NEW DATA ON CETACEAN ABUNDANCE AND DISTRIBUTION FOR THE THREE SPECIES PRESENT IN THE ROMANIAN TERRITORIAL BLACK SEA WATERS

PAIU Romulus-Marian, PAIU Angelica, TIMOFTE Costin, MIREA-CÂNDEA Mihaela, MURARIU Dumitru

Abstract. The Black Sea is hosting three species of cetaceans: Black Sea bottlenose dolphin (*Tursiops truncatus* ssp. *ponticus*, Barabasch-Nikiforov, 1940), Black Sea common dolphin (*Delphinus delphis* ssp. *ponticus*, Barabasch-Nikiforov, 1935), and Black Sea harbour porpoise (*Phocoena phocoena* ssp. *relicta*, Abel 1905). All three species are present in the Romanian Black Sea territorial waters and are subject of the IUCN Red List of Threatened species. The present study aims at filling the gap of knowledge regarding the present distribution and abundance of the cetacean species within the Romanian marine waters. Our new data are aimed at supporting the conservation efforts in line with the European Union Habitats and Marine Strategy Framework Directives and the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS). The paper presents the data collected and analysed from three vessel surveys during spring and summer, 2019 and 2020. The overall proportion of the stratum sampled was 7% of the 5871,423 Km^2 study area, with more than 1100 km of transect lines. Collecting 196 cetacean sightings on-effort with 363 individuals, from all the three species (with mentioned subspecies). The abundance estimates per species revealed an abundance range between 1719 (95%CI 682-4335) and 2705 (95%CI 1097-6670) for bottlenose dolphins; between 873 (95%CI 278-2015) and 1032 (95%CI 336-3626) for common dolphins and 333 (95%CI 53-1375) and 3775 (95%CI 1934-9475) for harbour porpoises. Distribution maps indicate an increasing presence of bottlenose dolphins in north and in central parts, and of harbour porpoises in the central and southern parts of the surveyed area. The common dolphins, as expected, were recorded mainly towards the offshore limits of the area.

Keywords: Black Sea, marine mammals, dolphins, porpoises, abundance, distribution.

Rezumat. Date noi privind abundența și răspândirea celor trei specii de cetacee, prezente în apele teritoriale românești ale Mării Negre. Marea Neagră găzduiește trei specii de cetacee: afalinul (*Tursiops truncatus* ssp. *ponticus*, Barabasch-Nikiforov, 1940), delfinul comun (*Delphinus delphis* ssp. p*onticus*, Barabasch-Nikiforov, 1935), și marsuinul (*Phocoena phocoena* ssp. *relicta*, Abel 1905). Toate cele trei specii sunt prezente în apele teritoriale românești ale Mării Negre și fac obiectul Listelor Roșii IUCN cu specii amenințate. Studiul își propune să completeze lipsa de cunoștințe privind răspândirea actuală și abundența speciilor de cetacee din apele românești. Apoi, noile noastre date vin în sprijinul eforturilor de conservare a biodiversității, în conformitate cu Directivele-cadru ale Uniunii Europene, Directiva-cadru Habitate și Directiva-cadru Strategia pentru mediul marin, precum și Acordul pentru Conservarea Cetaceelor din Marea Neagră, Marea Mediterană și zona contiguă a Atlanticului (ACCOBAMS). Lucrarea prezintă datele colectate și analizate ca urmare a trei expediții marine, în primăvara și vara anilor 2019 si 2020. Aria de studiu, 5871,423 Km^2, a fost eșantionată în proporție de 7%, acoperind peste 1100 Km de traseu (transect). Au fost înregistrate 196 de observații, pe transect, cu 363 de exemplare, aparținând tuturor celor trei specii (cu subspeciile menționate). Estimările privind abundența fiecărei specii în parte au indicat un interval cuprins între 1719 (95%CI 682-4335) și 2705 (95%CI 1097-6670) pentru afalini; între 873 (95%CI 278-2015) și 1032 (95%CI 336-3626) pentru delfinii comuni și între 333 (95%CI 53-1375) și 3775 (95%CI 1934-9475) pentru marsuini. Hărțile privind răspândirea speciilor indică o prezență crescută a afalinilor în partea de nord și centru și a marsuinilor în zona de centru și de sud a arealului studiat. Delfinii comuni, așa cum era de așteptat, au fost înregistrați cu precădere către limitele de larg (offshore) ale zonei.

Cuvinte cheie: Marea Neagră, mamifere marine, delfini, marsuini, abundență, răspândire.

INTRODUCTION

The Black Sea is hosting three species of cetaceans: the Black Sea bottlenose dolphin (*Tursiops truncatus* ssp. *ponticus,* Barabasch-Nikiforov, 1940), the Black Sea common dolphin (*Delphinus delphis* ssp. *ponticus,* Barabasch-Nikiforov, 1935), and the Black Sea harbour porpoise (*Phocoena phocoena* spp. *relicta*, Abel 1905) (BIRKUN, 2008; DI SCIARA N. G., 2002; TOMILIN, 1957). All three species are present in the ACCOBAMS area (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area) except the harbour porpoise which is found only in the Black Sea and Atlantic Ocean. Although the harbour porpoise is occasionally found in the Mediterranean Basin in small groups, it does not appear to form stable populations there. The Black Sea populations of these species have smaller body sizes and show some other morphological differences from the conspecific Atlantic and Mediterranean populations (SHARIR et al., 2011). Harbour porpoise and bottlenose dolphin are genetically distinct, considering their maternal lineages (VIAUD-MARTINEZ et al. 2007, 2008; TONAY et al. 2012). In the last paper published by DEKANOIDZE et. al. (2020), significant genetic differences were shown between the Black Sea and Atlantic populations for all three species. The differences were higher for the porpoise (Fst=0.46022; P=0.0002, Nm=0.586) than for either the common dolphin (Fst=0.12557; P=0.0090, Nm=3.482) or the bottlenose dolphin (Fst=0.12324; P=0.0451, Nm=1.779). The gene flow between the Black Sea and Atlantic populations of common and bottlenose dolphins is approximately 3.5 individuals per generation, and the gene flow between the Black Sea and Mediterranean populations of both species exceeds 15 individuals per generation.

The range of the three species is accepted as the entire Black Sea area in accordance to IUCN[*,**,***] and further strengthened by the CeNoBS survey (ACCOBAMS, 2021), with references to the primary habitats that each of the species is using. In the case of common dolphins, this species encompasses almost the entire Black Sea, including the territorial waters and exclusive economic zones of Bulgaria, Georgia, Romania (ANTONESCU, 1966; BORCEA, 1928; CĂLINESCU, 1936; MURARIU, 2004, 2005, 2012; NICOLAE et al., 2015, 2017; PAIU et al, 2019; RADU et al. 2013), Russia, Turkey and Ukraine, and internal waters of Ukraine in Karkinitsky Bay and more likely to be associated with greater depths (range 50 to 2250 m). Temperature appeared to be another important predictor, with a higher preference towards cooler waters (5-18°C) of the basin (SANCHEZ-CABANES, 2017). Common dolphins are well known also in the Bosporus, Marmara Sea and Dardanelles and do not occur in the Azov Sea, normally avoiding the Kerch Strait (BIRKUN et al., 2014). As a secondary habitat, they are inhabiting the circumlittoral area over the continental shelf (usually more than 6 m but less than 200 m deep) (BIRKUN et al., 2014). On the other hand, the Black Sea porpoise is recognized as an endemic subspecies with morphological and genetic differences from other populations elsewhere in the world (BIRKUN et al., 2014), and is encountered in the whole Black Sea basin and its contiguous areas (Azov Sea, Kerch strait, internal waters of Turkey). The population of harbour porpoise may consist of three or more subpopulations including those that are inhabiting different geographical and ecological areas during most of the year (BIRKUN et al., 2014). The Black Sea harbour porpoise inhabits mostly the waters over the continental shelf with depths ranging between 6 to 200m, but as a secondary habitat it can be encountered in open sea with depths of more than 200 m (BIRKUN et al., 2014; PAIU et al., 2019; ACCOBAMS, 2021). It annually begins migrations from the north-western part of the Black Sea before winter, in autumn, when they take routes to the southern parts of the Basin within the same ecological niche to the shore zone (BIRKUN et al., 2014). The primary wintering areas are in the south-eastern part of the Black Sea, including Georgian territorial waters and eastern Turkish territorial waters. During the cold season, there are subpopulations of the harbour porpoise wintering in the Azov Sea, where there is a well-known wintering grounds for the anchovy (BIRKUN et al., 2014). The bottlenose dolphins are widely spread over the entire Black Sea basin, occurring in the shallow coastal waters, like harbour porpoises, from the littoral zone of western-central coast of Turkey, to the continental shelf in the north-north-western of the Black Sea, predominantly below depths of 250 m and in warmer waters ranging between 18 and 24 C (SANCHEZ-CABANES, 2017). This is related to the feeding preference for predominantly benthic and nearshore pelagic fish (BIRKUN, 2012; GOL'DIN & GLADILINA, 2015; PAIU et al., 2019; ACCOBAMS, 2021).

MATERIAL AND METHODS

The survey was designed in accordance with principles of distance/line transect sampling (BUCKLAND et al. 1993; 2001). This was designed using the Distance 7.2. software package (THOMAS et al. 2010), following the single platform method determined by the overall conditions and restraints. The baseline used for mapping the boat survey stratum was plotted in accordance with the guidelines of the United Nations Convention on the Law of the Sea (UNCLOS) and Romanian territorial waters boundaries. The design follows the equal spaced zigzag design class, within the 12 nautical miles area (territorial waters TW) of Romania, between Vama Veche (Southern border) and Sulina (Northern border) (Fig. 1.). The overall proportion of the sampled stratum is 7% of the study areas, 5871,423 Km^2. A sailing yacht with an engine, equipped with a single platform was used for the expeditions. The observers acted both as observers and data recorders, changing the position at each new transect or half an hour. The survey speed was between 6-8 kts (11.12 – 14.82 km/h). Environmental conditions: sea state, glare, cloud cover, turbidity and a subjective assessment of overall conditions were recorded at the beginning of each transect and whenever a change occurred. Due to the limited time available for the survey and unfavourable hydrometeorological forecast, the observers remained active even in poor conditions with a sea state of 4 on the Beaufort scale. Observers searched a 110° arc from abeam to ahead with naked eyes and the binoculars for species identification, based on the features of the three cetacean species (length and size, colour, presence or absence of rostrum etc.). When a sighting was made, the following data were recorded: angle of the sighting to the transect line, radial distance, species, group size (min-max-best estimate, understanding within the same group all the animals at a length no more than 100 m one from another), and number of calves (the given size of a calf was considered less than 2/3 of an adult), initial cue, estimated swim direction, behaviour, and name of the observer who made the sighting. Tracks and coordinates were recorded using the GPS navigator Garmin Etrex 30. For quality assessment, digital pictures of the whole group and individuals were taken; animals were counted, and school size were recorded. Action was performed only "on effort" mode. The analysis was performed with the Distance 7.3. software package (THOMAS et al. 2010).

Previous surveys using the same protocol in the area were the "Adverse Fisheries Impacts on Cetacean Populations in the Black Sea" project (BIRKUN et al., 2014) and "Increase the regional capacity for developing cetacean distribution and abundance studies" (PAIU et al., 2019).

The angle to sightings was measured with fixed angle-boards that, together with the measured distance with the help of 7x50 WPC-CF Fujinon Mariner Binoculars, provided a precise measurement of the perpendicular distance to the animal or group of animals, using the LERCZAK & HOBBS (1998) method.

Data Analysis

All the analysis was performed with the help of Distance 7.3. software (THOMAS et al., 2010). The abundance was estimated using both conventional distance sampling or CDS and multiple covariate distance sampling or MCDS. The latter incorporates covariates, in addition to perpendicular distance, in the estimation of a detection function. Transects, including GPS coordinates and information on total distance, are presented in Table 1.

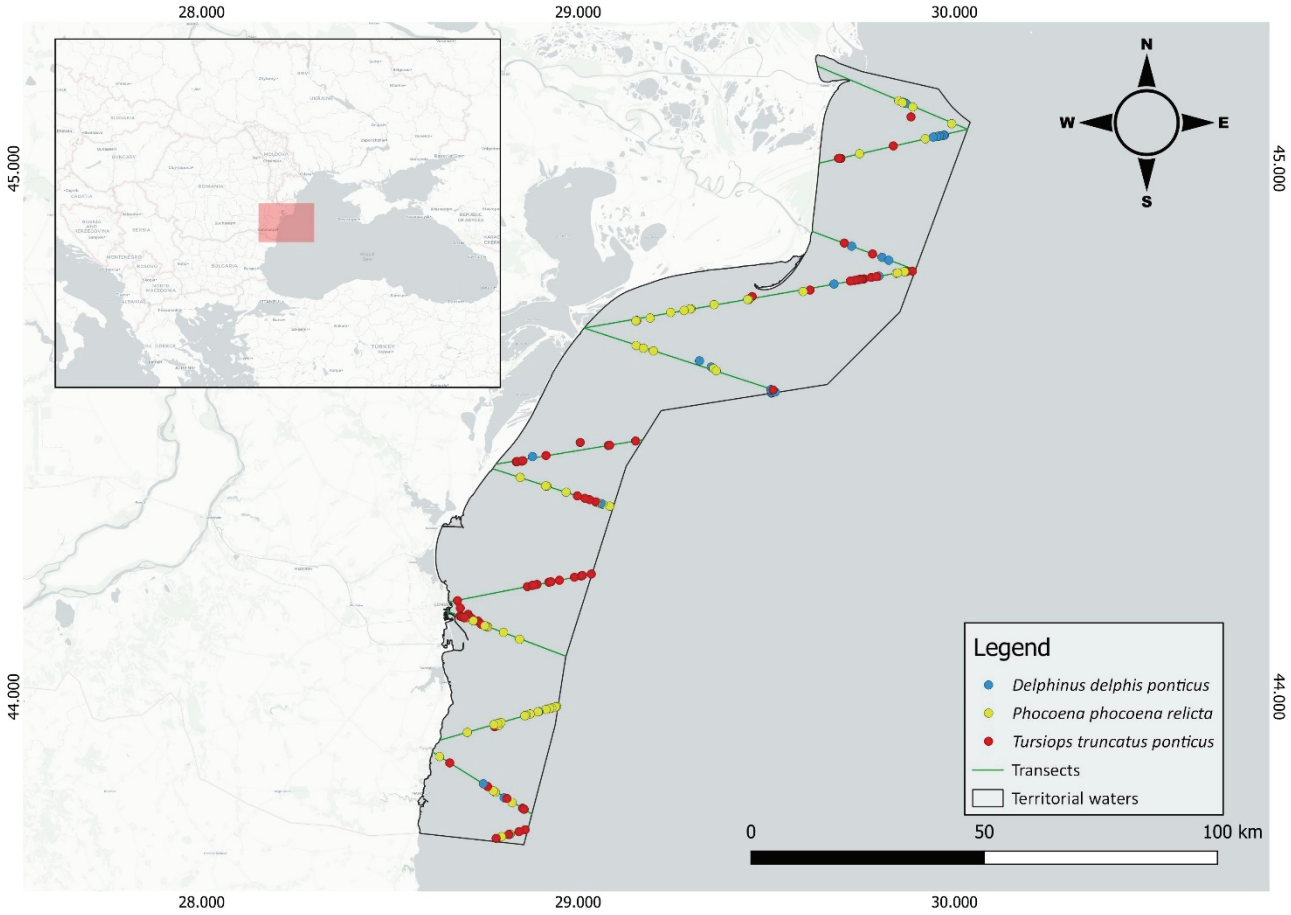

Figure 1. Representation of the surveyed area. The transect lines (green) and coloured bullets presenting the sightings of the three cetacean species are highlighted (Original).

Table 1. The details of the transects used during the cetacean vessel surveys in Romanian waters.

Number of transect	Coordinates	Distance(km)
1	43.75319°N 28.86913°E 43.72269°N 28.77715°E	8.067
2	43.77524°N 28.8771°E 43.89404°N 28.61265°E	29.773
3	43.9164°N 28.6314°E 43.98198°N 28.94691°E	27.046
4	44.07698 °N 28.96775°E 44.16127 °N 28.65895°E	31.739
5	44.18056°N 28.65707°E 44.23393°N 29.0369°E	32.46
6	44.36026°N 29.09294°E 44.43374°N 28.77288°E	31.223
7	44.44223°N 28.78136°E 44.48856°N 29.17184°E	33.342
8	44.57917°N 29.53631°E 44.69975°N 29.01612°E	50.732
9	44.69977°N 29.01615 °E 44.80952°N 29.89623°E	74.664
10	44.80952°N 29.89623°E 44.88182°N 29.62238°E	27.212
11	45.01015°N 29.64039°E 45.0738°N 30.03477°E	33.198
12	45.0738°N 30.03477°E 45.19241°N 29.6349°E	40.467

The observations were collected over the distance of 419.9 km in Romanian waters per session. Some part of the designed transect lines could not be completed due to logistical issues, unfavourable weather, and sea conditions. Therefore, incomplete parts were not considered in the abundance analysis.

RESULTS

Along the three vessel surveys performed in spring and summer 2019 and summer 2020, a total of 196 sightings were collected with 363 cetaceans. The three surveys will be referred hereinafter as Spring 2019, Summer 2019 and Summer 2020. It is important to mention that the Summer 2020 survey was covering only 7 of the 12 transects due to unfavourable weather and vessel technical problems. In respect to this, the analysis was performed on the proper area and not on the entire block. In order to ensure the confidence of results, the case of distribution of animals in the north part was left outside of the study. In this way, a case-by-case analysis was performed for each of the three surveys. Results of this are presented in the following, species by species, in comparison to the sightings recorded in each of the surveys.

As regards the **Black Sea bottlenose dolphin** (*Tursiops truncatus* ssp. *ponticus*), during the three surveys of the study a total of 96 bottlenose dolphin sightings were made, with a total of 204 individuals, on-effort and 3 additional sightings with 18 individuals off-effort within the second survey. Group size for bottlenose dolphin ranged between 1 and 25 individuals depending on the season: 1 – 5 in Spring 2019, 1-10 in Summer 2019 and 1 to 25 in Summer 2020, with average mean of 1.05; 3.98, respective 13.93. The best model for analysis was chosen as Hazard rate+Half normal for Spring 2019, uniform model for Summer 2019 and 2020, no truncation with group size covariate according to Akaike Information Criterion (AIC) values and goodness of fit tests. All sightings were pooled to fit detection function, but only on-effort sightings were used to estimate density and abundance. The estimated abundance for bottlenose dolphins is presented in Table 2.

Table 2. Black Sea bottlenose dolphin estimates during the surveys performed in the Romanian territorial waters.

Survey	Density of groups, groups/km		Density of animals, ind./km^2		Number of animals		Coefficient of variation CV%
	DS	95% CI	D	95% CI	N	95% CI	
Spring 2019	0.135	0.055-0.333	0.293	0.116-0.738	1719	682-4335	59.92
Summer 2019	0.320	0.131-0.781	0.837	0.339-2.063	2705	1097-6670	38.72
Summer 2020	0.195	0.100-0.381	0.337	0.161-0.708	1980	944-4156	37.2

As for the **Black Sea common dolphin** (*Delphinus delphis* ssp. *ponticus*), a total of 35 common dolphin sightings were made, with a total of 63 individuals, during the study. From these, 5 sightings with 17 individuals were off-effort. The group size for common dolphin varied from 1 to 8 individuals depending on the season: 1 – 8 in Spring 2019, 2 - 6 in Summer 2019 and 1 to 2 in Summer 2020. The best model was chosen as Hazard rate + Half normal for Spring 2019 and uniform model for Summer 2020. The analysis by species for Summer 2019 was not possible due to the very low number of sightings. No truncation was applied with group size covariate according to AIC values and goodness of fit tests. All sightings were pooled to fit the detection function, but only on-effort sightings were used to estimate density and abundance. The abundance estimate for common dolphins can be read in Table 3.

Table 3. Black Sea common dolphin estimates during the surveys performed in the Romanian territorial waters.

Survey	Density of groups, groups/km		Density of animals, ind./km^2		Number of animals		CV%
	DS	95% CI	D	95% CI	N	95% CI	
Spring 2019	0.103	0.032-0.332	0.176	0.050-0.672	1032	336-3626	67.2
Summer 2020	0.119	0.053-0.269	0.149	0.064-0.343	873	378-2015	37.8

For the **Black Sea harbour porpoise** (*Phocoena phocoena* ssp. *relicta*), a total of 65 harbour porpoise sightings were made during the study, with a total of 96 individuals. From these, 1 sighting with 1 individual was off-effort and is not included in the results of the Summer 2019 survey. The group size for the harbour porpoise varied from 1 to 5 individuals depending on the season: 1 to 5 for Spring 2019, 1 to 3 in Summer 2019 and 1 to 4 in Summer 2020. The best model was chosen as Hazard rate+Half normal for the Spring 2019 and uniform model for the Summer 2019 and 2020 surveys with no truncation with group size covariate according to AIC values and goodness of fit tests. All sightings were pooled to fit the detection function, but only on-effort sightings were used to estimate density and abundance. The abundance estimate for harbour porpoise can be read in the Table 4.

Table 4. Black Sea harbour porpoise estimates during the surveys performed in the Romanian territorial waters.

Survey	Density of groups, groups/km		Density of animals, ind./km^2		Number of animals		CV%
	DS	95% CI	D	95% CI	N	95% CI	
Spring 2019	0.057	0.025-0.132	0.09	0.036-0.234	536	209-1375	47.9
Summer 2019	0.069	0.011-0.425	0.103	0.016-0.642	333	53-2074	92.50
Summer 2020	*0.440*	*0.228-0.851*	*0.643*	*0.329-1.255*	*3775*	*1934-9475*	*32.10*

DISCUSSIONS

Abundance estimates are critically important to conservation, to the point that obtaining such estimates is something viewed as a prerequisite for management (JAMES, 2014). The lack of such data, as is the case of Romanian Black Sea waters, produces a delay in the management of the stocks. The efforts of the authors and the non-governmental organization that they are associated with aimed at raising the knowledge and increasing the capacity, not only at national level but also at regional and international level, to perform studies of cetacean abundance and distribution. At this moment, we can compare the results for the summer and spring seasons and discuss a range when it comes to cetacean abundances for the Romanian marine waters. There are four surveys performed in summer, at different area surfaces, starting with the summer of 2013 (BIRKUN et al., 2014) when the entire TW were surveyed using vessel surveys, in summer 2016 (PAIU et al., 2019) for the TW between Constanta - Vama Veche and the two surveys reported above from 2019 and 2020. Studying the four surveys reveals an inconsistence regarding the abundance and density of the animals, most probably due to the environmental conditions, the fluctuation of fish resources, questions that should be addressed in the future. The purpose of the present article is to report the cetacean abundance estimates produced by the three surveys in 2019 and 2020 within the ANEMONE project (Assessing the vulnerability of the Black Sea marine ecosystem to human pressures with the financial support from the Joint Operational Programme Black Sea Basin 2014-2020). The range in density (D) of bottlenose dolphins is between 0.217 to 0.837 individuals/km^2 underlining an animal abundance (N) range between 1265 and 2705 individuals (95%CI confidence interval). Out of the sets of results, 2013 and 2020 are the most consistent and in the same time indicate a possible positive trend for the specie. In the case of common dolphin, from 2013 (BIRKUN et al., 2014), 2016 (PAIU et al., 2019) and the present study, the density of groups and animals remained constant for the last two surveys and the animal abundance (N) range between 873-1624 animals. As regards the harbour porpoise, in 2016 just for the southern area, the animal densities recorded are higher than any of the other studies, reaching 5.359 animals/km^2, which is the closest to the estimates from 2013. According to the 2013 study (BIRKUN et al., 2014) and Summer 2019 and 2020, the trend is negative, indicating a decrease in the estimated number of animals.

For the spring season, the only two surveys available are from 2016 (PAIU et al., 2019) and the present study. Having in mind that in 2016 the survey plan covered only half of the TW area it is hard to assess as this moment how to deal with the results. Even the densities are recording differences from 1 to 3 times. Only a range suggestion of the population number, combining the two surveys, with the recommendations of further assessing the analysis and extending the research, can be made for each of the three species as follows: bottlenose dolphin between 667-1719 animals; common dolphin around 1000 and harbour porpoise 359-536 animals.

In the volume "Cartea roșie a vertebratelor din România" (BOTNARIUC & TATOLE, 2005), Murariu is presenting abundances of 1000 harbour porpoise, 1500-2000 bottlenose dolphins and 2500-3000 common dolphins. The figures fit in the actual abundances presented within our study, at least for summer, when the grates abundances are recorded in the western Black Sea. An exception is the case of harbour porpoise where the differences are high from one survey to another. The estimates from summer 2020 indicate an increase of the species stocks in comparison with data available in 2005.

CONCLUSIONS

The seasonal distribution of the vessel surveys performed within the projects revealed the seasonal variation in the abundance of cetaceans in the Black Sea Romanian territorial waters, with lower abundances in spring than in summer for some of the species.

The harbour porpoise is recording the highest differences, from all the three species, between the two seasons, by 10-15 times more.

In the case of bottlenose dolphins, the difference between the two seasons is indicating a more stable population with differences of 0,5 times between the seasons. This strengthens the possibility of a stable resident population with large movements in the area.

Although the common dolphin is recognized for using the area as a secondary habitat, abundances are decreasing within the territorial waters along the analysed period.

Regular monitoring should be implemented in the area, and not only, to better understand the actual situation and the trends of populations, and implement appropriate conservation measures for these vulnerable mammals, if appropriate. One of the next objectives includes the research of limiting factors (e.g. bycatch) in order to identify how they contribute to the status of the species.

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Paiu Romulus-Marian
[1]Mare Nostrum NGO, 215 Tomis Blvd., Constanța, Romania, 900647, Constanța, Romania
[2]Faculty of Biology, Bucharest University, Splaiul Independenței 91-95, Bucharest, R-050095, Romania.
E-mails: romulus.paiu@drd.unibuc.ro; romulus.marian@gmail.com

Paiu Angelica, Timofte Costin, Mirea-Cândea Mihaela
Mare Nostrum NGO, 215 Tomis Blvd., Constanța, 900647, Romania.
E-mails: angelica_paiu@marenostrum.ro; timofte_costin@marenostrum.ro; Mihaela_candea@marenostrum.ro

Murariu Dumitru
Faculty of Biology, Bucharest University, Splaiul Independenței 91-95, Bucharest, R-050095, Romania.
E-mail: dmurariu@antipa.ro

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