Cetacean monitoring protocols

Guide

Contents

1. Abstract

Monitoring cetaceans in the Black Sea is essential for understanding population dynamics, spatial distribution, and the cumulative impacts of human activities. This protocol offers a scientifically grounded framework to support coordinated monitoring efforts, serving as a reference for researchers, conservationists, and volunteers. It outlines clear objectives, robust methodologies, profiles of key indicator species, and standardized field forms to ensure consistency and data comparability.

The systematic monitoring of odontocete species, particularly dolphins and porpoises, constitutes a cornerstone of modern marine biodiversity conservation. This practice enables in-depth assessments of species specific behavioral ecology, spatiotemporal distribution patterns, and habitat use. By integrating long-term observational data with advanced analytical tools, researchers can identify ecologically critical habitats that support vital life-history processes such as feeding, breeding, and migration.

These datasets are fundamental for informing evidence-based management strategies aimed at reducing anthropogenic pressures, including maritime traffic, underwater noise pollution, fisheries bycatch, and the degradation of coastal and pelagic environments. Given the heightened ecological sensitivity of small cetaceans to such stressors, continuous and standardized monitoring not only enhances conservation outcomes at the species level but also supports the broader objective of preserving the functional integrity and resilience of marine ecosystems.

2. Objectives

The primary goals of cetacean monitoring in the Black Sea region are to collect, analyze, and interpret data that can inform management and conservation strategies. Objectives must align with the EU Marine Strategy Framework Directive (MSFD), national biodiversity targets, and regional conservation priorities. Key objectives include:

- Estimating cetacean population sizes, distribution, and demographic trends across seasons and years.
- Assessing calving rates and reproductive cycles using long-term observational data.
- Identifying critical habitats and high-use areas through geospatial and environmental analysis.
- Evaluating the impacts of anthropogenic activities, including bycatch, shipping, and underwater noise.
- Studying social structure, group dynamics, and subpopulation connectivity.
- Supporting the management of marine protected areas (MPAs) by tracking cetacean presence and pressures.

3. Indicator Species

Monitoring efforts in the Black Sea focus on three cetacean subspecies, all of which are endemic to this semi-enclosed basin and exhibit distinct ecological, behavioral, and conservation characteristics. These species are listed under Annex II of the EU Habitats Directive, requiring strict protection and coordinated monitoring under MSFD Descriptor 1 – Biodiversity. Their status serves as an essential indicator of the overall health and integrity of marine ecosystems in the region. Three cetacean species serve as primary indicators for marine ecosystem health in the Black Sea:

Tursiops truncatus ponticus (fig.1)

The Black Sea bottlenose dolphin is a coastal and semi-pelagic subspecies of the globally distributed *Tursiops truncatus*. It exhibits high site fidelity, particularly in shallow nearshore environments and areas with abundant benthic and pelagic prey. This species tends to form small, stable groups, often composed of females and calves, with males sometimes forming looser associations.

Its distribution is tightly linked to the shelf regions of the northwestern Black Sea, including marine protected areas (MPAs), estuarine zones, and fish-abundant habitats. As a top predator, *Tursiops truncatus ponticus* plays a crucial role in maintaining the ecological balance within coastal food webs.

Figure 1. *Tursiops truncatus ponticus*

Phocoena phocoena relicta (fig.2)

The Black Sea harbour porpoise is the most ecologically specialized and vulnerable of the three species. Adapted to colder waters, it occupies both shelf and deeper offshore habitats but is often recorded in northern and western coastal zones where bottom-set gillnet fishing is prevalent.

Phocoena phoceona relicta is a solitary or small-group species, typically more cryptic than dolphins and less likely to be detected through visual observation. It is particularly susceptible to bycatch, especially in illegal, unregulated, or high-effort fisheries.

Figure 2. *Phocoena phocoena relicta*

Delphinus delphis ponticus (fig.3)

The Black Sea common dolphin is a highly mobile, pelagic subspecies inhabiting the offshore and deepwater zones of the Black Sea. This species follows migratory patterns closely associated with pelagic fish movements, particularly anchovy and sprat.

Although less frequently encountered nearshore, *Delphinus delphis ponticus* can occasionally be seen in coastal upwelling zones or during seasonal aggregations linked to prey abundance. Its social structure is complex, with frequent inter-group interactions and high vocal activity.

Figure 3. *Delphinus delphis ponticus*

4. Setting Research Objectives

Establishing well-defined research goals is a cornerstone of successful cetacean monitoring programs. These goals should be specific, measurable, and directly relevant to conservation outcomes. In the context of the Black Sea, research objectives must also reflect the ecological and management realities of the region, particularly in relation to marine protected areas (MPAs) and national biodiversity strategies.

Objectives may include, but are not limited to:

- Estimating population size and structure across seasons and over multiple years to detect demographic trends.
- Assessing reproductive parameters, such as calving rates and breeding seasonality, through long-term observational data.
- Identifying habitat preferences, ecological niche breadth, and high-use areas by combining spatial sighting data and environmental variables.

- Evaluating physiological and behavioral responses to anthropogenic disturbances, including maritime traffic, noise pollution, and fisheries interactions.
- Understanding social structure, group composition, and movement ecology to reveal patterns of residency, site fidelity, and connectivity among subpopulations.

In the Black Sea region, priority is given to objectives that integrate:

- Seasonal distribution patterns of species like *Tursiops truncatus ponticus*, *Phocoena phocoena relicta*, and *Delphinus delphis ponticus*;
- Abundance estimates that inform MSFD Descriptor 1 (biodiversity);
- Identification of breeding and calving areas, especially for resident populations in coastal MPAs;
- Assessing cetacean presence and behavior in relation to fishing effort and maritime.

These objectives serve as the foundation for designing tailored monitoring protocols and selecting suitable methods. They ensure the standardization of data collection and promote regional coherence. Moreover, clear objectives help distinguish between short-term fluctuations (e.g., seasonal aggregations) and long-term ecological trends (e.g., shifts due to climate change or chronic anthropogenic pressures). Aligning these goals with spatial planning and ecosystem-based management allows decision-makers to prioritize conservation actions effectively and ensure the adaptive management of MPAs and other sensitive marine areas.

5. Delimiting the Study Area

A fundamental aspect of the monitoring protocol is the precise definition of the study area. This may include marine conservation areas, protected areas, or locations frequently used by cetaceans, such as migration routes or feeding sites. Delineation measures may be based on geographical coordinates, ecological zones or physical structures of the marine habitat, and monitoring should be carried out in both coastal and deep-water areas, depending on the species targeted.

6. Selection of Monitoring Methods

In order to ensure accurate and reliable data, appropriate monitoring techniques should be selected depending on the purpose of the study and the characteristics of the study area. All methods require standardized recording formats, including GPS logging, environmental parameters (sea state, wind, glare), and effort data. Data should be archived in compatible databases for regional integration. Metadata documentation must accompany datasets to support quality control and transparency. Data platforms like OBIS-SEAMAP or national biodiversity portals are recommended for long-term storage and access (ANEMONE Project Reports, 2019–2021, Paiu et al., 2024).

These may include:

6.1. Line Transect Sampling (annex 1)

Line transect sampling is a standardized and widely-used method for estimating the abundance and density of marine mammal populations by recording sightings along predefined survey lines. This method can be carried out from various platforms, such as land, ships, or aircraft, depending on the research goals and the area to be surveyed (Buckland et al., 2001).

When conducting land-based surveys, researchers typically use binoculars or theodolites from coastal observation points to spot animals along the transect line. Ship-based surveys involve observers scanning specific sectors of the ocean using binoculars or spotting scopes from research vessels. Aerial-based surveys, typically conducted from planes or drones, offer the ability to cover large areas of ocean quickly, providing a broader spatial coverage.

The key data collected during these surveys include the perpendicular distance from the transect line to the animal, which helps estimate the actual density of animals in the area. Other data collected include the group size and composition of the observed animals, as well as environmental conditions like sea state, visibility, and weather, all of which can affect detection rates. The method assumes that all animals on the transect line are detected, and detection rates decrease with increasing distance from the line. Statistical tools, such as Distance software, are often used to analyze the data and correct for detection biases.

6.2. Photo-Identification (annex 2)

Photo-identification (Photo-ID) is a non-invasive technique used to identify individual marine mammals based on unique natural markings, such as scars, pigmentation patterns, dorsal fins, and tail flukes (Würsig & Jefferson, 1990). This method allows researchers to monitor and track individuals over time without the need for capture or tagging. High-resolution photographs are taken during surveys or encounters with the animals, and these images are then compared to a catalogue of previously identified individuals.

Once identified, photo-ID data is using in mark-recapture models to estimate demographic parameters such as population size, survival rates, and migration patterns. The long-term nature of this method allows for the study of individual life histories, helping to understand behaviours, social structures, and interactions between individuals within a population.

However, the effectiveness of this method depends on the quality of the images captured, the consistency of sightings, and the ease of identifying unique markings. The method may also be biased toward individuals that are easier to identify, such as those with distinctive markings, while animals with less noticeable features may be overlooked. In the Black Sea, this method has provided insights into population structure of bottlenose dolphins.

6.3. Opportunistic Sightings

Opportunistic sightings involve using data collected incidentally from non-dedicated research platforms such as commercial vessels, tourist boats, ferries, or fishing vessels. These platforms provide valuable sightings that are not part of a structured survey, and the data is often recorded by non-expert observers. This approach is cost-effective and provides broad spatial and temporal coverage, making it useful for monitoring marine mammal presence over large areas or long periods of time.

Data collected typically includes information on species (Fig.4) presence or absence, relative abundance, and the location and date of sightings. However, because the data collection is not standardized, there can be significant variability in observer skill and effort, which can lead to biases in the data. Despite these limitations, opportunistic sightings contribute to the overall understanding of marine mammal distribution and behaviour, especially in areas that are not easily accessible for dedicated research.

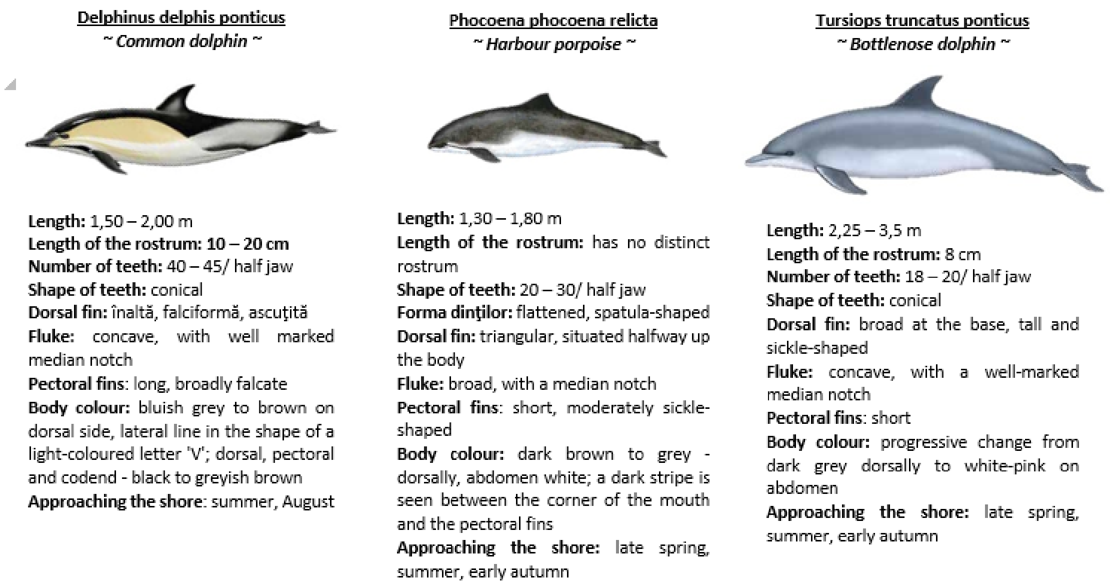


Figure 4. Species of cetaceans from Black Sea

6.4. Stranding Investigations (annex 3)

Cetacean strandings in the Black Sea provide essential information about the health status, anthropogenic pressures, and population dynamics of marine mammals. According to a study published in Frontiers in Marine Science titled "Spatiotemporal Patterns and Drivers of Cetacean Strandings in the Black Sea," the analysis of strandings between 2005 and 2020 revealed a significant correlation with periods of intense monofilament net fishing activity and increased maritime traffic. The most frequently stranded species were *Phocoena phocoena relicta* and *Delphinus delphis ponticus*, with a higher incidence recorded from April to June.

The updated protocol recommends:

- Systematic recording of each stranding event with precise GPS localization;
- Completing a standardized observation form (Annex 3);

- Performing necropsies to collect morphometric, reproductive-biological, and pathological data;
- Sending biological samples to laboratories for toxicological, histopathological, and genetic analyses.

Stranding investigations offer a valuable opportunity to collect biological and pathological data from deceased marine mammals. When animals wash ashore or are found dead, researchers perform necropsies—marine mammal autopsies—to obtain detailed information. Data collected typically include body measurements such as length and girth, reproductive status (e.g., presence of testes or ovaries, pregnancy), stomach contents (to analyze diet), blubber thickness (to assess body condition), and tissues for further laboratory analyses (Zaharia et. al., 2013; Zgura et al., 2006).

These investigations can provide critical insights into the health, nutrition, and overall condition of individual animals. However, it is important to note that strandings often reflect a biased sample, predominantly representing sick, injured, or otherwise compromised individuals, which may not accurately represent the wider population. Furthermore, decomposition can affect data quality, especially if the carcass has been exposed for a prolonged time before discovery.

Together, these data are essential for identifying the main causes of mortality and assessing the anthropogenic pressures impacting cetacean populations in the Black Sea.

6.5. Bycatch Rate Monitoring

Bycatch refers to the accidental capture of marine mammals in fishing gear, such as nets, lines, and traps (fig. 5). Bycatch rate monitoring is an essential tool for assessing the impact of fisheries on non-target marine species, including dolphins, porpoises, and whales. Data on bycatch is typically collected through onboard observer programs, where trained researchers are placed on fishing vessels to record interactions with marine mammals. Additionally, self-reporting by fishers and genetic analysis of bycaught animals can help to identify species and assess the overall impact of bycatch.

Monitoring bycatch rates is crucial for developing conservation strategies and designing mitigation measures, such as the use of pingers (acoustic deterrents) or exclusion devices, to reduce accidental captures. Bycatch data also aids in the development of regulations to protect vulnerable species and improve the sustainability of fisheries. In the Black Sea, harbour porpoises are most affected by bottom-set gillnets (ANEMONE, 2019, Popov et al., 2023).

Figure 5. Bycatch *Phocoena phocoena relicta*

6.6. Acoustic Monitoring

Acoustic monitoring methods are used to detect and analyze the vocalizations of marine mammals, providing valuable information on their presence, distribution, and behaviour. Marine mammals, such as whales and dolphins, produce a wide range of vocalizations used for communication, navigation, and hunting. Acoustic monitoring involves the use of hydrophones (underwater microphones) to detect these sounds in the environment.

There are several approaches to acoustic monitoring, including Passive Acoustic Monitoring (PAM), which uses stationary hydrophones or arrays to record vocalizations over extended periods, towed arrays deployed from research vessels, and autonomous recorders that can be left in the water for long-term monitoring (fig. 6). These methods allow researchers to monitor species in areas where visual observations may be difficult or impossible.

Applications of acoustic monitoring include estimating population abundance using cue rates (the frequency of vocalizations), identifying species based on their vocal signatures, and assessing the impact of human activities such as shipping or seismic surveys on marine mammal behaviour. Acoustic data can also be used to track migrations and detect unusual vocalization patterns, which may indicate changes in behaviour or health.

FPODs are specialized autonomous hydrophones designed specifically to detect echolocation clicks produced by harbor porpoises (*Phocoena phocoena relicta*)

The use of FPODs in the western Black Sea revealed that:

- Acoustic activity of harbor porpoises significantly decreases during periods of intense fishing activity (spring);
- Porpoises prefer areas with moderate depths (20–40 m) and low background noise;

- Vocal detection is a sensitive indicator of the presence and behavior of cetaceans that are difficult to observe visually.

The recommended protocol includes:

- Deploying FPODs near protected areas (e.g., Natura 2000 Site – Vadu Beach);
- Continuous recordings over seasonal periods (minimum 60 days);
- Signal analysis using FPOD or PAM Guard software with automatic/manual verification of echolocation clicks;
- Correlating acoustic data with visual observation data to calibrate detection rates.

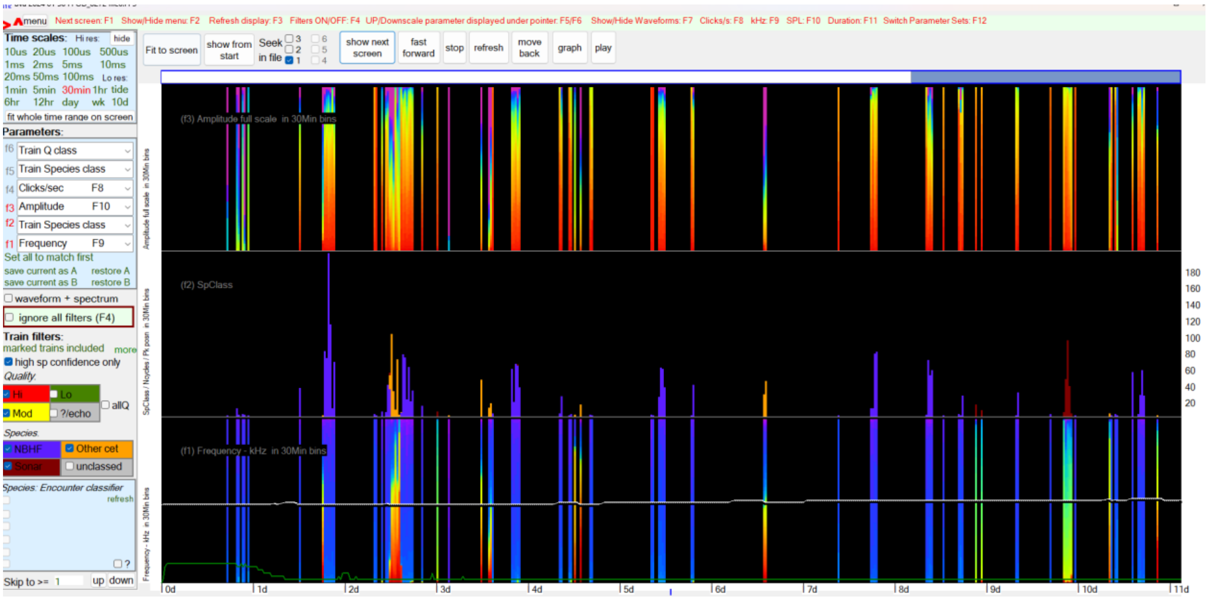


Figure 6. PAM analysis

6.7. Fixed-Point Observation (annex 4)

Coastal shore-based monitoring is a cost-effective and non-invasive method widely used to study cetacean presence and behaviour in nearshore environments. This approach involves placing trained observers on elevated coastal vantage points such as cliffs, observation platforms, towers, or designated coastal stations. Equipped with binoculars, theodolites, or spotting scopes, these observers systematically record cetacean sightings over extended periods.

Data collected during shore-based monitoring typically include species identification, group size, behaviour patterns (e.g., feeding, socializing, traveling), movement direction, and environmental conditions such as weather and sea state. Observations are usually conducted over several consecutive hours per day and are repeated regularly across different seasons to capture temporal variations in cetacean occurrence and activity.

This method is especially valuable in Marine Protected Areas (MPAs) or other locations with consistent cetacean presence where conducting vessel-based surveys may be challenging or impractical due to logistical, financial, or environmental constraints. Shore-based monitoring offers several advantages: it generates a continuous and long-term data set with minimal ecological disturbance, reduces the carbon footprint compared to boat surveys, and allows for safe observation even in adverse sea conditions.

Moreover, this technique is highly suitable for engaging local communities, volunteers, and educational institutions. Volunteer involvement not only helps in data collection over wider temporal and spatial scales but also raises public awareness and promotes stewardship of marine ecosystems. The integration of citizen science programs enhances monitoring capacity and fosters collaboration between scientists and the public.

Although shore-based monitoring has limitations such as restricted sighting range dependent on elevation and visibility, and potential observer bias it remains a vital complementary tool within comprehensive cetacean monitoring programs. When combined with other methods like acoustic monitoring and boat surveys, shore-based observations contribute valuable insights into population trends, habitat use, and behavioral ecology, supporting effective conservation and management strategies.

7. Data Collection and Data Management

Data collection should be carried out according to standardized procedures to minimize errors and ensure long-term comparability. The following aspects should be included in the monitoring protocol:

Frequency and Duration of Observations: Determine the optimal number of observations required to obtain accurate estimates of abundance and distribution. These observations should be evenly distributed over a year or several seasons to understand the temporal variability of populations.

Environmental Conditions: Factors such as sea state, visibility, weather conditions and natural lighting can influence detectability of cetaceans. These variables should be recorded whenever data are collected.

Reporting Systems: All observations must be documented in an accurate reporting system, which may include field sheets or digital platforms for real-time data management.

8. Data Analysis and Interpretation

Analyzing the collected data involves the use of advanced statistical techniques to estimate demographic parameters of cetacean populations, such as abundance, age structure, sex and population dynamics. Estimation models, such as mark-recapture or statistical distance models, are used to correct for detection errors and to provide accurate estimates of populations and their distribution.

In addition, acoustic data can be analyzed to understand cetacean vocal behaviors and to assess the impact of noise pollution on cetaceans.

Effective cetacean monitoring in the Black Sea requires multiple, complementary methods adapted to ecological conditions and logistical capacities. Each method brings unique strengths, and when integrated, they provide a comprehensive understanding of cetacean status and threats. Standardization, coordination, and regional collaboration are key to ensuring scientifically robust and policy-relevant monitoring systems.

9. Annexes

Annex 1: Transect method form

DATE			FORM Number	No. of transects/s
DAY	MONTH	YEAR		

TRANSECT METHOD

OBSERVATION SHEET

Species or vessel code: (DD) Delphinus delphis/Common dolphin; (TT) - Tursiops truncatus / Whitefish; (PP) –Phocoenaphocoena / Porpoise;motor boats (AM); yachts (Y), jetskis (J), paddle boats (fishing boats, kayaks, etc.)(P), passenger (PA), fishing vessels (PE), research vessels (VC), sailing vessels (V), ferries (F), cargo ships (C), platforms (PL), and undetermined (N).

Limit: OR–horizon; PA –earth

Behavior:displacement (D); displacement-submergence (DS); submergence (S);jumping, surface feeding (HS), foraging (CH), swimming in the bow of the ship (BO), socializing (SO); resting (O); following fishing boats (UP)

Observation number GPS registration number	Reticle Distance	Limit OR Or PA	Angle (degrees)	Card size			Species code Or boat	number chickens	Time (24h)		Coordinates				Behavior and direction of movement (N,S,W,E)
				low	environment	SAFE			h	min	Latitude N		Longitude E		
											degrees	min	degrees	min	

GPS point	Distance	Limit	Angle	Low MC	Medium MC	MC safe	Species or vessel code	No. of chickens	H	MIN	degrees	Min	degrees	Min	Behavior and direction of travel

Annex 2: Cetacean Photo-Identification Observation Form

Cetacean Photo-Identification Observation Form

Date __________ **Vessel name** _____________ **Characteristics** ___________________ **Captain's name** _____________________

Lead researcher (name) ________________________ **Observers and photographers: names** ____

Camera _______________ **Lens type** ______________ **Eye-level height (relative to sea level)** ____________

Event	**Vessel route information**		**Environmental conditions**			**Visibility (excellent, good, poor)**	**Cetacean sighting information**						**Additional information**		
	GPS*	Speed knots	Sea state Beaufort scale	Wind Direction, speed	Other weather conditions		Number	Species (TT, DD, PP)	Calves	Distance (approx)	Group size	Behavioral notes	Birds	Fishing boats or other vessels	Debris, oil slicks, fuel traces

*GPS data and the time of direction changes or other events during navigation (including photo-identification sessions).

Annex 3: Monitoring of stranded dolphins on the Black Sea coast form

Monitoring of stranded dolphins on the Black Sea coast

Observation sheet

Date: **Name and surname of observers:**

1. **LOCATION OF THE AREA WHERE THE OBSERVATIONS TAKEN PLACE**

- Latitude:
- Longitude:
- Coastal landmark:

2. **HYDROMETEOROLOGICAL CONDITIONS**

TEMPERATURE	Air °C	Water °C (0 m)
WIND	Calm ☐ Light wind ☐ Moderate wind ☐	Strong wind ☐ High wind ☐ Storm ☐
SKY COVERAGE	Clear sky ☐ Partly overcast ☐ Half overcast ☐	Mostly overcast ☐ Total overcast ☐
PRECIPITATIONS	Present ☐	Absent ☐
SEA STATE	Calm ☐ Small waves (max. 0,5 m) ☐ Medium waves (0,5-1,00 m) ☐	Large waves (1-3 m) ☐ Very large (above 3 m) and violent waves ☐
WATER COLOUR	Green ☐	Reddish ☐
	Blue ☐	Whitish ☐
WATER SMELL	Chemical ☐	Fetid ☐
	Hydrocarbons ☐	Algal ☐

3. **REMARKS**

- **Species:** **Sex:**

	M	F

☐ Code 1 – alive - in the case of identified alive dolphins at the time of observation

☐ Code 2 – recently dead - carcass is not swollen, integument is intact or almost intact

☐ Code 3 – in moderate decomposition - carcass swollen, integument disintegrates, internal organs are intact except for post-mortem depredations and in males the penis is visible

☐ Code 4 – in advanced decomposition - carcass excessively swollen, integument disintegrates, internal organs cannot be differentiated, skeleton is visible

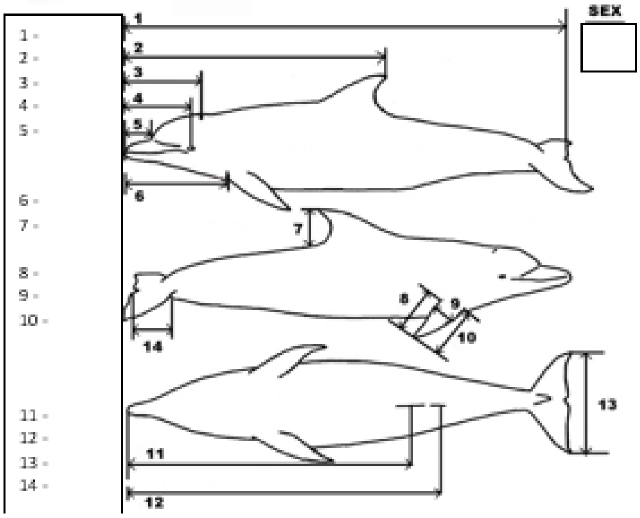
☐ Cod 5e – unidentifiable corpse - the carcass is mummified or only the skeleton can be identified

- **Photos taken:** YES ☐ NO ☐
- **Body weight (estimated in kg):**
- **Total length (in cm) - from the tip of the upper jaw to the middle of the fluke (notch):**
- **Thickness of the fat layer** (taken at the posterior insertion of the dorsal fin, in mm, if measurable):

4. **OTHER OBSERVATIONS** (which you consider relevant to the cause of death - e.g. presence of fishing net wrapped around the body, cuts, missing body parts, injuries caused by contact with a vessel, boat or cutting object used by the man, etc.):

5. BIOMETRICS (use the supplied roulette wheel and indicate in the appropriate spaces the dimensions in cm):

1. Total length
2. Distance from the tip of the upper jaw to the posterior edge of the tip of the dorsal fin
3. Distance from the tip of the upper jaw to the centre of the breathing hole (blowhole)
4. Distance from the tip of the upper jaw to the centre of the eye
5. Distance from the tip of the upper jaw to the front of the melon
6. Distance from the tip of the upper jaw to the anterior part of the base of the pectoral fin
7. Dorsal fin height
8. Posterior length of pectoral fin
9. Pectoral fin width
10. Anterior length of pectoral fin
11. Distance from the tip of the lower jaw to the centre of the genital opening
12. Distance from the tip of the lower jaw to the centre of the anal opening
13. Distance between the fluke tips



Annex 4: Fixed point method observation sheet

FIXED POINT METHOD

OBSERVATION SHEET

Observer names:		Time slot	Start:	Ending:
Date:		toponymy	Area/lot:	
			Station:	
			GPS coordinates:	
			Altitude:	
			Protected natural areas:	

Weather conditions Start		**30'**	**60'**	**90'**	**120'**	**'**	**'**	**'**
Temperature (°C)								
Water temperature								
Cloudiness (%)								
Precipitation (light rain, torrential rain, etc.)								
Visibility (1-4)								
Wind speed (m/s)								
Wind direction								
Sea state								
Reflex								

Species or vessel code: (DD) Delphinus delphis/Common dolphin; (TT) - Tursiops truncatus / Whitefish; (PP) – Phocoenaphocoena / Porpoise;
Behavior:displacement (D); displacement-submergence (DS); submergence (S);jumping, surface feeding (HS), foraging (CH), swimming in the bow of the ship (BO), socializing (SO); resting (O); following fishing boats (UP)

Human activity:motor boats (AM); yachts (Y), jetskis (J), paddle boats (fishing boats, kayaks, etc.)(P), passenger (PA), fishing vessels (PE), research vessels (VC), sailing vessels (V), ferries (F), cargo ships (C), platforms (PL), and undetermined (N).

Visibility
Code Description
1 - Very good visibility, with excellent view of the horizon
2 - Good visibility, but the horizon is not visible. It is still good for observations.
3 - Poor visibility, acceptable for observations. Minimum visibility of 500 m.
4 - Very low visibility, less than 500 m.

No.	Observ ation time	*End time of observati on of cetacean or group of cetacean s	Species code	No. of individua ls	No. of chicken s	Behavior	Human activity in the vicinity of the animal(s)	Initial geographic coordinates	
								Distance (R)	Angle (C)
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									
17.									
18.									
19.									

*when the observed animal moves out of the observer's field of vision.

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