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Assessment of Marine Cetacean Populations in Bulgarian Black Sea in 2017 According to Indicators of the EU Marine Strategy Framework Directive

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Abstract. Three species - harbour porpoise, common dolphin and bottlenose dolphin - represent the cetacean fauna in the Black Sea and require monitoring and protection by EU member states under the Habitats and Marine Strategy Framework Directives. Assessment of cetacean populations state was based on data, collected during a ship-based visual survey by line transect method, carried out during 24.11.2017 – 22.12.2017 in the whole Bulgarian coastal and shelf areas. Threshold values for population abundance (D1C2) and density (D1C4) indicated in the national monitoring program for Descriptor 1 of MSFD were applied and preliminary data for distributional range (D1C4) are reported. The three cetacean species - *P. phocoena*, *T. truncatus* and *D. delphis* were observed during the study with the total number of 123 sightings and 360 observed individuals. The abundance of Bottlenose dolphin was estimated at 1365 animals, density - 0.113 ind.km^2 and distributional range of 745.81 km^2. The common dolphin was less abundant – 963 individuals and with lower density - 0.0796 ind.km^2, but widely distributed (992.99 km^2). The most abundant was Harbour porpoise with an estimate of 6474 individuals, a density of 0.536 and a range of 2145.09 km^2. The integrated assessment of the status within species and to species group of marine mammals in coastal and shelf areas in 2017 showed that the two of the three species of cetaceans are in „Not good" status and the good environmental status is not achieved by species group.

Key words: cetaceans, abundance, distribution, monitoring, indicators, Bulgarian Black Sea, MSFD, Descriptor D1.

Introduction

The cetacean fauna in the Black Sea is represented by three species – the Black Sea Harbour Porpoise (*Phocoena phocoena*), Short-beaked Common Dolphin (*Delphinus delphis*) and Common Bottlenose Dolphin (*Tursiops truncatus*). All three marine mammal species are listed in Annex IV of the European Habitats Directive (HD 92/43/EEC) and require strict protection by EU member states. Two of the species - Common Bottlenose Dolphin and Harbour Porpoise - are listed in Annex II requiring member states to designate sites of community interests (NATURA 2000) to ensure the conservation of their habitat. The Marine Strategy Framework Directive (Directive 2008/56/EC) establishes the basis of integrated marine management taking into account the state of biological elements and corresponding pressures. In the case of marine mammals, the assessment of

conservation status of the species is under Descriptor 1 - Biodiversity and shall be based on the information on status and trends of species populations and the main pressures and threats. Good environmental status (GES) is monitored through a list of indicators and reference levels that are suggested at the national level. The indicators of D1 are grouped within five criteria - mortality rate per species from incidental by-catch, population abundance, population demographic characteristics, species distributional range and pattern and habitat for the species. The functional group of marine mammals is very sensitive to human-driven alteration in the marine environment as a result of fisheries, shipping, tourism and other maritime and land-based activities.

The present state of the Black Sea cetacean populations is not certain despite research and conservation measures during the last twenty years. The scientific information is lacking or insufficient about the trends in the population abundance, distributional range and patterns, migrations, critical habitats and anthropogenic and natural threats. The information about the population abundance and distribution of the cetacean species along the Bulgarian Black Sea coast is scarce. Most of the data were derived from stranding and opportunistic sightings during research cruises with other goals rather than cetacean sighting (Nikolov, 1963; Stanev, 1996; Raykov & Panayotova, 2012; Panayotova & Todorova, 2015a; b). Recent research surveys dedicated to estimating the cetacean abundance and distribution were carried out in 2015 in the pilot area enclosed between cape Galata and cape Emine up to 100m depth (Panayotova et al., 2017) and in SCI Strandzha (Popov et.al, 2020). During these surveys, visual or combined visual and acoustic observations were applied. Large scale aerial and ship-based surveys in the Western Black Sea area were carried out in 2013 (Birkun et al., 2014) which provided basic information about cetacean abundance, density and distribution in the Bulgarian Black Sea area.

The current study is aimed to assess for the first time the state of cetacean populations in front of Bulgarian Black Sea coast based on indicators under criteria D1C2 and D1C4 of Descriptor 1 of MSFD. Assessment was made on basis of data, collected during a ship-based visual line transect survey, executed in 2017 under the national monitoring program of MSFD.

Material and Methods

The study area, covered by the monitoring survey encompasses the Bulgarian coastal (up to 30 m) and shelf areas (30-200 m) – Fig.1, including seven marine reporting units (MRU). Data were collected during a ship-based visual survey within the period 24.11.2017 – 22.12.2017 over an area of 12 090 km^2 and the total length of transects of 684 km. Pre-determined track-lines were designed using Distance software following the principles of line transect sampling (Buckland et al., 1993; Thomas et al., 2010). Visual observations were carried out during the daylight hours using the single platform method. For each observation, the following data is recorded: date, time, platform, distance, angle, species, behavior and group size. Data on weather conditions (Beaufort's sea state, reflections and glare, wind direction and force) are also recorded. Observations were not conducted at reduced visibility (below 1000 m) or strong waves (> 4 at Beaufort). The abundance and density were estimated using the DISTANCE 7.0 software package (Thomas et al., 2010). During the observations, a constant vessel' speed of about 6-7 knots was maintained.

Assessment is based on the indicators and thresholds, available for criteria D1C2 and D1C4 and stated in the Monitoring program of Descriptor 1 (Marine mammals) for Bulgaria (bsbd.org), according to the new GES Decision (Commission Decision (EU) 2017/848), as follows:

- D1C2 – Primary: The population abundance of the species is not adversely

affected due to anthropogenic pressures, such that its long-term viability is ensured.

Indicator: abundance (number of individuals) per species and MRU

- D1C4 – Primary for species covered by Annexes II, IV or V to Directive 92/43/EEC and secondary for other species: The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions.

Indicators: distributional area by species (GIS layer); Density of distribution (ind.km^{-2}).

Threshold values for the population abundance (D1C2) and density (D1C4) indicated in the national monitoring program for Descriptor 1 of MSFD for the combined coastal and shelf MRU zones, were applied – Table 1.

The final assessment of the state of cetacean' population is done according to the following principles:

- The integration of individual indicators by species and MRUs for each criterion was carried out under the "One Out All Out (OAAO)" rule.
- The integration between criteria for each species - under the "One Out All Out (OAAO)" rule.
- The final assessment for the Descriptor 1 Biodiversity Mammals regarding the group of marine mammals was formed by the percentage of species in "Good" status. The threshold value is 100%.

Results and Discussion

All three cetacean species were observed during the survey - *P. phocoena*, *T. truncatus* and *D. delphis*, but in different numbers and distributional patterns. Totally, 123 sightings were recorded (Table 2), from which 24 of *T. truncatus*, 81 of *P. phocoena* and 18 - of *D. delphis*. The total number of observed individuals amounts to 360.

Population parameters of small cetaceans (abundance, density, group size) were calculated by Distance 7.0 software separately for each species observed. The data matrix includes all observations in coastal and shelf areas combined, due to the low number of sightings by marine reporting unit (MRU). In the case of cetaceans, which are highly mobile, it is reasonable, because they perform long distance movements related to the feeding and wintering (Birkun, 2008). The results of the analysis for the three cetacean species are presented in Table 3.

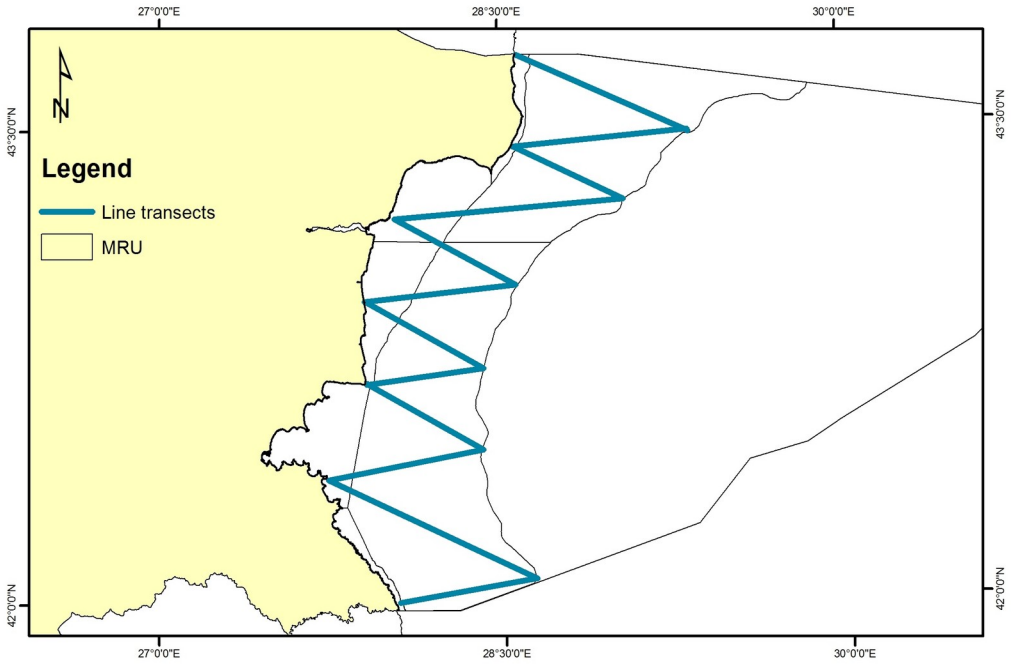

Fig. 1. Map of the study area in the Bulgarian coastal and shelf zones.

Table 1. List of criteria, indicators and thresholds currently applied in Bulgaria (coastal and shelf zone combined).

Feature	Element assessed	Criterion	Indicator	Threshold value	Unit
D1 Biodiversity (Mammals)	*D. delphis*	D1C2	Abundance	5019	Count
		D1C4	Density	0.718	ind.km^{-2}
		D1C4	Distributional range	Not yet set	km^2
	T. truncatus	D1C2	Abundance	4861	Count
		D1C4	Density	0.696	ind.km^{-2}
		D1C4	Distributional range	Not yet set	km^2
	P. phocoena	D1C2	Abundance	1003	Count
		D1C4	Density	0.144	ind.km^{-2}
		D1C4	Distributional range	Not yet set	km^2

Table 2. Number of marine mammals sightings and observed individuals by species and MRUs in 2017.

MRU (area)	Number of sightings	Number of sightings (observed individuals)		
		T. truncatus	*D. delphis*	*P. phocoena*
Sivriburun – Kaliakra (156 km^2)	-	-	-	-
Kaliakra – Galata (825 km^2)	1	-	-	1 (1)
Galata – Emine (699 km^2)	4	-	1 (2)	3 (7)
Emine – Maslen Nos (856 km^2)	8	4 (4)	3 (4)	1 (3)
Maslen Nos – Rezovo (155 km^2)	-	-	-	-
Northern shelf (3878 km^2)	4	1 (2)	-	3 (5)
Southern shelf (5522 km^2)	106	19 (51)	14 (36)	73 (245)
Total	**123**	**24 (57)**	**18 (42)**	**81 (261)**

Table 3. Estimated population parameters of three cetacean species in coastal and shelf areas.

Parameter	Species		
	T. truncatus	*P. phocoena*	*D. delphis*
Area, km^2	12090	12090	12090
Effort (total length of transects, *L*), km	684.176	684.176	684.176
Number of observations (individuals or groups)	24	81	18
Encounter rate (ER; *n/L*)	0.035	0.118	0.026
Coefficient of variation (CV), %	28.67	19.32	26.63
95% Confidence Interval (CI)	0.01979 - 0.0622	0.0809 - 0.1732	0.0154 - 0.0450
Value of pdf* at zero for line transects, *f(0)*	0.0027097	0.0031364	0.003151
Standard error	0.000374	0.0001934	0.000424
Coefficient of variation (CV), %	13.81	6.17	13.45

95% Confidence Interval (CI)	0.002039 - 0.00360	0.00277 - 0.00355	0.002375 - 0.00418
Probability of observing an object in defined area *(p)*	0.53649	0.24962	0.45903
Standard error	0.074078	0.015394	0.061756
Coefficient of variation (CV), %	13.81	6.17	13.45
95% Confidence Interval (CI)	0.40374 - 0.71290	0.22081 - 0.28219	0.34603 - 0.60892
Effective strip width (ESW), m	369.05	318.84	317.36
Standard error	50.957	19.662	42.697
Coefficient of variation (CV), %	13.81	6.17	13.45
95% Confidence Interval (CI)	277.73 - 490.39	282.04 - 360.44	239.24 - 420.99
Estimate of density of clusters/groups *(DS)*	0.0475	0.1857	0.04140
Standard error	0.0151	0.117	0.124
Coefficient of variation (CV), %	31.82	20.28	29.84
95% Confidence Interval (CI)	0.02543 - 0.0888	0.12469 - 0.27643	0.022971 - 0.074794
Estimate of expected value of clusters/group size *(E (S))*	2.1703	2.8843	1.9208
Standard error	0.299	0.2315	0.26117
Coefficient of variation (CV), %		8.03	13.6
95% Confidence Interval (CI)		2.4591 - 3.3831	1.4417 - 2.5591
Average cluster size	2.375	3.2222	2.3333
Standard error	0.3798	0.29502	0.3025
Coefficient of variation (CV), %	15.99	9.16	12.96
95% Confidence Interval (CI)	1.7096 - 3.2993	2.6865 - 3.8648	1.777 - 3.0639
Estimate of density of animals (*D*, individuals/km^2)	0.1129	0.53548	0.0796
Standard error	0.0402	0.117	0.0261
Coefficient of variation (CV), %	35.62	21.81	32.79
95% Confidence Interval (CI)	0.0565 - 0.225	0.34964 - 0.82016	0.041935 - 0.15115
Estimate of the number of animals in the surveyed area (*N*)	1365	6474	963
Standard error	486.16	1411.9	315.75
Coefficient of variation (CV), %	35.62	21.81	32.79
95% Confidence Interval (CI)	684.00 - 2722.0	4227.0 - 9916.0	507 - 1827

Common bottlenose dolphins – *T. truncatus*, (24 sightings, 57 animals) were observed in the Northern and Southern shelf areas, while in the coastal zone – only in Emine – Maslen Nos Region (Table 2). This species was unequally distributed, with the highest number of sightings and the highest relative number of observed groups (0.005 groups.km^{-2}) in the Emine – Maslen Nos area. Most of the observations were recorded in the shelf area at depths below 50 m. Bottlenose dolphins have been observed as single animals (8 observations; 14.04% of the total number of individuals) or groups of

two (7 sightings; 24.56% of the total number of individuals), three (7 sightings; 36.84% of total individuals) or more animals (2 sightings; 24.56% of total individuals). The largest observed group consists of 10 animals. The estimated value of the expected group size (E (S)) is 2.17 individuals – Table 3. The estimated values for the density of *T. truncatus* groups (DS) and for single animals (D) were low, respectively 0.0475 groups.km^{-2} and 0.113 ind.km^{-2} (Table 3). Absolute abundance (N) was calculated at 1365 individuals in the study area and the encounter rate (ER) - as 0.0351 ind.km^{-1} (Table 3).

The state of the *T. truncatus* population along the Bulgarian coast was assessed using the indicators and thresholds for criteria D1C2 and D1C4.

- Criterion D1C2: The estimated abundance of 1365 individuals (Table 3) is lower than the threshold (Table 1), and the population is assessed as in "Not Good" state.
- Criterion D1C4: the estimated species density (D) of 0.113 ind.km^{-2} for the whole coastal and shelf areas is lower than the threshold value (Table 1) and the population status is assessed as in "Not Good" state. The distributional range of bottlenose dolphin was estimated at 745.81 km^2.

The data and the final assessment across the indicators and criteria are presented on Fig. 2. The species status was assessed as "Not Good".

Short-beaked common dolphins – *D. delphis*, (18 sightings; 42 animals) were observed in the Southern shelf area and in the coastal zone – in Galata – Emine and Emine – Maslen Nos Regions (Table 2). Species were unequally distributed, with the highest number of sightings and the highest relative number of observed groups (0.004 groups.km^{-2}) in the Emine – Maslen Nos Area. Most of the observations were recorded in the shelf area at depths below 50 m. Common dolphins have been observed as single animals (5 sightings; 11.90% of the total number of individuals), groups of two (6 sightings; 28.57% of the total number of individuals), groups of three (5 sightings; 35.71% of total individuals) or more animals (2 sightings; 23.82% of total individuals). The largest observed group consists of 6 animals. The estimated value of the expected group size (E (S)) is 1.92 animals – Table 3. The estimated values for density of *D. delphis* (DS) groups and for single animals (D) are very low - 0.0414 groups.km^{-2} and 0.0796 ind.km^{-2}. Absolute abundance (N) was calculated at 963 individuals in the study area and the encounter rate (ER) - as 0.0263 ind.km^{-1} (Table 3).

The state of *D. delphis* population along the Bulgarian coast was assessed using the indicators and thresholds for criteria D1C2 and D1C4.

- Criterion D1C2: The estimated abundance of 963 individuals (Table 3) is lower than the threshold (Table 1), and the population was assessed as in "Not Good" state.
- Criterion D1C4: the estimated species density (D) of 0.0796 ind.km^{-2} for the whole coastal and shelf areas is lower than the threshold value (Table 1) and the population status was assessed as in "Not Good" state. The distributional range of Short-beaked common dolphin is estimated at 992.99 km^2.

The data and the final assessment across indicators and criteria are presented on Fig. 2. The species status was assessed as "Not Good".

Harbour porpoises – *P. phocoena*, (81 sightings; 261 animals) were observed in all marine regions except the coastal areas of Sivriburun - Kaliakra and Maslen Nos - Rezovo (Table 2). Individuals were unequally distributed, with the highest number of sightings and the highest relative number of observed groups (0.013 groups.km^{-2}) in the Southern shelf area. Harbour porpoises have been observed as single animals (16 sightings; 6.13% of the total number of individuals), groups of two

(25 sightings; 19.16% of the total number of individuals), groups of three (16 sightings; 18.39% of the total number of individuals) or more animals (24 sightings; 56.32% of the total number of individuals). The largest group observed consists of 20 animals. The estimated value of the expected group size (E (S)) e 2.88 individuals – Table 3. The estimated values for density of *P. phocoena* (DS) groups and for single animals (D) are - 0.186 groups.km^{-2} and 0.536 ind.km^{-2}. Absolute abundance (N) was calculated at 6474 individuals in the study area and the encounter rate (ER) - as 0.118 ind.km^{-1} (Table 3).

The state of *P. phocoena* population along the Bulgarian coast was assessed using the indicators and thresholds for criteria D1C2 and D1C4.

- Criterion D1C2: The estimated abundance of 6474 individuals (Table 3) is above the threshold value (Table 1) and the population is assessed as in "Good" state.
- Criterion D1C4: the estimated species density (D) of 0.536 ind.km^{-2} for the whole coastal and shelf areas is above the threshold value (Table 1) and the population status is assessed as in "Good" state. The distributional range of harbor porpoise is estimated at 2145.09 km^2.

The data and the final assessment across indicators and criteria is presented on Fig. 3. The species status was assessed as "Good".

The final integrated assessment of the functional group of marine mammals by indicators, criteria and at Descriptor 1 level, is summarized on Table 4. The state of the functional group of marine mammals in front of the Bulgarian Black Sea coast in 2017 is assessed as not in GES, because only one of the three species is in "Good" state according to the applied criteria.

According to the results shown in Table 3, the harbor porpoise was the most abundant species in the Bulgarian area. Birkun et al. (2014) reported that in 2013, the common dolphin was the most abundant cetacean species in Bulgarian waters. For the Romanian coast, assessments show that the total number of cetaceans are around 1800 individuals for the period 2001 – 2004 and 1710 individuals for 2013 (Tiganov et al., 2017). According to the results of Birkun et al. (2014), the *P. phocoena* was the most abundant species in the Romanian Black Sea area.

The marine areas inhabited by cetaceans are subject to multipurpose usage from fisheries, tourism and marine transport. All these activities generate a number of threats as habitat degradation, pollution, the introduction of alien species, over-exploitation of fishery resources, but the incidental entanglement in fishing nets is the major source of human-induced mortality of Black Sea cetaceans (Birkun et al., 2014). Profound knowledge of the spatial and temporal distribution of marine mammals is fundamental for the implementation of effective conservation measures and spatial planning of human activities in the conflict areas.

The three species are from regional importance and for the improvement of their population status regional cooperation is essential. All Black Sea coastal countries take measures to protect and conserve cetaceans. Coastal states have ratified commitments protecting biodiversity (e.g., the Convention on Biological Diversity, 1992) and endangered marine species through responsible fishing practices (e.g., the Code of Conduct for Responsible Fisheries, FAO, 1995). All coastal states also have national legislation in place that prohibits killing or injuring cetaceans. EU countries - Bulgaria and Romania, are obliged to take measures to establish a system of strict protection in their natural range, as the Black Sea cetacean species are listed in Annex IV of Directive 92/43/EEC (Habitats Directive). The NATURA 2000 network in Bulgaria currently includes a total marine area of 245 227 ha, designated in 14 marine sites, in which *T. truncatus* and *P. phocoena* are subject of conservation. Until the total regional ban on hunting was introduced in 1983, commercial hunting was the principal anthropogenic threat to the Black Sea cetacean populations.

Table 4. Assessment summary of the status of the functional group of marine mammals under Descriptor D1 - Biodiversity.

Element assessed	Criterion	Indicator	Threshold value	Values achieved	Unit	Criterion status	Status of popula-tion (element)	Extent to which GES is achieved
Delphinus delphis	D1C2	Abundance	5019	963	Count	Not good	Not good	Proportion of populations in good status: 33.33% (1 out of 3 populations)
	D1C4	Density	0.718	0.0796	ind.km^{-2}	Not good		
	D1C4	Distribu-tional range	Not yet set	992.99	km^2	Not assessed		
Tursiops truncatus	D1C2	Abundance	4861	1365	Count	Not good	Not good	
	D1C4	Density	0.696	0.113	ind.km^{-2}	Not good		
	D1C4	Distribu-tional range	Not yet set	745.81	km^2	Not assessed		
Phocoena phocoena	D1C2	Abundance	1003	6474	Count	Good	Good	
	D1C4	Density	0.144	0. 536	ind.km^{-2}	Good		
	D1C4	Distribu-tional range	Not yet set	2145.09	km^2	Not assessed		

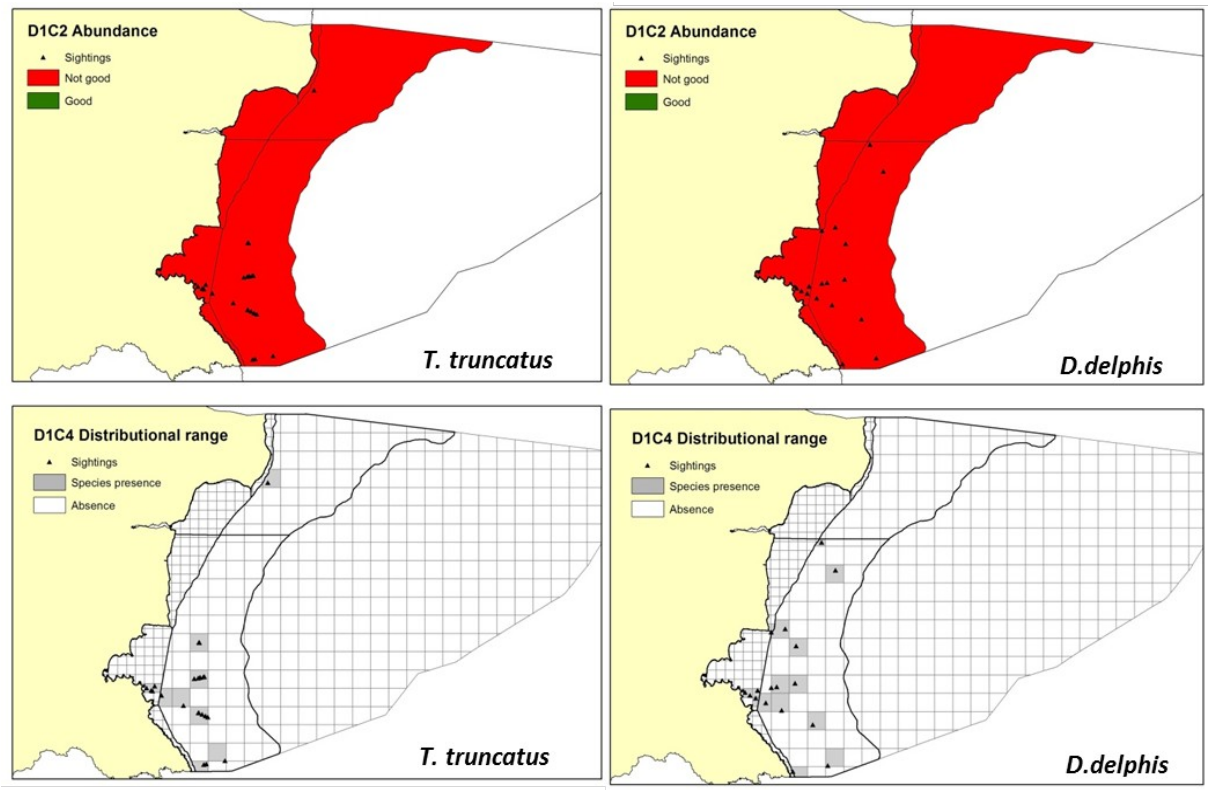

Fig. 2. Final assessments of *T. truncatus* and *D. delphis* in 2017, according to criteria D1C2 and D1C4 of Descriptor 1 Marine mammals.

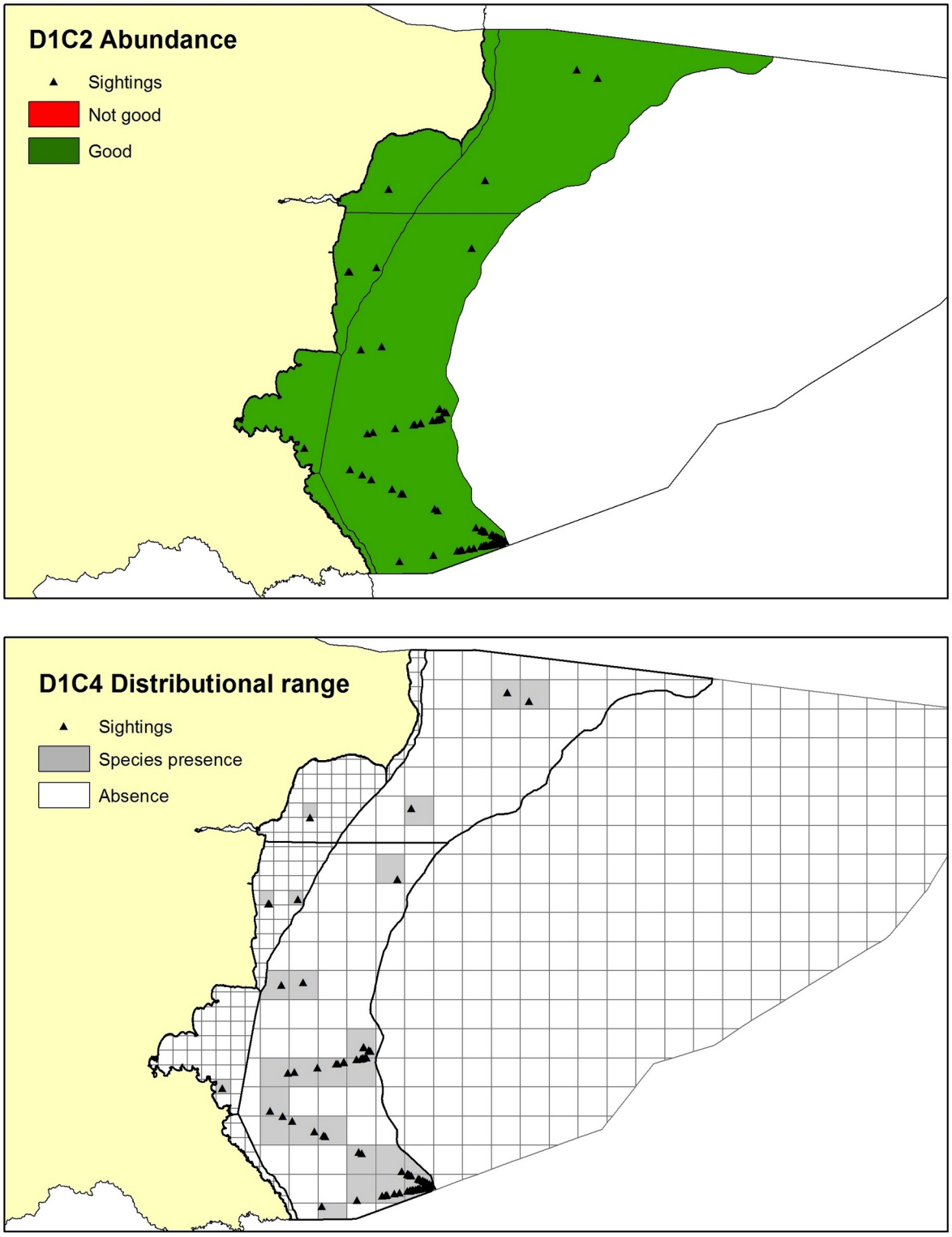

Fig. 3. Final assessment of *P. phocoena* in 2017 according to criteria D1C2 and D1C4 of Descriptor 1 (Marine mammals).

Nowadays, the mortality and non-mortal injuries in fishing gears are the most important threat to marine mammals. Harbour porpoises almost always represented the major part of cetacean by-catches around the Black Sea (Birkun et al., 2014), mainly in passive fishing, predominantly in spring, from March to May. Introduction of mitigation measures for reducing or preventing cetacean by-catch and their conservation in the Black Sea are very important and necessary. For the other side, the regular scientific surveys dedicated to marine mammals research will provide crucial information for updating of indicators and thresholds and success in achieving GES.

Conclusions

Assessment of the status of the functional group of marine mammals according to criteria, indicators and thresholds of Descriptor D1 Biodiversity - Marine Mammals was carried out in 2017. Obtained results revealed that the populations of the Short-beaked Common Dolphin and the Black Sea Bottlenose Dolphin along the Bulgarian coast are in "Not Good" state and the Good Environmental status for the whole group is not achieved, because only the Black Sea Harbour Porpoise is in "Good" status. For improvement of the status of their populations and achieving GES, adequate management of human activities affecting marine mammals and conservation measures are required. Scientific surveys are essential for the monitoring of the populations of marine mammals and for updating of indicators and thresholds, used in assessment.

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