



Cetacean Bycatch in Turbot Gillnets by Bulgarian Fisheries in the Black Sea

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Abstract: The bycatch in fishing gears is a significant threat to cetaceans. However, there is almost no information on the impact of bycatch in the Black Sea shore of Bulgaria. Our study aimed to identify and estimate the bycatch of the three endemic species of cetaceans occurring in the Black Sea by turbot fisheries. Between 2014 and 2018, data on bycatch from 1337 km turbot gillnets were collected. A total of 413 cetaceans were recorded as bycatch. The results suggest that bycatch is likely to have significant demographic effects on populations of the Black Sea cetaceans. The most bycaught cetacean is the harbour porpoise representing 82.8 % of the total bycatch. However, more data and long-term monitoring are needed to understand better the impact of interactions between cetaceans and fisheries.

Key words: accidental catch, Black Sea bottlenose dolphin, Black Sea harbour porpoise, Black Sea common dolphin

Introduction

Incidental catches of cetaceans in fishing gears is among the most serious threats to their conservation worldwide (READ et al. 2006, 2012, READ 2008, REEVES et al. 2013, DESPORTES 2014). In Europe, the interactions with fisheries affect some cetacean species (ICES 2010). In particular, the harbour porpoise is proved to be very vulnerable to bycatch in gillnets (TREGENZA et al. 1997, VINTHER 1999, BIRKUN 2002, RADU et al. 2003, DEAVILLE & JEPSON 2011, READ et al. 2012, BENKE et al. 2014, NORTHBRIDGE et al. 2015).

The Black Sea is a semi-closed sea between Eastern Europe and Asia connected to the Mediterranean Sea only through the Turkish Straits System of Bosphorus, Marmara Sea and Dardanelles (PRODANOV et al. 1997). Three cetacean species occur in the Black Sea: the Black Sea harbour por-

poise (*Phocoena phocoena relicta* Abel, 1905), the Black Sea common dolphin (*Delphinus delphis ponticus* Barabash, 1935) and the Black Sea bottlenose dolphin (*Tursiops truncatus ponticus* Barabash-Nikiforov, 1935). These cetaceans are recognised as distinct subspecies occurring only in this sea due to its relative disconnection from the Mediterranean Sea (TZALKIN 1938, BARABASCH-NIKIFOROV 1960, AMAHA 1994, ROSEL et al. 1994). As the most abundant predators, they are vulnerable to various factors such as water pollution, food shortages and incidental catches in fishing gear (BIRKUN 2002, BIRKUN et al. 2006).

The earliest reported cases of cetacean bycatch in the Black Sea (along with the Sea of Azov) during fishing operations are from the late 19th and early of 20th century (DANILEVSKY 1871, SILANTYEV 1903). However, there are no publicly available detailed statistics on cetacean bycatch in the Black Sea

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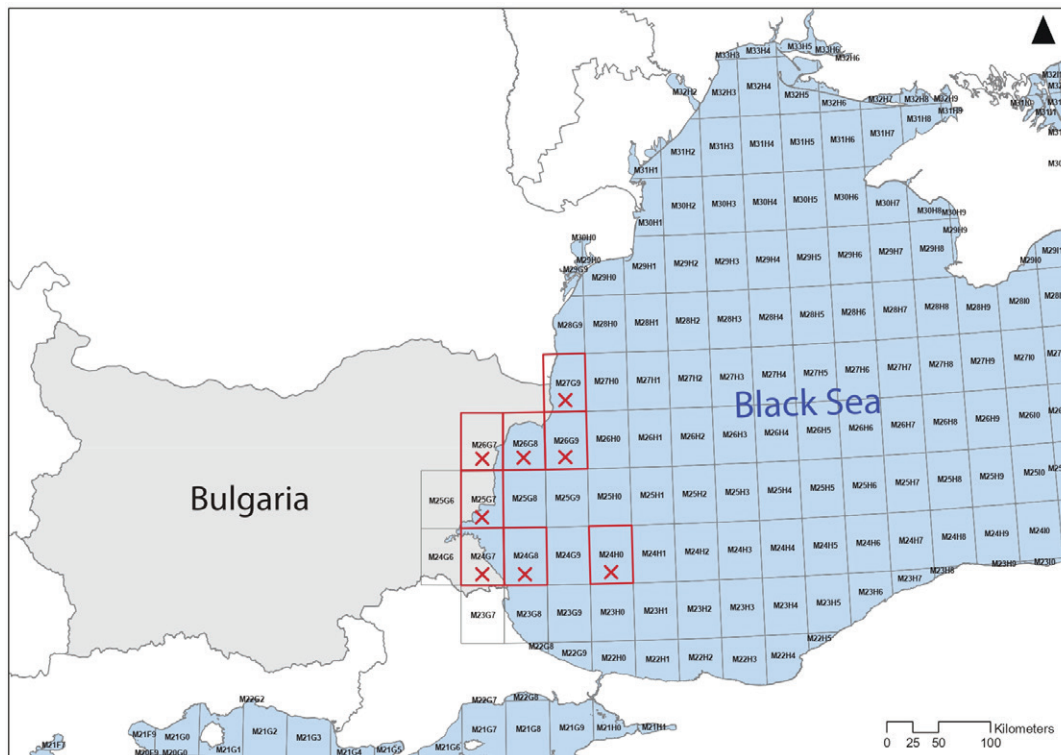


Fig. 1. Zones included in the research are marked with X on the Grid map of Geographical Subareas (GSAs, page 8) of the General Fisheries Commission for the Mediterranean (GFCM). (Source: <http://www.fao.org>)

countries (SALNIKOV 1967) until the late 50s. In the former Soviet Union, a regular recording of bycatch numbers has begun in 1968 (BIRKUN 2002). Unfortunately, in no small extent, the data from internal annual reports are not published and only summaries are available (ZHURAVLEVA et al. 1982, ARTOV et al. 1994, PAVLOV et al. 1996). The latest publications illustrate that the harbour porpoise forms a significant share of the bycatch recorded in different areas of the Black Sea. At the same time, the bottlenose dolphin and the common dolphin are rarely counted as a bycatch (VASILIU & DIMA 1990, PAVLOV et al. 1996, BLASDOL 1999).

Most of the recently published cases of cetacean bycatch in gillnets relate to the spring fishing season from April to June (VASILIU & DIMA 1990, Öztürk et al. 1999a, POPOV et al. 2020). Data is also available for the incidental catch in the Turkish territorial waters of the Black Sea during the sole (*Solea solea* L., 1758), turbot (*Scophthalmus maeoticus* Pallas, 1814) and sturgeon fishing seasons. Results show that many harbour porpoises and bottlenose dolphins were drowned in bottom gillnets (TONAY 2016). Öztürk (1999a, 1999b) assumed that at least 2000–3000 harbour porpoises and 200–300 bottlenose dolphins were bycaught in the Turkish territorial waters of the Black Sea every year. Some studies have also attempted to estimate the bycatch of

cetaceans in turbot fisheries in this area (TONAY & Öztürk 1999, 2003, GÖNERER & BILGIN 2009, TONAY 2016). In Bulgaria, a total of 982 turbot nets (88.4 km) were surveyed during an onboard observation program carried out in 2010 and 2011. The results show 21 bycatch of cetaceans – 19 individuals of harbour porpoise (90%) and two bottlenose dolphins (10%) (MIHAYLOV 2011). The main factors that were taken into account in these studies were the type and size of fishing gear, the species and the number of cetacean bycaught. Other relevant data were demographic characteristics of animals by age and sex. Recently, studies were published related to the reduction of bycatch by using acoustic deterrent devices (pingers) (POPOV et al. 2020). In their study in the Bulgarian Black Sea area, POPOV et al. (2020) found that bycatch rates in active and control nets have shown significant difference during spring and summer seasons.

As a member of the Agreement on the Conservation of Cetaceans of the Black Sea, the Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS), Bulgaria has committed itself to protect cetaceans and minimising the interaction with fishing gear (NORTHRIDGE et al. 2006). The present study aims to estimate the bycatch of cetaceans resulting from turbot fishery in the Bulgarian Black Sea waters, to discuss various factors that potentially affect

Table 1. Data on fishing missions included in the study for the period 2014–2018.

Year	2014	2015	2016	2017	2018
Bycaught ind. per fishing mission: mean \pm SD (min – max)	3.8 \pm 3.2 (0 – 10)	3.4 \pm 2.65 (0 – 8)	2.5 \pm 1.5 (0 – 5)	3.6 \pm 2.1 (1 – 8)	2.2 \pm 1.19 (0 – 5)
Total length of nets (km)	205.6	302	276	266	287
Length of nets per mission (km): mean \pm SD (min – max)	10.8 \pm 9.7 (3 – 38)	9.4 \pm 6.7 (3 – 32)	8.6 \pm 5.1 (2 – 25)	10.2 \pm 6.6 (4 – 46)	10.2 \pm 6.1 (3 – 25)
Depth (m): min – max (mean \pm SD)	57.9 \pm 7.2 (45 – 75)	59.2 \pm 6.3 (46 – 70)	61.3 \pm 5.6 (48 – 71)	59.8 \pm 7.3 (47 – 71)	60.3 \pm 7.5 (47 – 71)
Soaking time (days): mean \pm SD (min – max)	16.0 \pm 4.9 (9 – 21)	15.0 \pm 5.6 (7 – 20)	15.75 \pm 5.6 (7 – 24)	16.1 \pm 4.67 (9 – 20)	14.5 \pm 4.8 (7 – 20)
Length of vessels (m): mean \pm SD (min – max)	11.9 \pm 5.9 (5.25 – 25.5)	12.5 \pm 6.0 (5.25 – 25.5)	12.6 \pm 5.5 (5.25 – 25.5)	13.5 \pm 6.1 (5.25 – 25.5)	12.0 \pm 3.7 (5.25 – 17.5)
Number of fishing missions	19	32	32	26	27

the amount of bycatch and thus supplement bycatch information. Based on existing information to date, we hypothesise that turbot gillnets negatively affect Black Sea cetaceans and especially the populations of the harbour porpoise.

Materials and Methods

The Bulgarian Black Sea is divided into northern and southern regions by physical-geographical, climatic features and economic factors (PENIN 2007), as well as by the seasonal distribution of fish species. The turbot fishing in Bulgarian waters occurs in the Food and Agriculture Organization of the United Nations (FAO) authorised fishing zones (FAO, <http://www.fao.org/3/a-ax819e.pdf>). The present study was conducted in more than 50% of these zones randomly – M24HO, M24G7, M24G8, M25G7, M26G8, M27G9, M26G9, M26G7 (Fig. 1).

In Bulgaria, the turbot's spring fishing season usually begins in late February and ends in mid-April. According to the Fisheries and Aquaculture Act (FAA 2009), no catch, retention on board, transshipment, landing, sale and transport of turbot are permitted in the Black Sea waters for 60 days after April 15 (FAA 2009, Annex 1). After this period, the fishing is allowed again until April 15 next year. However, until the end of June, fishing is more intense as summer continues, the water heats up, and the fish move further out to sea. Boats with a length of 5.25 to 25.5 m are used. Turbot catches are allowed only with gillnets with a mesh size of at least 400 mm stretched (Article 11 of Council Regulation 850/98). In 2017, the Executive Agency of Fisheries and Aquaculture registered 90,174 gillnets with a total length of approximately 900 km for turbot fishing in Bulgaria (Eafa, <http://iara.government.bg/>).

This study collected data from 31 turbot fishing vessels between 2014 and 2018 on the cetacean bycatch during the spring-summer fishing seasons on turbot (March – June), including during the turbot fisheries ban (15 April – 15 June). Anchored gillnets (GNS) with a standard length of 70–100 m each, a mesh size of 400 mm and a height of about 2.0–3.0 m were used for the fishing. Gillnets were connected in long formations of 10–60 or more nets. After setting the nets, fishers usually left them in the water (soaking time, days) for about one to three weeks (Eafa, <http://iara.government.bg/>). The soaking time also depends on the weather conditions.

All data was collected from boat crews. The boat crews filled the data in a standard form prepared by our team. We attended part of the fishing operations in order to control the data collection. The standard form included the period of soaking of nets (in days), the presence of cetacean bycatch (number) and the species of bycatch. Bycatch rates (number of specimens per km net) and bycatch rates including fishing effort (number of specimens \times 100 (km net \times day)⁻¹ of bycaught cetaceans were calculated to standardise the data (according to TONAY 2016) in order to make the results for the Black Sea basin compatible.

The Kruskal-Wallis test was used to look for statistically significant differences between bycatch rates across years. The Mann-Whitney *U* test was used to compare bycatch rates between the northern and southern regions of the Bulgarian Black Sea coast. The *P*-value less than 0.05 was considered statistically significant. The Spearman's Rank Correlation Coefficient was used to measure the strength association between length of the nets, soaking time and the number of cetaceans.

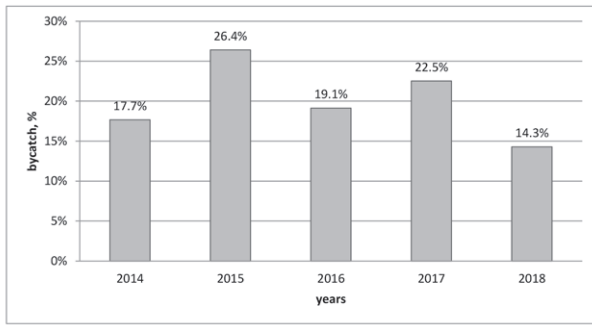


Fig. 2. Bycatch of cetaceans by turbot gillnets in the Bulgarian Black Sea waters per year for the period 2014–2018.

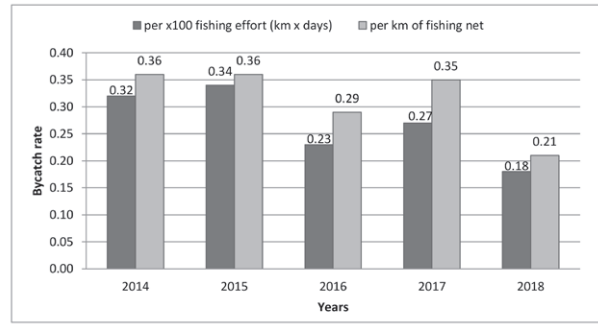


Fig. 3. Bycatch rate for the period 2014–2018.

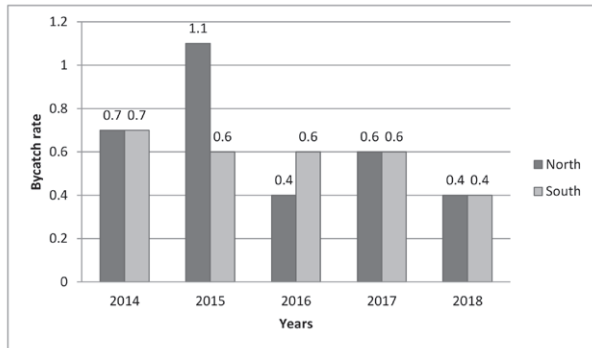


Fig. 4. Comparison of bycatch rate between the northern and southern regions of the Bulgarian Black Sea territorial waters [per × 100 fishing effort (km × days)].

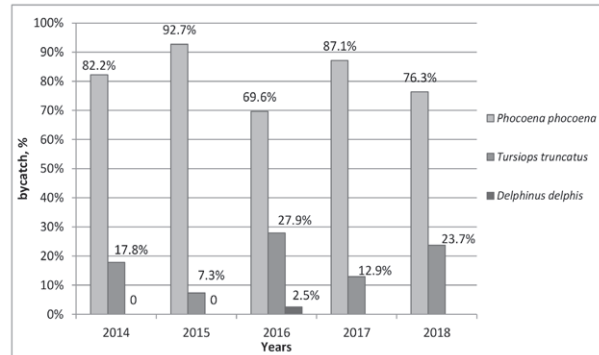


Fig. 5. Bycatch of *Phocoena phocoena*, *Tursiops truncatus* and *Delphinus delphis* in the Bulgarian Black Sea waters for the period 2014–2018 (in %).

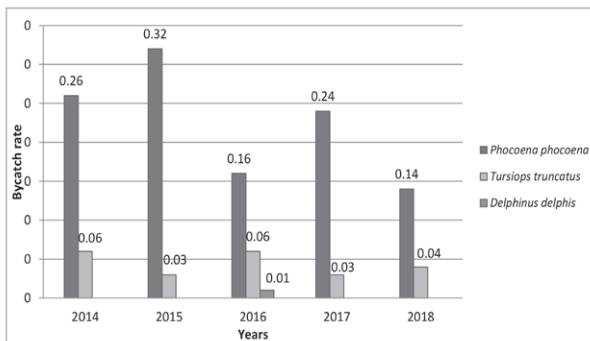


Fig. 6. Bycatch rates per x100 fishing effort (km × days) per species in the Bulgarian Black Sea waters for the period 2014–2018.

Results

The 31 boats included in the present study hauled a total of 1336.6 km of turbot nets with a soaking time of 7–24 days (Table 1). A total of 413 cetaceans were recorded for the research period as bycatch: 73 in 2014, 109 in 2015, 79 in 2016, 93 in 2017 and 59 in 2018. The highest share of bycatch was registered in 2015, and the lowest was in 2018 (Fig.

2). The bycatch rate for the entire study period was estimated at 0.31 (individuals/km) and 0.27 per 100 fishing effort (km × days)⁻¹ (Fig. 3). There was no statistically significant difference between bycatch rate per 100 fishing effort between the years during the study period (Kruskal-Wallis Test, $H = 1.52$, $p = 0.82$). There was no statistically significant difference found comparing the bycatch rate in the northern and southern regions (Fig. 4) of the Bulgarian Black Sea coast (Mann-Whitney U Test, $U=12$, $p > 0.05$).

A correlation was found between the length of the nets and the number of cetaceans caught only for 2015 ($r_s = 0.76376$, $p = 0.04$) and 2016 ($r_s = 0.71084$, $p = 0.04$) with a confidence level of $p < 0.05$. For the remaining three years (2014, 2017 and 2018) this relationship was not established. Such a correlation was found between soaking time and the number of cetaceans caught only for 2016 ($r_s = 0.77$, $p = 0.02$).

Regarding the composition of the bycatch species for the entire period (total 413 individuals), 342 individuals (82.81 %) were *P. phocoena*, 69 (16.71%) – *T. truncatus*, and 0.48% – *D. delphis* (only two individuals in 2016) (Fig. 5). The same

tendency of domination of *P. phocoena* in the bycatch was established also as bycatch rate (Fig. 6). The age and sex of bycatch individuals were not recorded in the present study. No new-born individuals were registered as bycatch (Fig. 7).

Discussion

The soaking time of the turbot nets in the water varies depending on weather conditions, water temperature and other factors. When the water is colder, fishermen can leave their nets underwater for a more extended period, thus increasing the chance of catching more fish and not worrying that the caught fish can spoil quickly. According to fishermen, the soaking time of the nets could also depend on the length of the nets used, as larger vessels (≥ 15 m long) that leave 20 km of nets or more cannot afford to check them too often because it involves a lot of cost and labour. Boats that use nets of 1 or 2 km can review them regularly. In the present study, the soaking time does not seem to affect the bycatch rate. The bycatch rates are almost identical in the northern and southern areas. This fact suggests that the bycatch size does not depend on physical-geographic features of the water basin such as different structure of the bottom and sea currents. Our results do not show significant differences in bycatch rates during the studied years. The length of nets seems to have the most significant impact on cetacean bycatch volume. However, further research may fill current information gaps.

The reported cetacean bycatch rate in the Black Sea varies significantly. The average bycatch rate for the period of our study is 0.31 (ind./km). The result is close to one as of 0.24 obtained during on board observations from April to July 2010 and throughout 2011. Then, in examined 982 turbot nets (88.4 km), 21 cetaceans were registered as bycatch – 19 harbour porpoises (90%) and two bottlenose dolphins (10%) (MIHAYLOV 2011). Recently, studies were published related to the effect of acoustic deterrent devices (pingers) for reduction of bycatch (POPOV et al. 2020). In their study in the Bulgarian Black Sea area, POPOV et al. (2020) found that bycatch rates in active and control nets have shown significant increase during summer season compared to spring. High rates of 7.6 ind./km were registered in Ukraine in shark nets (BIRKUN & KRIVOKHIZHIN 2011) and 4.14 ind./km along the Central Turkish coast of harbour porpoises in trammel gillnets (GÖNENER & BILGIN 2009). The lowest bycatch rates were reported from Russia in turbot and shark gillnets – 0.09 ind./km (PAVLOV et al. 1996), and on dolphins (for



Fig. 7. *Phocoena phocoena* as bycatch in turbot gillnets.

both species) in fisheries with trammel gillnets off the West Coast of Turkey (0.01 ind./km) (TONAY 2011). It can be assumed that the difference in the obtained values is due to a difference in the study period (year, season), equipment used and other factors. In Europe, ACCOBAMS and ASCOBANS maintains the goal reducing of the bycatch of small cetaceans towards zero (ACCOBAMS 2011, LEAPER & CALDERAN 2018).

The collected data (Figs. 5 and 6) strongly suggest that the direct impact of fisheries is mostly on harbour porpoises and the severity of effects is probably 3–4 times higher than the adverse effects of fishing on the other two species. The high percentage of bycatch of the harbour porpoise is perhaps due to two main reasons: first, the species distribution area overlaps most with turbot fishery sites (about 10 miles away from the shore, see STANEV 1996), and, secondly, because of its weaker echolocation capacity. The harbour porpoise probably detects the nets too late and fails to avoid a collision. According to KASTELEIN et al. (2000), the 90 % detection range by echolocating harbour porpoises approaching the nets at perpendicular angles, under low noise level conditions, varies between 3 and 6 m, while for bottlenose dolphins, under high noise conditions, this value is between 25 and 55 m.

In a broader Black Sea context, our study confirms that the harbour porpoise generally represents the major part of bycatch of cetaceans (BIRKUN 2002, 2009, TONAY et al. 2003, TONAY 2016).

Regarding the bottlenose dolphin, no general conclusion could be drawn on what exactly causes its bycatch. The bycatch of this species in the current study is higher than in other studies in the Black Sea, where the values are usually close to zero (BLASDOL 1999, Öztürk et al. 1999b, BIRKUN 2002). Although within the Black Sea, the bycatch rates of the bottlenose dolphin are lower than those found in the current study, the incidental catch of bottlenose dolphin in gillnets worldwide is a common phenomenon (LOPEZ et al. 2003, BEARZI et al. 2008, ZAPPES et al. 2016). The habitat of this species includes broadly the shelf area (similarly the harbour porpoise), which overlaps with the setting sites of nets. Because of the study limits, we cannot argue whether the bycatch of the *T. truncatus* is a result of individuals being young and inexperienced, having health problems or due to other reasons. About the individuals of *D. delphis* caught during the fieldwork, both were adults, about 160 cm in length, with no visible signs of injury or illness (fishermen note). We assume that the common dolphin is an exceptional part of the bycatch, as found in other studies (VASILIU & DIMA 1990, PAVLOV et al. 1996, BLASDOL 1999, Öztürk et al. 1999b).

Conclusions

The current study presents new data for the bycatch of cetaceans in turbot fisheries in the Black Sea. They show that the turbot gillnets are dangerous fishing gear for cetaceans. The harbour porpoise is the most vulnerable species. More data about the demographic structure of the bycatch is needed as well as bycatch monitoring is necessary to better understand the impact of interactions between the cetaceans and fisheries in the Black Sea. Establishing contacts and working relationships between Bulgarian scientific organizations, fishermen and fishing associations would be very useful for the effective management and protection of cetaceans in the Black Sea.

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