.

Material and Methods

Data

The fisheries data used in the analysis was collected in three subsequent trawl surveys carried out in Autumn 1983, Spring 1984, and Autumn 1984, each covering 60 trawl stations (Figure 2). In each trawl haul, the samples were sorted out to the species level. Each species was separately weighed. The number of individuals was counted, and the length was measured to the nearest cm. Since the data at hand were scarce and limited to trawl survey results, the following procedures were applied to evaluate the geographically important areas.

Figure 2. The study area – Northeast Mediterranean Sea.

Determination of spawning and nursery grounds

It was assumed that the individuals larger than the length of the first maturity eventually aggregate on the spawning grounds just before and during the spawning season. Therefore, the sites represented by large individuals in high abundance indicated the spawning grounds. Similarly, the areas where small-sized individuals were concentrated in high numbers right after the spawning season indicated the location of the nursery grounds. Based on these assumptions, the L_{mean}/L_{inf} ratio (size index) was used to determine the spawning and nursery grounds in the NE Mediterranean Sea. Here, L_{mean} represents the average mean length of the individuals sampled at a station, and L_{inf} stands for the asymptotic length of the von Bertalanffy growth equation estimated for the region (Gücü, 1995). For every trawl station, the ratio was calculated for the major teleost fishes composing 80% of the total catch, namely *Arnoglossus laterna* (Walbaum, 1792), *Equulites klunzingeri (Steindachner, 1898), Spicara maena (Linnaeus, 1758), Mullus barbatus, Pagellus erythrinus (Linnaeus, 1758), Saurida lessepsianus Russell, Golani & Tikochinski, 2015, Chelidonichthys lucerna (Linnaeus, 1758), Upeneus moluccensis (Bleeker, 1855), Citharus linguatula (Linnaeus, 1758), Zeus faber Linnaeus, 1758, Boops boops (Linnaeus, 1758)*. The calculated L_{mean}/L_{inf}

ratio of each station was plotted on the map of the area. The points on the map where a high size index was associated with high biomass were assumed to indicate the position of the spawning grounds. Similarly, the small size index on the map in the post-spawning (recruitment) season displayed the importance of the site as a nursery site. It was assumed that the spawning season of the species incorporated in the analysis was late spring, and they recruit in early Autumn (Bingel, 1987; Ok, 2011).

The mean length of the most abundant native fish species, *M. barbatus*, was calculated for each trawl station. The values were plotted on the map. Similarly, the species' abundances (number of individuals/unit area) and biomass (catch per unit trawling effort) were calculated, and the results were plotted on the map of the region.

Results

Comparison of relative size index and Teleost biomass

Post spawning period – Autumn 1983

In 1983, after the spawning season of almost all important species in the NE Mediterranean Sea, the large-sized individuals tended to accumulate at deeper depths. On the other hand, the small ones remained close to the shore at the eastern half of the basin (east of 34.5 E). The smallest individuals were found in front of Seyhan River (arrow at the right-hand side on Figure 3a), where one of the main rivers runs into the basin. The teleost biomass at this point was relatively low. From this point to the west, larger individuals formed noticeable local aggregations on sites where the continental shelf gets narrower (arrow in the middle). The largest biomass recorded in autumn 1983 was observed at two stations located at the Lamas river mouth. 90% of this high biomass value, which scored 210 kg and 135 kg per trawling hour, consisted of 4 species; *B. boops*, *M. barbatus*, *P. erythrinus* and *P. acarne*, respectively. This value was far beyond the average biomass score for the entire basin. In front of Göksu River (at the stations indicated by the left arrow on Fig 4a), the size index was small compared to the surrounding stations. However, the biomass at the same station was very high (arrow on Fig 4b). The small-sized, immature (probably newly recruited) fishes were accumulated at this point.

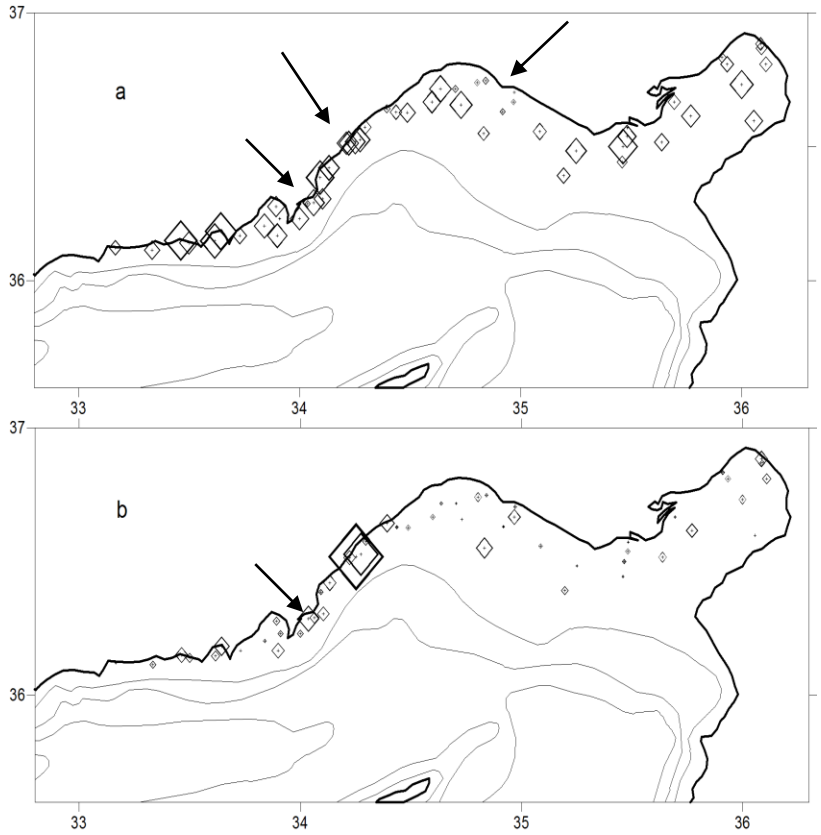

Figure 3. Spatial distribution of a) relative size index of some teleost fishes (see text); b) biomass (weight per unit trawling time) of all teleost fishes in Autumn 1983. See text for arrows.

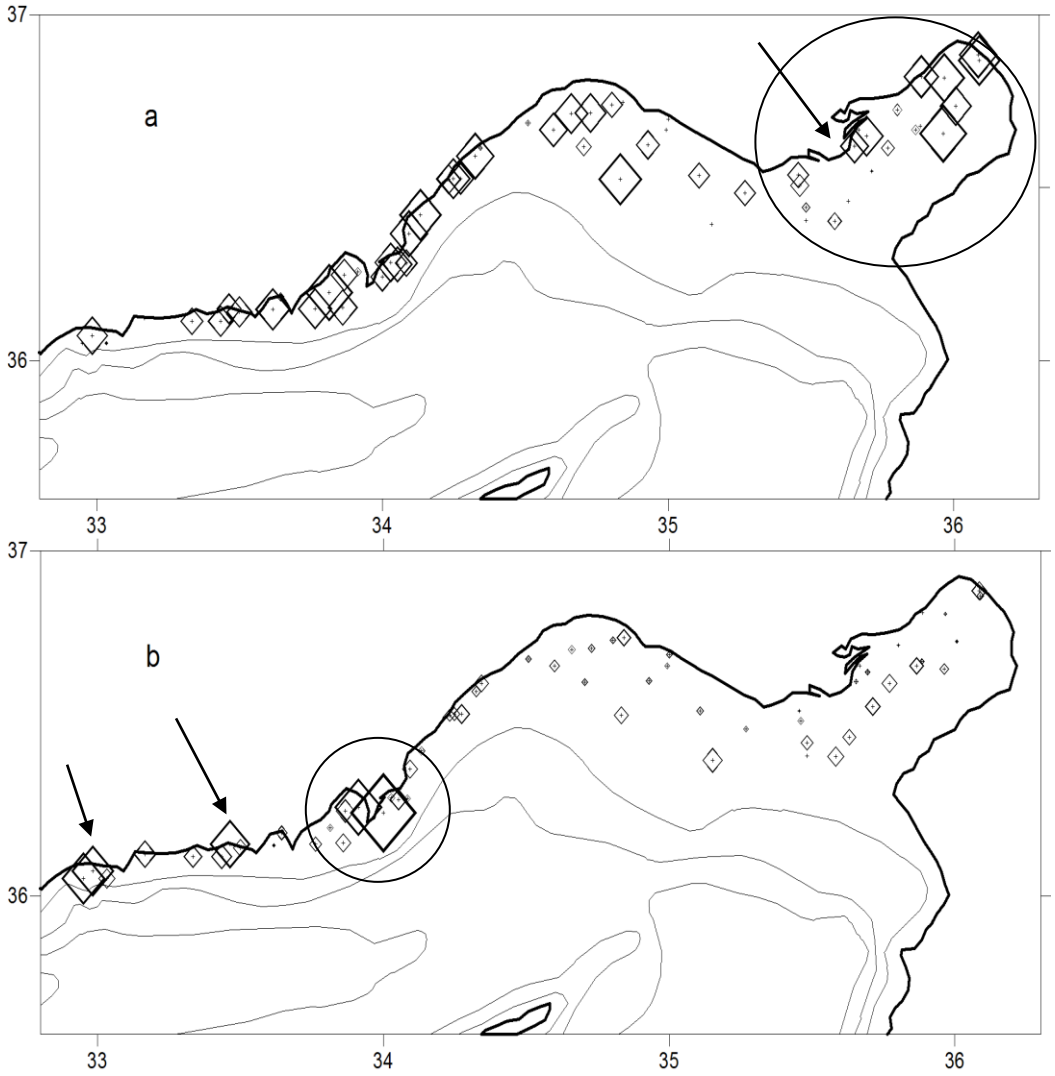

Figure 4. Spatial distribution of a) relative size index of some teleost fishes (see text); b) biomass (weight per unit trawling time) of all teleost fishes in May 1984. See text for arrows.

Pre-spawning period – Spring 1984

In the Gulf of İskenderun (indicated by the circle in Figure 4a), larger individuals, assumingly ready for spawning during this time of year, were observed near the eastern corner of the basin and in front of Ceyhan River (the arrow in Figure 4). However, biomass values at these sites were relatively low except at the easternmost station located at the far end of the gulf.

The Göksu River (indicated by the circle in Figure 4b) had the largest biomass. Two stations located there represented very high Teleost biomass. One of these stations (located on the eastern side of the cape) was composed of small-sized individuals situated around 10 m. The station with the second-highest fish biomass was located at 30m depth. Two other trawl stations on the western side (arrows on Figure 4b) seem important since they show a high size index and biomass.

Post spawning period – 1984

One of the largest fish aggregations in Autumn 1984 was observed at the far end of the Gulf of İskenderun. The contribution of the Lessepsian species to the teleost biomass at this site was significantly high, exceeding 70% of the total catch, *Equulites klunzingeri* being the highest.

An almost similar, however less pronounced pattern was observed in front of the Seyhan River mouth, where one of the largest aggregations was found in autumn 1984. Despite the high values, no sign of spawning aggregations was observed at this site in May 1984. At the same site, 79% of the teleost biomass was formed by *E. klunzingeri*.

The Göksu river, where the highest Teleost biomass recorded in Figure 4b, held its position when the 0-year class appeared in the catch in Autumn 1984 (Figure 5b).

High biomass values around the Göksu River were generally located at shallow depths not deeper than 15m.

Another site drawing attention was the basin's western side (arrow on Figure 5b). Although the size index is almost equal to the surroundings at this station, the biomass was noticeably high.

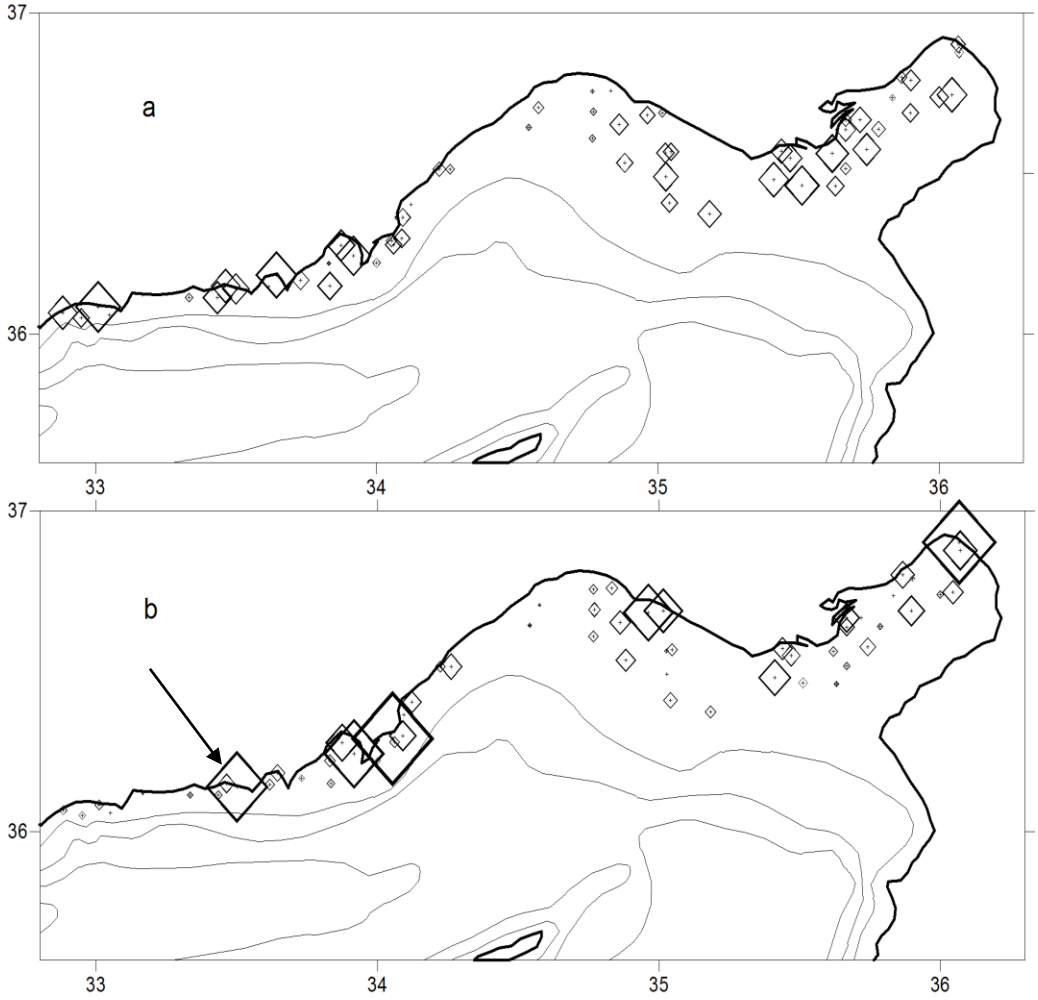

Figure 5. Spatial distribution of a) relative size index of some Teleost fishes (see text); b) biomass (weight per unit trawling time) of all Teleost fishes in Autumn 1984. See text for arrows.

Red Mullet - *Mullus barbatus*

Post spawning period – 1983

The mean length of the red mullets at almost all trawl stations was below 13 cm (Figure 6a), which is the size attained by 1-year-old fish in the region (Gücü and Bingel, 1993). The exceptions were the central part of the Gulf of İskenderun and the western part of the basin. There, the abundance (Figure 6b) and biomass (Figure 6c) were low. However, three stations located in front of Lamas River (see arrow in Figure 6a) represent high values in all three parameters (individual larger than maturity size (>13cm), abundance (number of individuals per unit trawling time) and biomass (weight per unit trawling time).

The other two *important M. barbatus* aggregations were seen in Figure 6b, located very close to the river fronts. The mean sizes of the fishes forming these aggregations were lower than 13 cm. Also, the biomass values at these stations were slightly higher than the surrounding stations.

There were no remarkable accumulations on the east, especially in the Gulf of İskenderun. The abundance and biomass values for red mullet were by far lower than the western half of the basin.

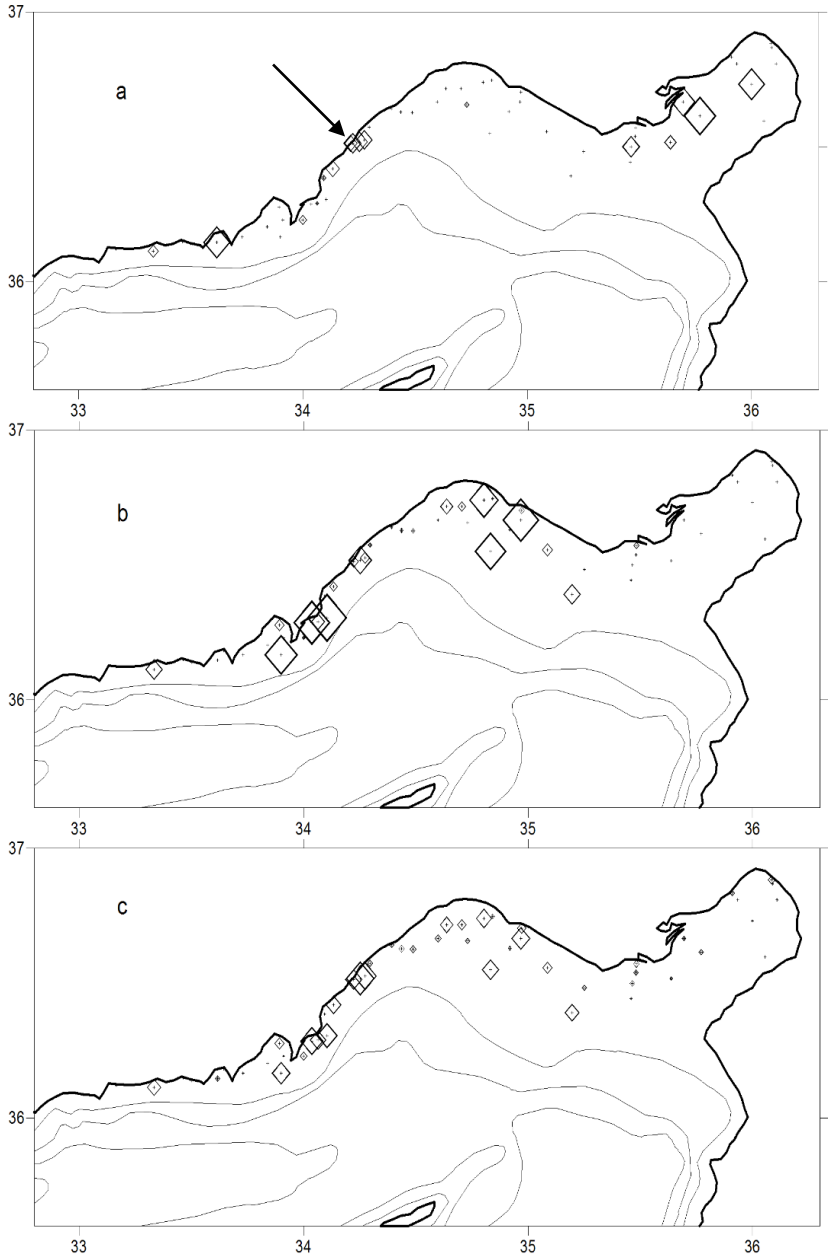

Figure 6. Spatial distribution of a) individual larger than maturity size (>13cm); b) abundance (number of individuals per unit trawling time) and; c) biomass (weight per unit trawling time) of red mullet, *Mullus barbatus* in Autumn 1983.

Pre-spawning period – Spring 1984

At the onset of the spawning season of red mullet, the average length of the fishes caught within the Gulf of İskenderun was relatively high, exceeding the size at first maturity. Their abundance at this site, however, was very low. In fact, no remarkable accumulation within the gulf was observed in this survey. On the rest of the eastern part of the basin, high abundance (Figure 7b) and biomass (Figure 7c) values were found at offshore stations (>50m). These aggregations were composed of small red mullets that had not yet attained sexual maturity size.

The western half represented quite different spatial distribution patterns in all parameters. Almost all the near-coastal stations remained within the marked area in Figure 7a, representing a very high mean length well above maturity size. On the other hand, the quantity of fish at these stations was not noticeably high. There is only one exception to this pattern; the station with the largest abundance and biomass value had a mean length slightly higher than the size at first maturity. This may indicate that only a part of the aggregation was ready for spawning at this period. Although the quantity of fish in the area indicated by a circle in Figure 7b was not very high, the aggregation was composed of large individuals.

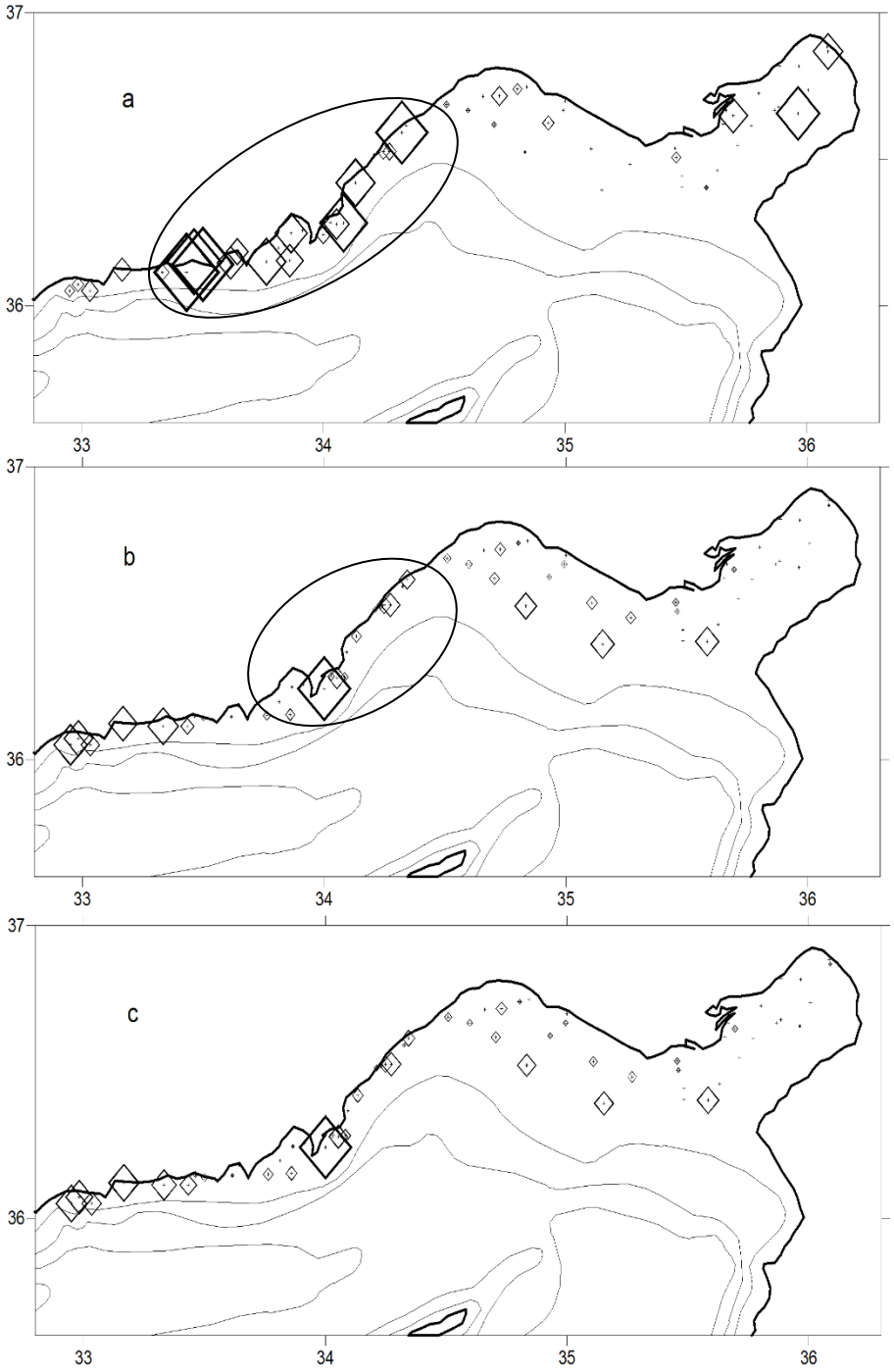

Figure 7. Spatial distribution of a) individual larger than maturity size (>13cm); b) abundance (number of individuals per unit trawling time) and; c) biomass (weight per unit trawling time) of red mullet, *Mullus barbatus* in May 1984

Post spawning period – 1984

Spatial distribution patterns in this period were almost identical to those in Autumn 1983. Dense accumulations composed of small red mullets were located at two sites, as they are during the previous year. The circle on the left (Figure 8b) represents the red mullet aggregations around the Göksu River. The circle on the right gives the position of the second aggregation located in front of the Seyhan River. It is worth noting that the station marked with an arrow on Figure 8c reflects very high abundance. However, the biomass of red mullet at the same station is rather low. The contradiction between abundance and biomass may indicate that the aggregation is formed by very small individuals, which are probably spawned in the previous spawning season.

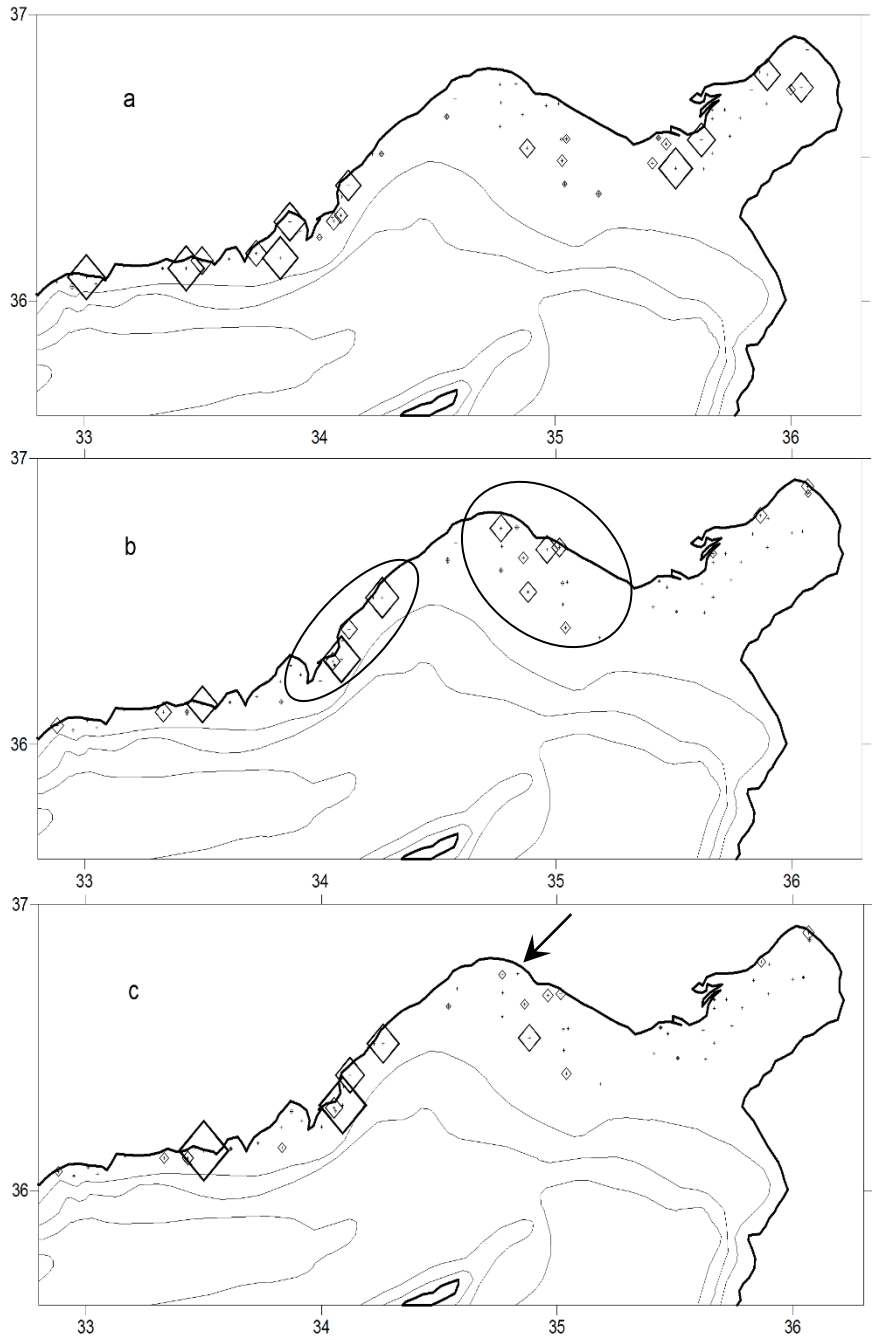

Figure 8. Spatial distribution of a) individual larger than maturity size (>13cm); b) abundance (number of individuals per unit trawling time) and; c) biomass (weight per unit trawling time) of red mullet, *Mullus barbatus* in Autumn 1984.

Discussion

Spawning and nursery grounds

Spawning and nursery grounds were identified based on spatial comparison of size and quantity of fish at the stations before and after the spawning season. The locations where small-sized fishes accumulate in large quantities after the spawning season indicated the nursery grounds where recruits aggregated. On the other hand, the aggregation of the mature fish above sexual maturity size shortly before the spawning season was taken as an indicator of the spawning grounds' location. A monthly investigation on qualitative and quantitative distribution of ichthyoplankton conducted in the NE Mediterranean Sea concluded that the fishes of the northeastern Mediterranean Sea mainly spawn between May and August (Ak, 2004). In the present study, May is therefore taken as the onset of the spawning season of the main Teleost fishes.

The major difficulty in this approach was the unequal fishing pressure on different parts of the basin in the

1980s (Figure 9). The area on the west of the Göksu River was almost intact in terms of the fishery. The stocks were at a near virgin state. They remained unfished until 1986 due to the lack of fisheries infrastructure, such as landing ports and harbors in the region. On the other hand, the eastern half is one of the most heavily exploited trawling grounds on the Turkish coast. When the trawling season is banned in May, the fish stocks are reduced to their lowest level. The differences in the biomass values on highly exploited and slightly fished parts of the basin were, therefore, very pronounced in May (Figure 4b). This created problem in the comparison of fish aggregations along the basin.

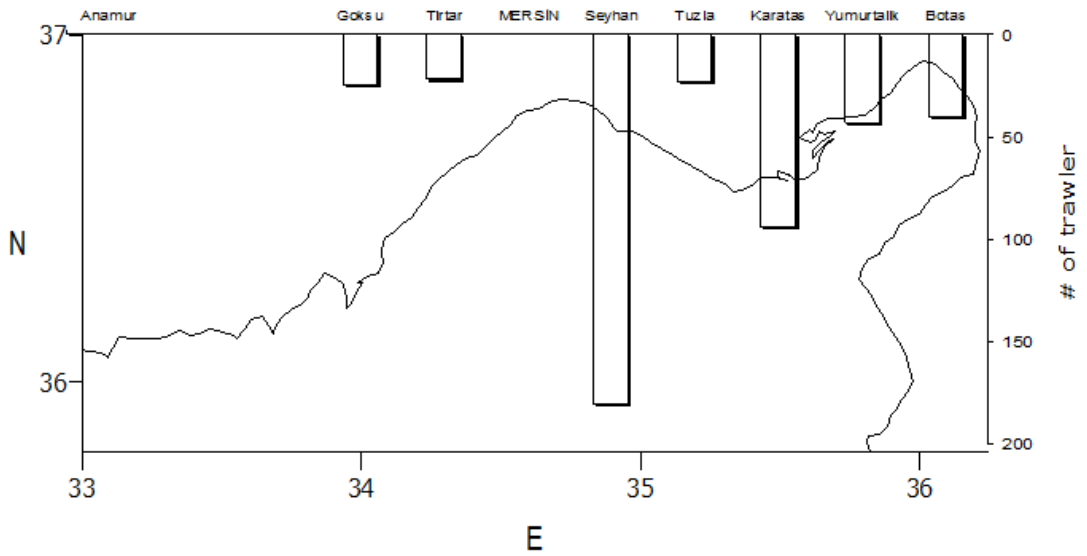

Figure 9. Distribution of fishing efforts – number of trawlers sighted during the surveys (1983-1984).

This problem is less pronounced in autumn surveys because following the spawning season in early summer, the recruits of the year nourish the stocks just before the onset of the trawling season in early Autumn (Bingel, 1987). The area at the outlet of the Göksu River (shown by a circle in Figure 4b) was apparently the most important site, where the teleosts of the region were aggregated in significant quantities during the spawning and post-spawning seasons. The patchy and irregularly positioned high-density fish aggregates around the Göksu River is probably the consequence of the rapid changes in the topography and depth preference of the species at different life stages. Individuals tend to aggregate at around 50m during spawning. Following the spawning, small-sized juveniles move closer to the coast, and schooling takes place at shallower depths below 15m.

As the eastern half of the area is evaluated as a separate unit and the incompatibility of fisheries pressure on east and west were disregarded, the high biomass areas are found at the offshore stations deeper than 50m during the pre-spawning period. The fishes at this depth range were evenly distributed with no remarkable accumulation indicating the position of spawning aggregations. The distribution of fishes during the post-spawning period indicated three major sites where small-sized fishes were found in large quantities. Among them, the Göksu River has the most important place. In the 1983 and 1984 post-spawning periods, the largest fish aggregations were found around or near this rivers' vicinity. The most pronounced fish aggregation observed in front of Lamas River in 1983 (Figure 3b) was not observed the following year when the major concentration was moved to the Göksu River. The combination of 3 successive periods' findings may indicate a westward migration after the spawning season. Apparently, the spawning takes place on an offshore strip at around 50m depth. During autumn, the evenly distributed juveniles on the broad continental shelf move towards the Göksu River. As observed in autumn 1983, the distribution gets denser when they reach Lamas River. At this point, the continental shelf gets narrower. It seems that changes in the bathymetry act as a bottleneck and the fish schools moving to the west get concentrated at this point. The shift in the position of high biomass areas in Figure 3b and Figure 5b may

indicate that the final destination of the juveniles is the shallow and nutrient-rich outlet of the Göksu River.

The high biomass sites recognized on the west of Göksu were located on *Posidonia oceanica* meadows. This seagrass, which is known to provide food and shelter to sub-juvenile and juvenile fish, is naturally absent on the east of the Göksu River (Gücü and Gücü, 2002). The increase in the summer biomass of relatively small fishes on the seagrass meadows emphasizes the ecological significance of the seagrass habitat as an important nursery area for the fishes at early life stages.

The very high teleost biomass found near the Göksu River in autumn 1983, which was far above the average of the entire basin, suppressed the significance of other stations in Figure 3b. In fact, the aggregation of fish around the Seyhan River was relatively high when the maximum value of the season was overlooked.

In general, shallow areas surrounding rivers seem to be the most important nursery ground of the northeastern Mediterranean. The concentration of the species partitioning this area may also suggest differences among native and immigrant species. The general tendency of the fishes is that Göksu is preferred by native fishes, such as Mullids and Sparids. In contrast, Lessepsian migrants are more abundant around the rivers in the eastern part.

Red Mullet – *Mullus barbatus*

The data analyzed indicates that the main summer spawning red mullets aggregations were at 30m found near to Göksu River. Apart from these groups, the rest of the stock, which was mainly composed of sub-adults, was dispersed along the offshore band at around 50m depth. In general, the abundance and biomass of red mullet at the station shallower than 30m were very low. This pattern suggests that the red mullet has no regular spawning pattern in the region, and spawning takes place on the entire basin (disregarding the Gulf of İskenderun) along the offshore strip located between 40-60 meters. This depth range is slightly shallower than those reported for the Adriatic Sea, where the most intensive spawning occurs at depths of 60 to 70 m (Haidar, 1970; Guescini et al., 1983).

An interesting finding is although red mullet was by far the most abundant demersal teleost species of the NE Mediterranean in the 1980s, nearly no spawning aggregation was observed in the Gulf of İskenderun. This may, partly, be due to heavy fishing pressure in the area. However, it is also very likely that the red mullet in the eastern half of the basin is severely influenced by the Lessepsian counterparts. For instance, due to its proximity to a river and suitable bathymetry, the central part of the gulf, in front of Ceyhan Rivers is expected to be an ideal spawning ground for red mullet. This area, on the contrary, hosted very high concentrations of *E. klunzingeri* and *Upeneus mollocensis*. Competition for feeding habitat between these zoobenthivorous species is quite possible.

Although the main spawning season of red mullet is reported to occur in late spring/early summer (Ok, 2011), it is also known that the bigger specimens have a biennial sex cycle with the extended reproductive phase from May to December (Haidar. 1970). Following the spring spawning, the subsequent batch mainly produced by individuals older than 3 years was reported in early Autumn (Bingel, 1987; Gücü, 1995). The aggregates of large fish found in autumn are probably associated with the secondary spawners.

Similar to the general biomass distribution pattern of Teleost fishes discussed above, the abundance and biomass of red mullet are significantly high in the western part of the region (around 33^{o} E), which is the only part in the basin inhabited by *Posidonia oceanica* meadows. The areas with high red mullet density were always formed by small-sized individuals. The aggregation of the larger fish was always represented by a few individuals. This may be another indication of the lack of dense spawning schools and widespread spawning behavior of the species. Eventually, this is confirmed by the lack of significant red mullet aggregates in the post-spawning seasons.

The concentration of large fishes around the Göksu River during the spawning season was not observed in the post-spawning season. There, the mean size of the red mullet at the sampling stations dropped remarkably, possibly indicating that the newly recruited individuals dominated the aggregations. The Göksu River, and especially its eastern coasts, may be taken as one of the most important nursery grounds of red mullet in the northeastern Mediterranean Sea. The Seyhan River seems to be the second important nursery ground, although no aggregation of red mullet was observed during the spawning season.

The rivers, in general, are the best sites acting as nursery grounds for many fish species and *M. barbatus* in particular (Scaccini, 1947). Larvae, post-larvae, and juveniles up to 4-5 cm of total length are pelagic (Ok,

2012) and very rarely observed in the bottom trawl catch. The results indicate that when the juveniles attain 5-6 cm in length, they move towards coastal areas where settlement occurs. In the region, *M. barbat*us approaches Göksu and Seyhan rivers at this stage. This is a well-known pattern represented by the species elsewhere in the Mediterranean; they concentrate near river mouths and sometimes enter rivers for hundreds of meters (Scaccini, 1947a). It is evident that Göksu and Seyhan rivers are essential sites for red mullets. However, not all rivers are equally vital for the species. For instance, no remarkable red mullet aggregation was found around the Ceyhan River, although it has the same geographic and hydrological features as Göksu and Seyhan Rivers. The Ceyhan River or the Gulf of İskenderun does not seem to be a preferred nursery ground for red mullet. The reason is likely that the gulf has long been overexploited (Çiçek, 2015) and the high concentration of Lessepsian immigrants occupying the gulf.

Conclusion

The most important sites for the demersal fish assemblages in the NE Mediterranean Sea seem to be located in the area near the Göksu River mouth. This area is probably the major nursery ground for the native species. No isolated spawning ground could be found for the commercially important species.

In general, the life history of red mullet in the NE Mediterranean agrees with what is already known about the species. The juvenile fish approaches the river mouths, which are apparently the major nursery grounds of the fish in the NE Mediterranean Sea. However, it was observed that there is a kind of nursery ground partitioning between red mullet and its Lessepsian counterparts. The rivers on the eastern half of the region, the Gulf of İskenderun in particular, were occupied by the Lessepsian species. Almost no significant red mullet aggregation was observed in these areas. This may represent that even in the early 1980s the fisheries ecosystem of the NE Mediterranean Sea has been subjected to remarkable changes due to the occurrence of Lessepsian immigrants.

Acknowledgment

The authors are grateful to the crew of the research vessel Lamas1, and the staff of the IMS-METU who participated in the demersal trawl surveys.

Conflicts of Interest

No potential conflict of interest was reported by the authors.

Ethical approval

All applicable national guidelines for the care and use of animals were followed.

Funding

The data used in this study were collected in demersal trawl surveys funded by the State Planning Office (DPT). The compilation and the analysis of the data are part of the first work package of a project (TUBITAK 102Y347) funded by the Turkish Scientific and Technical Research Council.

References

Aasen, O., & Akyuz E. (1956). Some Data Concerning Fisheries in the İskenderun Bay. *Reports from the Fishery Research Center, Meat and Fish Office: Series Marine Research. Istanbul, 1*(4), 1-8.

Ak, Y. (2004). The abundance and distribution of the pelagic eggs and larvae of some teleost fishes on Erdemli coast (Levant Sea). PhD Thesis, Ege University Institute of Sciences. Izmir. 387p.

Akyuz, E. (1957). Observations on the Iskenderun Red Mullet (*Mullus barbatus*) And Its Environment. *Proceedings and technical papers, General Fisheries Council for the Mediterranean*, 4, 305-326.

Annon. (2008). Fisheries circular – 2008. Turkish Ministry of Agriculture and Rural Affairs. General Directorate of Protection and Control http://www.kkgm.gov.tr/teblig/2008-48.html

Bingel, F. (1987). Doğu Akdeniz'de Kıyı Balıkçılığı Av Alanlarında Sayısal Balıkçılık Projesi Kesin Raporu. ODTÜ-DBE, Erdemli.

Bingel, F., Özsoy, E., & Ünlüata, Ü. (1993). A Review of the State of the Fisheries and the Environment of the Northeastern Mediterranean (Northern Levantine Basin) Food and Agriculture Organisation. Technical Reports, No 65, FAO-Rome, 74.

Çiçek, E. (2015). Age, growth and mortality parameters of *Mullus barbatus* Linnaeus, 1758 (Perciformes: Mullidae) in İskenderun Bay, northeastern Mediterranean. *Iranian Journal of Ichthyology*, 2(4), 262–269.

Gücü, A. C. (1995). A Box Model for the Basic Elements of Northeastern Levant Sea (Mediterranean) Trawl Fisheries. *Israel Journal of Zoology*, 41(4), 551-568.

Gücü, A. C. (1997). An Ecosystem Model for the Northeastern Mediterranean. 1st International Mediterranean Fisheries Congress, İzmir, Turkey, 9-11 April 1997.

Gücü, A. C., & Bingel, F. (1993). On the Red Mullet fisheries in northeast Mediterranean. 1st National Congress on the Ecology and Environment Issues 5 – 7 October 1993, Izmir.

Gücü, A. C., & Bingel, F. (1994a). State of the Fisheries along the Turkish Mediterranean Coast. *Turkish Journal of Zoology*, 18, 251-258.

Gücü, A. C., & Bingel, F. (1994b). Trawlable Species Assemblages on the Continental Shelf of the Northeastern Levant Sea (Mediterranean) with an Emphasis on Lesseptian Migration. *Acta Adriatica*, 35(1/2), 83-100.

Gücü, G., & Gücü, A. C. (2002). Ecological significance of sea grass meadows (*Posidonia oceanica* (l.) delile) in Bozyazi-Kizilliman marine protected area Proceedings of the "Second International Conference on Oceanography of the Eastern Mediterranean and Black Sea: Similarities and Differences of Two Interconnected Basins" - 14-18 October 2002 METU Cultural and Convention Center Ankara/TURKEY: 924-930.

Guescini, A., Piccinetti Manfrin, G., & Piccinetti, C. (1983). Distribution des larves de *Mullus barbatus* L. en Adriatique. *Rapp. Comm. int. Mer. Medit*., 28(5), 155-158.

Haidar, Z. (1970). L'oecologie du rouget (*Mullus barbatus* L.) en Adriatique orientale. *Acta Adriatica,* 14(1), 1-94.

Ok, M. (2012). Evaluation of the demersal fish assemblages of the Northeastern Levant Sea. PhD thesis, Middle East Technical University, Turkey. 227 p.

Scaccini, A. (1947). Contributo alla conoscenza della biologia dei Mullidi nell'Adriatico medio occidentale. *Note Laboratorio Di Biologia Marina e Pesca Di Fano*, 1(1), 1-8.