DOI: 10.2478/cjf-2024-0019

**CODEN RIBAEG ISSN 1330-061X (print)
1848-0586 (online)**

sciendo

TARGETED FISHERY FOR BOGUE *Boops boops* (Linnaeus, 1758) AROUND SEA-CAGE FISH FARMS IN THE TURKISH AEGEAN SEA

Okan Ertosluk[1], Okan Akyol[2*], Tevfik Ceyhan[2], Aytaç Özgül[2]

[1] Aydın Adnan Menderes University, Bozdoğan Vocational School, Aydın, Türkiye
[2] Ege University, Faculty of Fisheries, Urla, İzmir, Türkiye

*Corresponding Author: okan.akyol@ege.edu.tr

ARTICLE INFO

Received: 16 February 2024
Accepted: 28 October 2024

Keywords:
Bogue
CPUE
Coastal fishery
Catch composition
Mediterranean Sea

ABSTRACT

This study investigated artisanal fishing activity near sea cages in Güllük Bay in the southeastern Aegean Sea based on dockside sampling with local fishermen. The daily fishing activity of bogue *Boops boops* gillnetters was randomly observed in the ports of Göltürkbükü, Gündoğan, Yalıkavak and Torba over two fishing seasons, from November to April 2018 and 2019. A total of 18,163 kg of fish were caught in 147 daily operations. The composition of catches from the bogue gillnet fishery comprised 48 species from 30 families, including both fish and invertebrates. *B. boops* was the most abundant species with 91.9% of the catch, followed by *Diplodus annularis*, *Scomber colias*, *Trachurus trachurus*, *Pagellus acarne* and *Scomber scombrus*. The ratio of total bycatch biomass to commercial target species was 1:0.09. The fork length (FL) and weight of the 536 sampled *B. boops* ranged between 25.5 ± 0.12 cm and 293.6 ± 3.87 g, respectively. The highest catch per unit effort (CPUE) of *B. boops* occurred in April and averaged 58.83 ± 11.47 kg/1000 m, likely due to an increased catch during its spawning migration to open sea areas in spring.

How to Cite

Ertosluk, O., Akyol, O., Ceyhan, T., Özgül, A. (2024): Targeted fishery for bogue *Boops boops* (Linnaeus, 1758) around sea-cage fish farms in the Turkish Aegean Sea. Croatian Journal of Fisheries, 82, 153-158. DOI: 10.2478/cjf-2024-0019.

INTRODUCTION

The term "fish aggregation device" (FAD) usually refers to floating structures designed to attract fish. However, sea cages are also considered large FADs as they attract pelagic fish which often form dense aggregations around them (Dempster and Taquet, 2004; Sanchez-Jerez et al., 2007). Commonly attracted species include sparids, carangids, clupeids and mugilids. Uneaten food from these cages can further draw a variety of species to the area and impact the local ichthyofauna and fisheries (Dosdat, 2001; Sanchez-Jerez et al., 2007). This attraction of fish farms to commercially important pelagic species has garnered the interest of local fishermen (Fernandez-Jover et al., 2008).
In recent years, recreational fishing near sea cages has gained popularity. Since the mid-1980s, when the first fish farms were introduced in the Turkish Aegean Sea, artisanal fishing near these cages has also been intensively practised. Aquaculture farm staff often use traps, handlines and gillnets to catch wild fish near their cages (Akyol and Ertosluk, 2010). In the Turkish Aegean, there are three main groups of stakeholders interacting in these areas: fish farmers, small-scale fishers and recreational anglers, and conflicts have been observed between these groups (Akyol et al., 2019).
While sparids, carangids and pomatomids are mainly found in the vicinity of sea cages, local small-scale fisheries (SSF) mainly target bogue *Boops boops* (Linnaeus 1758) (Sparidae). Studies suggest that bogue is the most abundant species around marine cage farms in the Mediterranean (Dempster et al., 2002; Valle et al., 2007; Akyol et al, 2020). This is probably due to their omnivorous diet, their gregarious and semi-pelagic nature, and their adaptability to different substrates such as sand, mud, rocks, algae and seagrass beds at depths from 0 to 350 meters (Arechavala-Lopez et al., 2011; Froese and Pauly, 2022). Numerous studies have examined the effects of fish farming on local fishery landings, the responses of demersal fish communities to fish farms, and the attraction of these farms to common bottlenose dolphins in Greek waters (Machias et al., 2005, 2006; Bonizzoni et al., 2014). In a comprehensive study on the impact of marine fish farming on SSF catches in the northwestern Mediterranean, Bacher and Gordoa (2016) reported on these dynamics. However, only one study has specifically examined local fisheries near sea-cage farms in İzmir in the northern Aegean Sea (Akyol and Ertosluk, 2010). This study focused on the yields of commercially valuable species caught intentionally around fish farms using gillnets, traps and handlines, as well as potential conflicts between SSF and sea-cage fish farms, though without detailed analysis of catch rates or species diversity (Akyol et al., 2019).
This study aims to evaluate the catch of *Boops boops* as the target species around sea-cage farms by assessing catch per unit effort (CPUE), catch composition and bycatch ratios in Güllük Bay, a significant fish farming region in the southern Aegean Sea.

MATERIALS AND METHODS

This study was conducted by sampling at the small-scale fisheries (SSF) port, focusing on the daily unloading of catches from fisheries near fish farms in Güllük Bay in the southeastern Aegean Sea. The daily fishing activities of 13 representative gillnet boats were observed randomly in the ports of Göltürkbükü, Gündoğan, Yalıkavak and Torba (Fig 1). A total of 147 fishing trips were observed over two fishing periods from November to April in 2018 and 2019 (January, April, November, December 2018; February, March, April, December 2019). Only professional fishermen were involved in this study.

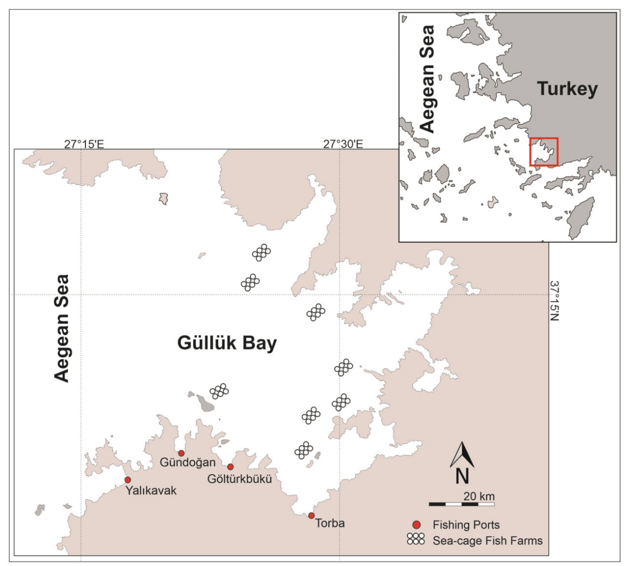

Fig 1. Study area

Fishing took place at a depth of 40–60 meters. Samples were taken at the harbor during each fishing trip and additional data was recorded in logbooks. The dataset comprised three main categories:

(i) date, location and depth of fishing;

(ii) fishing boat characteristics, such as length and engine power (hp), along with gillnet specifications, including mesh size and total net length; and

(iii) catch data which included wet weight (kg) of the target species (*Boops boops*) and other species. A total of 536 bogue specimens were measured to the nearest 0.1 mm and weighed to the nearest gram.

Fishing effort (*f*) and catch per unit effort (CPUE) were calculated using the following formula:

$$f = (a' / 1000) \times g$$

where a'⁄1000 represents the average daily length of the net deployed in the sea (in kilometres), and g is the number of fishing days. The CPUE, expressed as weight per kilometer of net, was calculated using the formula $CPUE = kg \times f^{-1}$. Monthly data from both years were combined for analysis.
Data analysis, visualization and statistical significance tests were conducted in R (R Core Team, 2020) using the tidyverse library (Wickham et al., 2019). For statistical significance testing, data were first examined for normality. Since CPUE followed a log-normal distribution, ANOVA was applied. All means are reported with standard errors (± s.e.).

RESULTS

The overall length (LOA) and engine power (hp) of the gillnetters studied ranged from 8 to 10 meters and 28 to 135 hp, respectively. The gillnets used were between 500 and 5,000 meters long, with an average length of 2,716 ± 69.6 meters. These gillnets were made of polyamide (23 Tex/4 no), with a mesh size of 32 mm, a depth of 50 meshes and a length of 80 meters per individual net. The highest fishing intensity for bogue near sea-cage farms occurred between January and May. The legal guidelines stipulate a soak time from sunset to sunrise, with bottom gillnets allowed up to 200 meters from the sea cages.
Across 147 daily operations, a total of 18,163 kg of fish was caught in the bogue gillnet fishery. The catch composition comprised 48 species from 30 families, including both fish and invertebrates (Table 1). *Boops boops*, the target species, accounted for 91.9% of the catch, followed by *Diplodus annularis*, *Scomber colias*, *Trachurus trachurus*, *Pagellus acarne* and *Scomber scombrus*. Among the bycatch, the family Sparidae was the most abundant, followed by the Scombridae, Carangidae, Moronidae, Engraulidae, Pomatomidae and Soleidae. The biomass ratio of total bycatch to target *B. boops* was 1:0.09.
The length and weight distribution of *B. boops* samples ranged from 17 to 32 cm in length (mean: 25.5 ± 0.12 cm) and from 98 to 625 g in weight (mean: 293.6 ± 3.87 g), with a mid-length range of 26 cm, representing the largest proportion at approximately 28.5% (Fig. 2).
Yearly and monthly CPUE values showed significant variations between the two years (2018-2019) and across months ($P < 0.05$). Monthly average CPUE ranged from 19.64 ± 5.49 kg in January (daily catch: min. 1.7 – max. 100 kg) to 58.83 ± 11.47 kg in April (daily catch: min. 6.7 – max. 525 kg) (Fig. 3), with statistically significant monthly differences ($P < 0.05$).

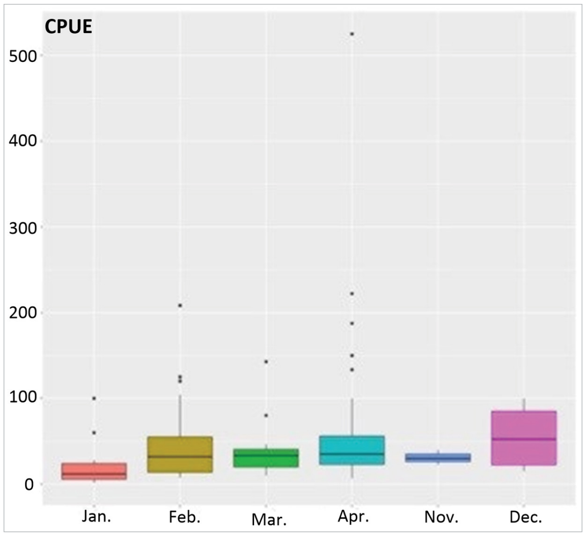

Fig 3. Box-whisker plots of monthly CPUE values for *Boops boops* around sea-cage fish farms in Güllük Bay, Aegean Sea

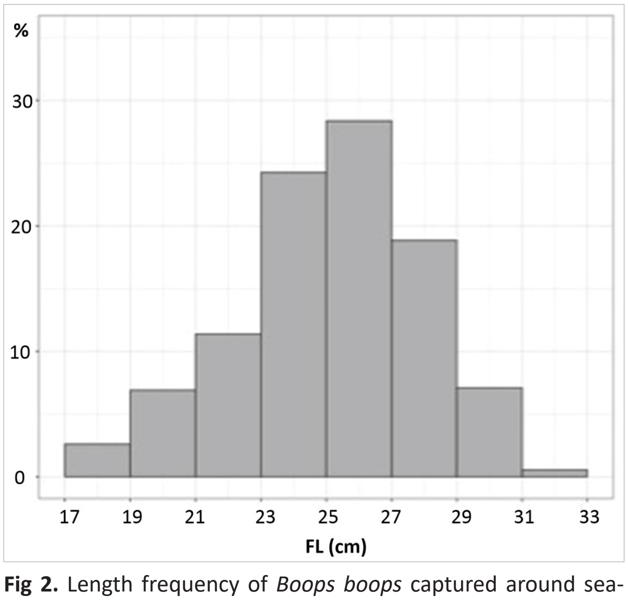

Fig 2. Length frequency of *Boops boops* captured around sea-cage fish farms in the Aegean Sea

DISCUSSION

Fishing with gillnets near sea-cage fish farms is well established in the Aegean Sea. This study represents the first systematic monitoring of a commercial gillnet fishery specifically targeting *B. boops* near fish farms. This fishery, mainly conducted in Güllük Bay, is the most intensive in the southern Aegean, while only limited activity has been observed in İzmir in the northern Aegean. Therefore, Güllük Bay is a valuable example for studying the dynamics of this fishery.
In this study, 48 species from 30 families, including invertebrates, were caught as bycatch in the gillnet fishery. *B. boops* accounted for 91.9% of the catch, which is consistent with findings that it is one of the most abundant wild fish around marine cage farms in the Mediterranean (Dempster et al., 2002; Valle et al., 2007; Fernandez-Jover et al., 2008). This abundance is attributed to its omnivorous diet and its adaptability to different substrates (sand, mud, rocks, seagrass) and depths from 0 to 350 meters (Arechavala-Lopez et al., 2011; Froese and Pauly, 2022).

Table 1. Total weight and weight percentages of commercial (C) and non-commercial (NC) fish and invertebrate species caught by bogue gillnet fishery around sea-cage fish farms in Güllük Bay, Aegean Sea

Family	Species	C/NC	∑ Weight (kg)	Weight (%)
Carangidae	*Pseudocaranx dentex* (Bloch & Schneider, 1801)	C	0.6	0.003
	Trachurus trachurus (Linnaeus, 1758)	C	70.57	0.388
Clupeidae	*Alosa fallax* (Lacepéde, 1803)	C	21.7	0.119
	Sardinella aurita Valenciennes, 1847	C	0.8	0.004
Congridae	*Conger conger* (Linnaeus, 1758)	NC	4.0	0.022
Coryphaenidae	*Coryphaena hippurus* Linnaeus, 1758	C	4.0	0.022
Engraulidae	*Engraulis encrasicolus* (Linnaeus, 1758)	C	50.0	0.275
Hemiramphidae	*Hemiramphus far* (Forsskal, 1775)	NC	0.1	0.000
Loliginidae	*Loligo vulgaris* Lamarck, 1798	C	8.5	0.047
Moronidae	*Dicentrarchus labrax* (Linnaeus, 1758)	C	62.6	0.345
Mugilidae	*Chelon auratus* (Risso, 1810)	C	1.0	0.006
	Mugil spp.	C	6.0	0.033
Mullidae	*Mullus barbatus* Linnaeus, 1758	C	15.5	0.085
Octopodidae	*Octopus vulgaris* Cuvier, 1797	C	19.0	0.105
Penaeidae	*Penaeus kerathurus* Forsskal, 1775	C	0.6	0.003
Phycidae	*Phycis phycis* (Linnaeus, 1766)	NC	0.2	0.001
Pomatomidae	*Pomatomus saltatrix* (Linnaeus, 1766)	C	36.5	0.201
Rajidae	*Raja clavata* Linnaeus, 1758	NC	2.0	0.011
Sciaenidae	*Argyrosomus regius* (Asso, 1801)	C	3.5	0.019
Scombridae	*Sarda sarda* (Bloch, 1793)	C	27.7	0.152
	Scomber colias Gmelin, 1789	C	259.5	1.428
	Scomber scombrus Linnaeus, 1758	C	67.1	0.369
Scorpaenidae	*Scorpaena porcus* Linnaeus, 1758	C	7.9	0.043
	Scorpaena scrofa Linnaeus, 1758	C	0.9	0.005
Sepiidae	*Sepia officinalis* Linnaeus, 1758	C	0.6	0.003
Serranidae	*Serranus cabrilla* (Linnaeus, 1758)	NC	0.2	0.001
Siganidae	*Siganus rivulatus* Forsskal & Niebuhr, 1775	C	0.8	0.004
Soleidae	*Solea solea* (Linnaeus, 1758)	C	35.0	0.193
Sparidae	*Boops boops* (Linnaeus, 1758)	C	16687.0	91.874
	Dentex machrophthalmus (Bloch, 1791)	C	10.0	0.055
	Diplodus annularis (Linnaeus, 1758)	NC	537.9	2.961
	Diplodus puntazzo (Walbaum, 1792)	C	6.0	0.033
	Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	C	7.0	0.038
	Lithognathus mormyrus (Linnaeus, 1758)	C	1.5	0.008
	Oblada melanura (Linnaeus, 1758)	C	1.6	0.008
	Pagellus acarne (Risso, 1827)	C	69.1	0.380
	Pagellus bogaraveo (Brünnich, 1768)	C	59.4	0.327
	Pagellus erythrinus (Linnaeus, 1758)	C	38.5	0.212
	Sarpa salpa (Linnaeus, 1758)	C	3.3	0.018
	Sparus aurata Linnaeus, 1758	C	8.4	0.046
	Spicara maena (Linnaeus, 1758)	C	10.8	0.059
Sphyraenidae	*Sphyraena sphyraena* (Linnaeus, 1758)	C	0.3	0.001
Torpedinidae	*Torpedo marmorata* Risso, 1810	NC	6.0	0.033
Trachinidae	*Trachinus draco* Linnaeus, 1758	C	0.1	0.000
Triakidae	*Mustelus mustelus* (Linnaeus, 1758)	NC	4.5	0.024
Triglidae	*Chelidonichthys lucerna* (Linnaeus, 1758)	C	1.8	0.001
Uranoscopidae	*Uranoscopus scaber* Linnaeus, 1758	NC	0.3	0.001
Zeidae	*Zeus faber* Linnaeus, 1758	C	2.6	0.014
		Total	18163	100.000

Previous studies in the İzmir region by Akyol and Ertosluk (2010) recorded 34 species, with *B. boops* as the most abundant, using various fishing methods near sea-cage farms. Similarly, Akyol et al. (2020) identified 39 species from 21 families at Aegean fish farms, 34 of which were observed in Güllük Bay. In their study, *B. boops* accounted for 80.5% of the associated fish, followed by *Atherina boyeri*, *Scomber colias*, *Sardinella aurita* and *Oblada melanura*. In contrast, low densities of bycatch were observed in the present study, primarily *Diplodus annularis*, *Scomber colias*, *Trachurus trachurus*, *Pagellus acarne* and *Scomber scombrus*. The predominance of *B. boops* in the gillnet catch highlights the efficiency of gillnets in targeting this species and capturing a variety of other species, including benthic species such as scorpaenids and pelagic species.

The fork length (FL) and weight distribution of *B. boops* specimens ranged from 17 to 32 cm (mean: 25.5 ± 0.12 cm) and from 98 to 625 g (mean: 293.6 ± 3.87 g), respectively. Golani et al. (2006) reported a smaller size range for *B. boops* (10 to 22 cm), suggesting that the animals may grow larger near marine cage farms, possibly due to access to uneaten food pellets. Izquierdo-Gomez et al. (2015) observed that wild fish near fish farms in no-take zones could benefit from excess food and alter their lipid profile. Similarly, recent studies on whiting *Merlangius merlangus* near fish farms in the Black Sea show that feed pellets are their main food source throughout the seasons (Şensurat-Genç et al., 2019). Local fishermen also noticed the well-conditioned fish near farms and targeted them when they stray outside the farm environment (Arechavala-Lopez et al., 2011). For example, exceptionally large *B. boops* (402 mm TL) and *Oblada melanura* (357 mm TL) were observed near marine cage farms (Akyol et al., 2014; Ceyhan et al., 2018).

A similar trend was observed in a study of small-scale and recreational fishers near a sea bream farm at L'Ametlla de Mar, Spain. An analysis of vessels with at least 40 fishing days revealed catch rates between 36.1 and 119.4 kg/day with diverse species composition, although *B. boops* was absent (Bacher and Gordoa, 2016). This absence could be due to the fact that the vessels fished 800 meters from the farm boundary, whereas the vessels in our study operated within the prescribed 200-meter limit, suggesting that *B. boops* remains close to the sea cages.

In April, *B. boops* exhibited the highest catch per unit effort (CPUE), averaging 58.83 ± 11.47 kg per 1,000 meters of net length, likely due to its spawning migration. Coastal fishermen have observed this behavior, with the bogue fishing season ending in early May (T. Bıçak, S.A. Özcan, pers. comm.). This is in line with studies by Kara and Bayhan (2015) who found that the spawning season of *B. boops* in İzmir Bay peaked in spring. After this period, fishermen usually shift their efforts to tourism or other fishing methods.

Although regulations stipulate that bottom gillnets must be set at least 200 meters away from sea cages, fishing often takes place close to this limit, leading to constant enforcement issues and conflicts between recreational fishers, commercial fishers and sea cage operators in the Aegean (Akyol et al., 2019). To mitigate the impact on the environment, it is important to maintain the ecological role of wild fish in the vicinity of sea cages. Wild fish help to filter organic matter, contribute to water purification and reduce sedimentation (Arechavala-Lopez et al., 2015). However, few studies quantify the fish caught near fish farms or the ecological impact of commercial and recreational fishing on wild populations. Further bio-ecological and bio-economic studies are needed to assess these impacts and enable sustainable management of these fisheries.

ACKNOWLEDGEMENTS

The authors would like to thank Aydın Adnan Menderes University, Scientific Research Project Funding for their financial support [Project Number: BOMYO-17002].

CILJANI RIBOLOV NA BUKVU *Boops boops* (Linnaeus, 1758) OKO UZGAJALIŠTA RIBE U TURSKOM EGEJSKOM MORU

SAŽETAK

Ova studija istraživala je aktivnost gospodarskog ribolova u blizini morskih kaveza u zaljevu Güllük u jugoistočnom Egejskom moru na temelju uzorkovanja na pristaništima lokalnih ribara. Dnevna ribolovna aktivnost mreža stajačica tipa *Boops boops* nasumično je promatrana u lukama Göltürkbükü, Gündoğan, Yalıkavak i Torba tijekom dvije ribolovne sezone, od studenog do travnja 2018. i 2019. Ukupno 18 163 kg ribe ulovljeno je u 147 dnevnih aktivnosti. Sastav ulova ribolovom mrežama stajačicama sastojao se od 48 vrsta iz 30 porodica, uključujući ribe i beskralješnjake. *B. boops* je bila najbrojnija vrsta s 91,9% ulova, a slijede je *Diplodus annularis*, *Scomber colias*, *Trachurus trachurus*, *Pagellus acarne* i *Scomber scombrus*. Omjer ukupne biomase usputnog ulova i komercijalnih ciljanih vrsta bio je 1:0,09. Duljina vilice (FL) i težina 536 uzorkovanih *B. boops* kretale su se između 25,5 ± 0,12 cm odnosno 293,6 ± 3,87 g. Najveći ulov po jedinici napora (CPUE) *B. boopsa* dogodio se u travnju i iznosio je u prosjeku 58,83 ± 11,47 kg/1000 m, vjerojatno zbog povećanog ulova tijekom njegove mrijesne migracije u otvorena morska područja u proljeće.

Ključne riječi: Bogue, CPUE, obalno ribarstvo, sastav ulova, Sredozemno more

REFERENCES

Akyol, O., Ertosluk, O. (2010): Fishing near sea-cage farms along the coast of the Turkish Aegean Sea. Journal of Applied Ichthyology 26 (1), 11–15.

Akyol, O., Kara, A., Sağlam, C. (2014): Maximum size of saddled bream *Oblada melanura* Linnaeus 1758 (Osteichthyes: Sparidae) in the Southern Aegean Sea. Turkey. Journal of the Black Sea/Mediterranean Environment 20, 270-273.

Akyol, O., Özgül, A., Şen, H., Düzbastılar, F.O., Ceyhan, T. (2019): Determining potential conflicts between small-scale fisheries and sea-cage fish farms in the Aegean Sea. Acta Ichthyologica et Piscatoria 49 (4), 365–372.

Akyol, O., Özgül, A., Düzbastılar, F.O., Şen, H., Ortiz de Urbina, J.M., Ceyhan, T. (2020): Seasonal variations in wild fish aggregation near sea-cage fish farms in the Turkish Aegean Sea. Aquaculture Reports 18, 100478.

Arechavala-Lopez, P., Sanchez-Jerez, P., Bayle-Sempere, J., Fernandez-Jover, D., Martinez-Rubio, L., Lopez-Jimenez, J.A., Martinez-Lopez, F.J. (2011): Direct interaction between wild fish aggregations at fish farms and fisheries activity at fishing grounds: a case study with *Boops boops*. Aquaculture Research, 42, 996–1010.

Arechavala-Lopez, P., Borg, J.A., Segvic-Bubic, T., Tomassetti, P., Özgül, A., Sanchez-Jerez, P. (2015): Aggregations of wild Atlantic Bluefin Tuna (*Thunnus thynnus* L.) at Mediterranean offshore fish farm 452 sites: environmental and management considerations. Fisheries Research, 164, 178-184.

Bacher, K., Gordoa, A. (2016): Does marine fish farming affect local small-scale fishery catches? A case study in the NW Mediterranean Sea. Aquaculture Research, 47 (8), 2444–2454.

Bonizzoni, S., Furey, N.B., Pirotta, E., Valavanis, V.D., Würsig, B., Bearzi, G. (2014): Fish farming and its appeal to common bottlenose dolphins: modelling habitat use in a Mediterranean embayment. Aquatic Conservation, 24, 696–711.

Ceyhan, T., Ertosluk, O., Akyol, O., Özgül, A. (2018): The maximum size of Bogue, *Boops boops* (Perciformes: Sparidae) for the Mediterranean. Acta Aquatica Turcica, 14, 399-403.

Dempster, T., Sanchez-Jerez, P., Bayle-Sempere, J.T., Gimenez-Casalduero, F., Valle, C. (2002): Attraction of wild fish to sea-cage fish farms in the south-western Mediterranean Sea: spatial and short-term temporal variability. Marine Ecology Progress Series, 242, 237–252.

Dempster, T., Taquet, M. (2004): Fish aggregation device (FAD) research: gaps in current knowledge and future directions for ecological studies. Reviews in Fish Biology and Fisheries, 14: 21–42.

Dosdat, A. (2001): Environmental impact of aquaculture in the Mediterranean: nutritional and feeding aspects. In Uriarte A and Basurco B (eds.), Environmental Impact Assessment of Mediterranean Aquaculture Farms. Zaragoza: CIHEAM, pp. 23–36 (Cahiers Options Méditerranéennes; n. 55).

Fernandez-Jover, D., Sanchez-Jerez, P., Bayle-Sempere, J.T., Valle, C., Dempster, T. (2008): Seasonal patterns and diets of wild fish assemblages associated with Mediterranean coastal fish farms. ICES Journal of Marine Science, 65, 1153–1160.

Froese, R., Pauly, D. (2022): FishBase. World Wide Web Electronic Publication. www.fishbase.org version (08/2022). Accessed on 01 December 2022.

Golani, D., Öztürk, B., Başusta, N. (2006): Fishes of the eastern Mediterranean. Turkish Marine Research Foundation, Publication no. 24, Istanbul.

Izquierdo-Gomez, D., Gonzalez-Silvera, D., Arechavala-Lopez, P., Lopez-Jimenez, J.A., Bayle-Sempere, J.T., Sanchez-Jerez, P. (2015): Exportation of excess feed from Mediterranean fish farms to local fisheries through different targeted fish species. ICES Journal of Marine Science, 72 (3), 930–938.

Kara, A., Bayhan, B. (2015): Age and growth of *Boops boops* (Linnaeus, 1758) in Izmir Bay, Aegean Sea, Turkey. Journal of Applied Ichthyology, 31, 620-626.

Machias, A., Karakassis, I., Giannoulaki, M., Papadopoulou, K.N., Smith, C.J., Somarakis, S. (2005): Response of demersal fish communities to the presence of fish farms. Marine Ecology Progress Series, 288, 241–250.

Machias, A., Giannoulaki, M., Somarakis, S., Maravelias, C.D., Neofitou, C., Koutsoubas, D., Papadopoulou, K.N., Karakassis, I. (2006): Fish farming effects on local fisheries landings in oligotrophic seas. Aquaculture, 261, 809–816.

R Core Team (2020): R: A language and environment for statistical computing. R Foundation for Statistical Computing. https://www.R-project.org/. Accessed date: 26 Oct. 2020.

Sanchez-Jerez, P., Bayle-Sempere, J., Fernandez-Jover, D., Valle, C., Dempster, T. (2007): Ecological relationship between wild fish populations and Mediterranean aquaculture in floating fish cages. Impact of mariculture on coastal ecosystems. Lisboa, 21-24 Feb., CIESM Workshop Monographs No. 32, 86 p.

Sensurat-Genç, T., Akyol, O., Özgül, A., Özden, U. (2019): Food composition of whiting *Merlangius merlangus*, captured around the sea-cage fish farms in Ordu, South-eastern Black Sea. Journal of the Marine Biological Association of the U.K., 99, 1651-1659.

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L.D., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Pedersen, T.L., Miller, E., Bache, S.M., Müller, K., Ooms, J., Robinson, D., Seidel, D.P., Spinu, V., Takahashi, K., Vaughan, D., Wilke, C., Woo, K., Yutani, H. (2019): Welcome to the tidyverse. The Journal of Open Source Software 4(43), 1686.

Valle, C., Bayle-Sempere, J.T., Dempster, T., Sanchez-Jerez, P., Gimenez-Casalduero, F. (2007): Temporal variability of wild fish assemblages associated with a sea-cage fish farm in the south-western Mediterranean Sea. Estuarine, Coastal and Shelf Science 72, 299-307.

