European Union Network for the Implementation and Enforcement of Environmental Law

Monitoring marine macro-fauna using ferries/large vessels as multidisciplinary research platforms: handbook.

Handbook

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Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the EU Member States, acceding and candidate countries of the European Union and EEA countries. The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal Network of European regulators and authorities concerned with the implementation and enforcement of environmental law. The Network's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation.

During the previous years IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 7th Environment Action Programme and the Recommendation on Minimum Criteria for Environmental Inspections, and more recently in the General Union Environment Action Programme to 2030 and EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil'.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation.

Information on the IMPEL Network is also available through its website at: www.impel.eu

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Executive Summary

This technical-scientific report presents the final outcome of two interconnected projects: IMPEL FLT (2020/21) and IMPEL MTT (2022/24). The goal of these projects was to harmonize the data stewardship practices of various research organizations across Europe, focusing on the study of cetaceans and other large marine vertebrates (e.g., turtles and birds). These organizations use large ships, such as ferries and cargo vessels, as research platforms for systematic data collection in various EU sea regions, including the outermost regions: the Mediterranean Sea (Western and Central Mediterranean), the Northeast Atlantic, and the Macaronesia Sea. Building upon the state of the art, which identified common needs across these organizations, the report addresses key issues, including general protocols (with data collection fact sheets included as annexes), data validation, database functionality, and the technical analyses required to ensure the effective implementation and enforcement of the European environmental legislative framework, particularly the Habitats and Birds Directives, the Marine Strategy Framework Directive (D1 and D10), and the "Waste" Directive.

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1. Introduction

Marine ecosystems are increasingly subject to the pressures derived by anthropogenic activities, such as maritime transport and traffic, intense and unsustainable fishing, pollution and the industrialisation and urbanisation of coastal areas, whose impacts on marine biodiversity are further enhanced by the unpredictable effects of climate change.

The marine macrofauna, and especially large vertebrates species such as cetaceans and marine turtles, are particularly affected by these pressures, given their generally long life-span, their high position on the trophic chain, and, for what concerns marine mammals, low fecundity and long gestation periods. Large vertebrate species play a relevant ecological role in regulating marine ecosystems and are a key target for the preservation of marine biodiversity. However, given their "elusive" nature and the intrinsic difficulties inherent to the study of highly mobile species, the conservation status of several large marine vertebrates is still poorly known, which prevents the development of well-targeted conservation actions.

For all these reasons, a large body of international and European laws and directives has been produced in the past few decades, aiming at the protection of the species and/or the marine biodiversity (e.g., CITES, 1973; Barcelona Convention, 1975; Bern Convention, 1979; Bonn Convention, 1979; Convention on Biological Diversity, 1992; Habitat Directive, 1992; ASCOBANS Agreement, 1992; ACCOBAMS Agreement, 2001; Marine Strategy Framework Directive, 2008, Marine Spatial Planning Directive, 2014). This legal framework requires, at different levels, the monitoring (e.g., of the abundance, distribution, habitat use) of priority species and of their interactions with environmental and anthropogenic parameters for conservation purposes.

Despite huge efforts have been boosted to fill information gaps, the current knowledge about many species remains somehow limited in several marine regions, especially those located in offshore areas, including in the Mediterranean Sea and the North Atlantic Ocean. This is also a consequence of the high costs involved in carrying out large-scale and long-term systematic surveys, especially in open sea areas, which limit the capacity to secure continuous funding and resources for data collection. To cope with logistic and economic constraints, several research institutions have proposed and implemented the use of platforms of observation travelling along fixed routes, such as cargo vessels or passenger ferries, for monitoring purposes. Such methodology allows carrying out research in offshore habitats at limited costs and enables long-term monitoring of wide areas with constant observation parameters, which in turn allows

investigating potential trends in patterns of occurrence and to collect fine-scale information on seasonal and inter-annual changes (MacLeod *et al,* 2009).

Since this methodology has been applied by different research groups, across several routes and platforms, there is still a need to uniform and standardise the techniques and protocol adopted, to allow a comparison of data across geographical and spatial scales. The scope of this document is to provide guidance throughout this process and be used as a reference for any researcher willing to start their own monitoring activity using large vessels as a platform of observation.

2. State of art

Fixed line surveys have been implemented across European waters to monitor cetaceans, marine turtles and other threatened marine fauna for over three decades to date. Line transect surveys from large vessels have been carried out from ferries in the Bay of Biscay and English Channel since the mid-1990s (Kiszka *et al,* 2007), in the Mediterranean Sea since the late '80s (Marini *et al,* 1997), and onboard cargo vessels in the Portuguese waters and Macaronesia archipelago since 2012 (Correia *et al,* 2015). A number of international and regional projects lay behind the organisation of monitoring and data collection along these routes, which are described in detail in the IMPEL project report *Monitoring large marine vertebrates along fixed transects from ferries and cargo vessels: a state of the art* (Campana and Vighi, 2021).

In the North Atlantic, the Biscay Dolphin Research Programme (BDRP) was established in 1995 to carry out a monthly, year-round seabird and cetacean monitoring programme in the western English Channel and eastern Bay of Biscay, using volunteer observers onboard a cruise-ferry travelling from Portsmouth (South England), to Bilbao (North Spain) (Brereton *et al,* 2001). Similarly, the Irish Whale and Dolphin Group (IWDG) has been carrying out cetacean line transect surveys on board commercial car ferries since 2001 using volunteer citizen scientists.

In 2001, the Atlantic Research Coalition (ARC) was established as a collaborative, pan-European approach to the annual monitoring of cetaceans in west European waters. At its foundation, the ARC partnership included BDRP, IWDG, and the Spanish Society for the Study and the Conservation of the Marine Fauna (AMBAR). All partners were undertaking fixed-route transect surveys onboard commercial ferries using effort-related and standardised scientific recording methods (Brereton *et al,* 2001). Since its creation, the ARC membership grew steadily: in 2010, all regular ferry surveys for cetaceans in the UK were operated by ARC, which included 12 partners from five European countries: University of Aberdeen (Scotland), AMBAR (Spain), IWDG (Ireland), Marinelife (BDRP) (UK), NORCET (Scotland), Organisation Cetacea (ORCA) (UK), PSMS (England), Rugvin Foundation (Netherlands), Sea Trust (Wales), Oceanopolis (France) and the Isles of Scilly Wildlife Trust (England) (Brereton *et al,* 2011). Subsequently, the European Cetacean Monitoring Coalition developed from ARC as a further network of European organisations that collected data onboard ferries, some of which were contributing to the Joint Cetacean Protocol (JCP). Currently, ORCA, a dolphin conservation charity founded in 2001, is the institution that, after the first stages within the ARC, gradually took the coordination role of the UK fixed line monitoring network. ORCA's Marine Mammal Survey Teams are made of three fully trained volunteers that conduct monthly scientific surveys across line-transects on board ferries and cruise ships using a

standardised survey protocol based on the distance sampling methodology. Wildlife Officers have also been employed to collect standardised data since 2014 from the open decks, across a network of ferries. ORCA regularly surveys nine regions: Arctic Waters, North Sea, English Channel, Celtic Sea, Irish Sea, Minches and West Scotland, Bay of Biscay and Iberian Coast, Wider Atlantic and the Mediterranean Sea.

In the Mediterranean Sea, the Italian Institute for Environmental Protection and Research (ISPRA) has been leading the Fixed Line Transect Mediterranean Monitoring Network (FLT MED NET) since 2007. All partners involved in the Network share the same protocol to systematically survey the vertebrate marine species listed in the Habitat Directive, including cetaceans, marine turtles and seabirds, and their main threats (such as maritime traffic and marine litter) from ferries travelling across the Mediterranean Sea. Started along the Tyrrhenian route between Civitavecchia (North to Rome) and Golfo Aranci (Sardinia), the network grew with the introduction of new transects in the Central-Western Mediterranean Sea, and currently includes over 20 scientific partners from Italy, France, Spain, Tunisia, and Greece, which are involved in the data collection and analysis, and eight collaborating ferries companies that host researchers on board and allow the collection of data from the command deck. The systematic surveys cross high seas and national waters and are undertaken with a frequency of at least three/five surveys per season and during all year round along most of the routes (Arcangeli *et al,* 2019).

In the Eastern North Atlantic, cetacean monitoring surveys have also been conducted from cargo ships by CETUS – the cetacean monitoring program in Macaronesia - since 2012. The project is led by the Interdisciplinary Centre for Marine and Environmental Research (CIIMAR - University of Porto) in collaboration with the Oceanic Observatory of Madeira, CIMA Research Foundation (Italy), and in partnership with the Transinsular cargo ship Company. Line transect routes between Continental Portugal and Madeira, Azores, Canary and Cape Verde islands, and Northwest Africa are surveyed by volunteers trained as Marine Mammal Observers to collect data on the presence of cetacean species and other pelagic megafauna, survey effort, weather conditions and marine traffic, among other variables (Correia *et al,* 2020).

Thanks to the support of IMPEL, the three latter networks (ORCA, FLT MED NET, CETUS) joined in 2020 in the FLT-Europe project, followed by the Marine Transboundary Transect (EU MTT) project (2021-2024), to create a wider network, with the aim to share their experience, protocols, and methodologies to define the common standards for monitoring and produce a standardised protocol that could be applied across all networks to produce comparable data.

3. General protocols for data collection

3.1. Methodological approach for visual monitoring along fixed sampled transects

The methodological approach is based in systematic monitoring along fixed routes, known as sampling transects. These routes are repeatedly surveyed using a predetermined range of platform types and speeds. The observation platform is a large vessel, such as a ferry or cargo ship, which allows continuous offshore monitoring usually throughout all seasons. Data on meteorological conditions, cetaceans, sea turtles, other marine macrofauna, and, additionally, maritime traffic and floating marine macro litter (FMML), are recorded by experienced Dedicated Observers, following specific protocols (see Chapter 3.6).

The main advantages of this survey methodology are:

- Sustainable, long-term monitoring program;
- Consistency over space and time;
- Repeatability and replicability all year round (also in seasons when data are scarce);
- Large geographical scale (including high sea areas);
- Simple standard common protocol;
- Multidisciplinary data collection;
- Facilitate collaborations among different organisations (research institutions, shipping companies, institutions with different missions);
- Potential for increasing awareness on sea life conservation;
- Cost-effectiveness.

3.2. Observation parameters to be considered within monitoring protocol

Before the beginning of the work, the metadata of each trip are recorded: name of the ship, height of the platform of observation (command deck), date, number and names of observers and code of the transect. According to the route and vessel company, deck height as well as mean travel speed are registered and potentially used for subsequent grouping of the surveys.

The monitoring is a multi-target and multi-taxon survey. It targets mainly cetaceans and sea turtles, but also other megafauna (i.e., rays, sharks, specific seabirds, jellyfish), human activities such as marine traffic and impacts such as the presence of FMML. The metadata also indicate if a dedicated protocol is followed for the collection of additional data (i.e., other species, sea birds, FMML).

Other observation parameters are recorded, referring to weather conditions, including: visibility, cloud coverage, glare, swell and rain. Wind speed is recorded based on the Beaufort scale: cetacean observations and opportunistic monitoring of other species are carried out only when the sea state based on the Beaufort scale is less than 4, while for FMML and sea turtles sea state must be lower than 3. ORCA network, which performs monitoring in the Atlantic, considers positive effort up to sea state ≤ 6 on the Beaufort scale.

3.3. Sampling design

3.3.1. Spatial identification of Fixed Line Transects

When planning surveys in new areas, the fixed line transects should be identified to intersect potential density gradients of the target species. This allows to monitor variability through repeated samplings. For most of the existing transects, including those used for FMML monitoring, the sampling design is typically oriented perpendicular to bathymetric gradients (coastal-offshore habitats), migratory movements (north-south, channels), or main oceanographic features (fronts, currents).

3.3.2. Frequency of survey and minimum sampling effort

The trip is scheduled in coordination with the vessel company and aligned to its schedule. The number of surveys performed for each month or season could vary for each surveyed route, according to the vessel availability, duration of the trip and general logistics. However, at least one survey per month should be ensured. Five surveys for each season are recommended for seasonal representativeness and statistical analyses, with each trip considered a statistical unit. A “season” refers to a full three-month period (e.g., summer: from the beginning of July to the end of September).
For FMML, a minimum sampling effort of 25 km^2 per season in offshore areas is considered adequate to detect seasonal variability. However, in areas of low density or during the autumn-winter seasons, the minimum sampling area should be increased to 31-40 km^2 (MEDSEALITTER Consortium, 2019).

3.4. Experience of observers

Only experienced Dedicated Observers (DOs) are involved in the surveys, to avoid potential biases due to differences in detectability. Observers can be grouped in at least three stages according to their experience: senior, experienced, in training. There is not a comprehensive method to evaluate the experience of observers, as it depends on a combination of personal characteristics, previous experience, number of surveys already carried out specifically on large vessels, and number of species already sighted in different sea/weather/monitoring conditions. So, the experience of the observer in training is established by the senior observer, who has the

responsibility to assess the progress of each observer. The observer team encompasses at least one senior observer and maximum one observer in training.
DOs are located on the command deck of the vessels, on both sides and collect data continuously. DOs rotate side each 30 minutes or 1 hour.
At least two DOs are dedicated to the standard line transect monitoring on each side of the command deck, while one observer is dedicated to implement the strip-transect protocol on one side of the ship to collect data on FMML and marine turtles. The specific protocol on sea birds can be applied only when experienced observers with specific skills are also present. In this latter case, one person is dedicated upon rotation to seabird monitoring.

3.5. Distance sampling compliant data

The distance sampling method involves estimating the distance to each target to compensate for the decreasing detection probability as distance to the target increases. The width of the strip effectively searched (i.e., the effective strip width, ESW) is estimated a posteriori, by fitting a detection function to the measures of perpendicular distances, as the detection probability decreases with increasing distance from the transect line (Buckland *et al,* 2001). This method therefore requires the assessment of the sighting angle and radial distance to the first observed animal(s). Data on radial distance are measured using tools such as a rangefinder stick, a binocular with reticle rangefinder, or a clinometer, while the angle between cetacean sighting and the bow of the observation platform is measured using a compass or a protractor/goniometer. The angle measurement must refer to the bow of the vessel and not to the position of the observer. Angle 0 should therefore only apply to animals sighted directly in front of the ship's bow. It is crucial to estimate the distance and angle of detection with the highest possible precision, avoiding rounding to the nearest 5 degrees. These two parameters then can be used to compute perpendicular distances through a detection function.
The maximum range considered for cetacean sightings varies depending on the vessel deck height. According to the distance sampling methodology, in fact, the ESW can be calculated for different platforms, with distances truncated to include only the sightings within the defined effective range for the analysis. For example, for large ferries this is approximately 2.5 km from the ship, as only large whales can be detected at a further distance (Tepsich *et al,* 2020).

3.6. Integration of protocols and data collected

3.6.1. Standard fixed line transects for biota

Data about the sightings of megafauna (i.e., cetacean, sea turtle, other spp.) are noted on the GPS and on the datasheets, or directly recorded by means of digital tools (dedicated or non-dedicated mobile data collection platforms).
During the observations of biota, recorded data include: the time, coordinates, side of sighting, observer's name, species, number of individuals, presence and number of juveniles, radial distance from the ship, angle between the detected group and the ship bow, direction of swimming, response to ship, surface behaviour, entanglement (Table 1, see Annex). Sightings are noted by one of the DO avoiding double counting of the same group of animals (e.g., large group sighted on both sides of the command deck). When sightings occur, communication between observers is due to avoid double counting. A sighting done by a crew member, observer under training or people other than DO is recorded only if confirmed by the senior DO.

Cetacean identification, group size, behaviour of individuals
The identification of the species and approximate count of individuals are the minimum information that should be collected during a sighting. Common practice is that either the same or a second researcher use binoculars or photographic cameras to confirm sightings and assess species and group size a posteriori. Where species identification cannot be confirmed, sightings are either downgraded to unidentified dolphin/whale, unidentified small/large cetaceans, or left in the unidentified category. When it is not possible to determine the exact number of individuals, a minimum and maximum number of animals are recorded, as well as the most probable number of individuals according to the observer´s perception (best estimate).
If mixed species are sighted in a single group, a single sighting is recorded on the GPS, but the information for each species is reported separately (using the same time/GPS code) in the datasheet, or other data collection tool, specifying that it is an association of species. If multiple groups of the same species are simultaneously recorded over a large area, they will be recorded as a single sighting if they are assessed to be "sub-groups" (according to the definition of group), indicating the distance/angle of sighting of the first sub-group.
Further information regarding the general behaviour of the species is collected, classified in categories, such as travelling, resting, socialising/playing, and feeding/foraging. The group composition (i.e., presence of young individuals) and the response of the animals towards the ship (i.e., indifferent, escaping or approaching) are also registered, as well as the information on the swim direction of the group (as cardinal direction) and swim speed for travelling animals.

Table 1 Type of data collected during sightings of cetaceans, marine turtles, large fishes, jellyfish and sea birds. The white cells indicate discretionary data.

	Cetaceans	Marine turtles	Large fishes	Jellyfish	Sea birds
GPS code					
Side of sighting					
Observer´s name					
Species					
Group size					
Group composition					
Linear distance from the ship					
Angle between group and the ship bow					
Surface behaviour (including the response to the vessel)					
Collision/Near or Likely collisions					
Estimated size					
Life stage					
Interaction with litter					

Marine turtles are considered a high priority, and systematic data on their presence is collected using the fixed-strip width methodology by the observer dedicated to FMML monitoring when present. The observer, positioned on the side of the command deck with the best visibility, scans by naked eye a 50 m

wide strip and records all turtles encountered within it. Information on the number of individuals, estimated size, life stage, sex, direction of swimming, response to the ship, surface behaviour and interaction with litter is collected (Table 1). The linear distance from the ship is taken when the animal is at an angle of 90° from the observer. Additionally, during cetaceans and other species surveys, any turtles sighted outside the monitoring strip are also recorded. All relevant information, as noted above, is collected in this case too: linear distance from the ship and angle between the animal and the ship bow are measured at the moment of first sighting.

Other species - Data on the large fishes (i.e., ocean, devil and swordfish, tuna, marlins, sharks, sunfishes), jellyfish and sea birds (i.e., Levantine and Scopoli's shearwater) are opportunistically collected, and their identification at the specific level is recommended but not always required.
Data regarding these species are collected using a dedicated form, which includes the same information of the cetacean data collection form (Table 1). For species usually observed in large groups (e.g., jellyfish), groups are categorised into small (<10 individuals), medium (10- 100), and large (>100). These species, except for seabirds, are also systematically recorded within the fixed-strip monitoring performed for FMML. In case of contemporary monitoring (cetaceans, other species and FMML), all marine turtles, large fishes and jellyfish recorded within the FMML monitoring are 'copied' in the general database compiled for the biota, ensuring they are included in this dataset as well.

3.6.2. Maritime traffic and Near Miss Events

Within the FLT MED NET, a sampling protocol was specifically designed, which is applied to all FLT MED NET transects, and the CETUS network, to provide real-time information on maritime traffic and investigate the relationship between vessels presence and cetacean sightings (Campana *et al,* 2015). Sampling of maritime traffic is carried out in the presence and absence of cetaceans by counting all vessels visible by eyesight around the vessel (see Annex): at the beginning and end of the survey effort, each time a cetacean sighting occurs (record in presence of cetaceans), and at approximately every hour (minimum distance of 45 minutes or 10 nm) throughout the transects when animals are not sighted (random record at approximately every hour along the transect in absence of cetaceans). To avoid replication, a minimum interval of around 15 minutes is defined between presence/random records to exclude re-sampling of the same vessels. In case of two very close consecutive cetacean sightings, information on marine traffic must be collected only if a detectable change in the composition of vessels occurred; in case of two close sightings involving one rare species (e.g., pilot, sperm or Cuvier's beaked whales, Risso's and short-beaked common dolphin), the traffic data should be primarily collected concurrently with that sighting. Under positive effort conditions, all the vessels up to the horizon are counted (about 18 km distance, calculated with onboard instruments), to include both vessels within the range of detection of cetaceans and a buffer of potential influence, given that ships can cause physical and acoustic disturbance over a large scale. Vessels are divided into close (<2 nm from the observation platform) and far (>2 nm) and classified by size as small (<5m), medium (between 5m and 20m, distinguished in: Motor, Sailing, Fishing), and big (>20m, such as cargos, tankers, passenger ships).

Particular focus is given for recording possible events of collision/near collision in order to contribute to the comprehension and the definition of mitigation measures against ship strikes (David *et al,* 2022). A "near collision" or "Near Miss Event", is considered when the cetacean is sighted at a minimum distance of 50 m in front of the bow and 25 m on the side, unaware of the approaching ship, so not taking into account species that usually show an approach behaviour (e.g., bow-riding dolphins). DOs are required to warn the ship crew about the presence of cetaceans to avoid ship strikes. During a near collision event, data are collected on the distance between the vessel and the cetacean, swim direction and speed, and its behaviour in response to the vessel, at the first sight and at the closest point of approach. A more detailed narrative of the event is also recommended to be included in the note.
Data on collision events also need to be collected concurrently with sea turtle sightings. For this species a slightly different assessment is done: a "near collision event" is considered when the animal is taken by the boat vortex but remains floating on the side, and a "likely collision event" when the animal disappears under the bow and doesn't emerge behind.

3.6.3. Fixed line Strip transects for Floating Marine Macro Litter

FMML monitoring from large vessels is based on the MEDSEALITTER/JRC approach. The monitoring is performed on a fixed-strip of 50 m width that is defined at the beginning of the effort (see Annex). Every litter item larger than 20 cm detected within the strip is recorded by a dedicated experienced observer and classified according to the Joint list categories (Fleet *et al,* 2021). Litter monitoring should be performed from the side of the navigation bridge with better visibility (i.e., lower sun glare effect) and in the vicinity of the bow to avoid the turbulence generated by the bow itself and only in optimum weather conditions (≤2 of the Beaufort scale).
The observer records the GPS coordinates, the size class, the colour, the buoyancy, the source activity, the material and the category of each item detected according to the definitions given in the JRC Guidelines (MSFD TG-ML, 2023). Details of the protocol and tools (e.g., how to measure the strip width) are provided in the MEDSEALITTER final protocol (MEDSEALITTER consortium, 2019) and in the JRC Guidelines (MSFD TG-ML, 2023).

3.6.4. Fixed line transects for Sea birds

Two species of seabirds, selected based on their priority for conservation purposes, are recorded within the general biota monitoring: the Yelkouan/Levantine shearwater (*Puffinus yelkouan*) and Scopoli's shearwater (*Calonectris diomedea*).
A specific protocol for recording all seabird species is under development based on a fixed-strip width approach and will be performed only if a dedicated observer with specific skills is on board.

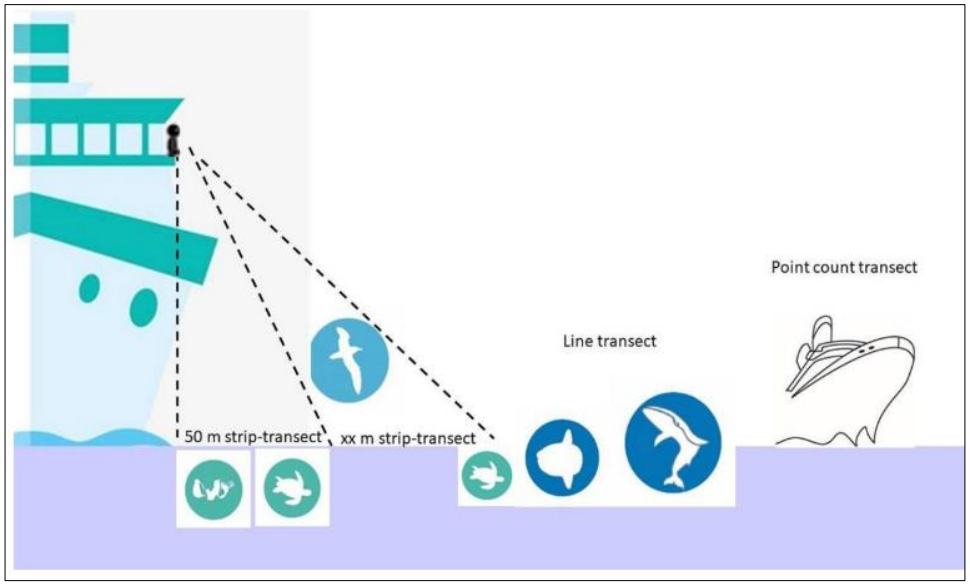

Figure 1 Implementation of different protocols for data collection from large vessels for the monitoring of cetaceans, other species, sea birds, sea turtles, marine litter, maritime traffic (from Arcangeli *et al,* 2022).

3.6.5. Commercial vessels as a lab

Water sampling from commercial vessels has been successfully implemented to collect oceanographic data in a highly cost effective manner over a wide range of time and space scales. For example, the EU FerryBox project (2003-2005) has developed and tested water quality monitoring systems on board ferries across European waters (Petersen *et al,* 2005), and it is now an integral part for the gathering of data streams together into a pan-European system for assimilating data in to the marine management cycle (https://www.ferrybox.org/).

In 2005, the French project TRANSMED installed different sensors on board ferries crossing the Mediterranean, to monitor the surface of the ocean and highlight climatological changes (https://miolaseyne.ifremer.fr/sciences/TRANSMED/update_page/index.html).

Since 2002, the OceanScope partnership has been employing a comprehensive suite of oceanographic and meteorological instruments to continually collect the ocean's vital signs from four Royal Caribbean Groups cruise ships travelling around the world (https://www.royalcaribbeangroup.com/sustainability/, Figure 2).

A multidisciplinary sampling is also carried out by the FLT MED NET based on the approach developed within the Life CONCEPTU MARIS (https://www.lifeconceptu.eu/). This includes standard visual data collection, water sampling and filtering for environmental DNA (eDNA) and isotopic analyses, and measurements of biotic/abiotic parameters by ship sensors, performed simultaneously along the same fixed route by a team of partner experts (Life Conceptu Maris Protocol, 2024).

Water samples can be collected from the vessel engine room, via a derivation pipe intercepting marine cooling water upstream of the engine using a BAG-IN-BOX Sampling system (BiBSS). Each sample consists

of 13 litres of seawater collected from each sampling site and decanted directly from the derivation pipe into sterile foil laminated plastic “Bag-in-the-Box” (BiB) containers until sample processing.
Shipping companies support data collection to gather data on marine megafauna species both visually and by eDNA/stable isotope analysis (SIA), which gives the possibility to simultaneously identify multiple taxa within a single seawater sample through the ‘metabarcoding’ technique, allows detecting the composition of the biological communities that inhabit or cross the sampled area, reconstructing food webs, and creating maps of the baseline distribution of stable isotopes (the so-called “isoscapes”). Isoscapes provide data on SI baseline values, which are needed to assess the relative trophic position of the monitored species, and their use of habitats. This information can be integrated with that obtained through the eDNA to monitor food-webs, and biotic and abiotic features (obtained through i.e., ship sensors, remote sensing and model-based data).

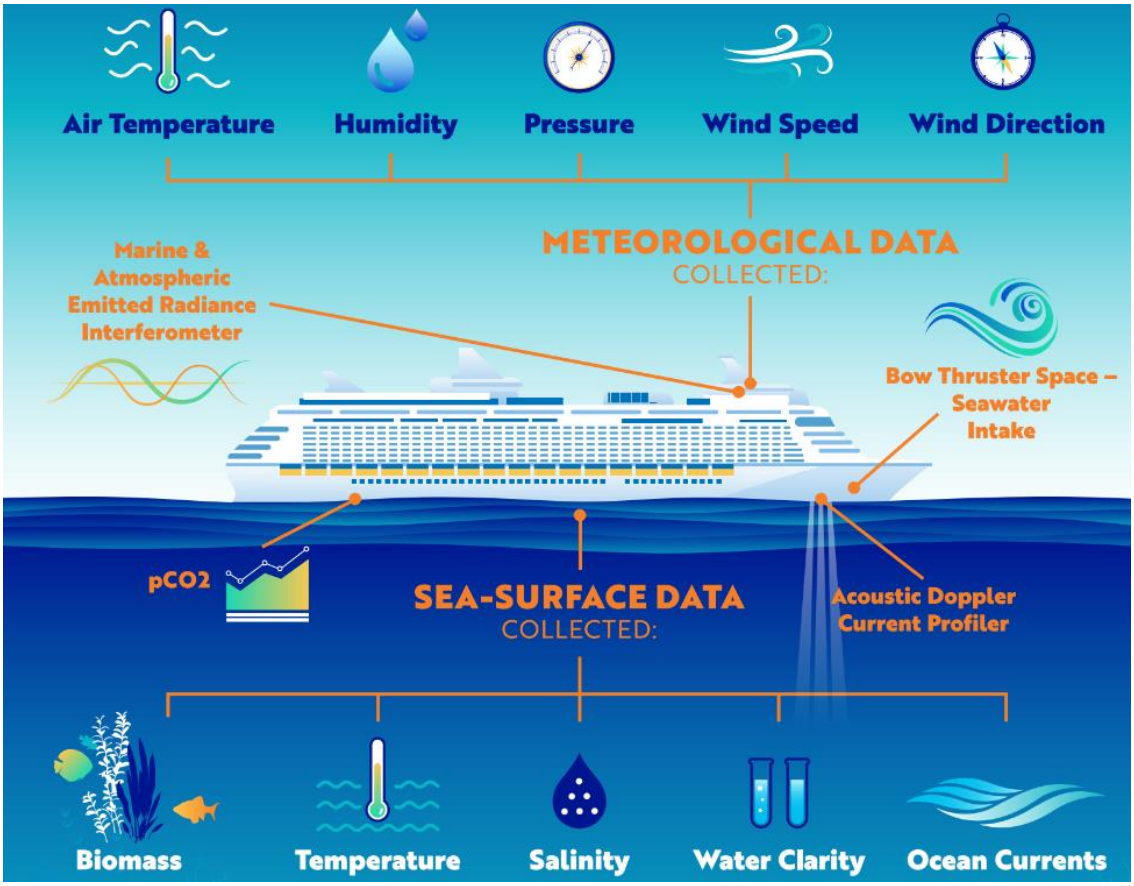

Figure 2 Schematic representation of the different oceanographic and meteorological data collected from cruise ships within the OceanScope partnership (from www.royalcaribbeangroup.com).

4. Data validation, format and storage and database interoperability

Since marine data are expensive to collect, sharing and properly organising them for scientific and management purposes can produce wide benefits. Indeed, the creation of common databases aligns with the FAIR Data Principles, which are designed to make biodiversity data Findable, Accessible, Interoperable and Reusable.

The interoperability of data is also strongly encouraged at EU level through the INSPIRE Directive (2007/2/EC). According to it, spatial data and services established and operated by EU Member States should be combined in a consistent manner, and datasets accessed via network service. The achievement of these objectives is possible through the use of common metadata and data standards, and the harmonisation of data through semantic artefacts that allow information to be integrated with other data, applications and workflows.

Despite these requirements, interoperability and semantics are still unfamiliar to many data collectors. Indeed, there is a recognised need to increase knowledge on existing standards for harmonisation and data interoperability, and the need for review, guidance, and validation protocols of the many existing metadata standards.

Within this context, the EU MTT project partners have been working to overcome the differences in protocols and data formats, to harmonise their data, and to obtain interoperable and high-quality information. In this perspective, the implementation of a common training programme among the researchers belonging to the different partner institutions will be useful to guarantee that all involved institutions operate in a consistent way, both in data collection and management, as they are already cooperating to reach interoperability of their databases and also share their datasets into international common repositories (e.g., Correia *et al,* 2019).

Many data repositories related to biodiversity/marine species exist at global, European and regional level, which are characterised by different levels of information required, access possibilities and functioning. The specific requirements of each repository, standards used, and information on how it is possible to contribute to them is described in detail in the project report *Data validation, format, and storage, and database interoperability* (Arcangeli *et al,* 2023a). The document also reports similarities and connections among these databases and their links with the international legislative framework, with the aim to provide a useful tool for the network partners to improve the integration of the data collected within their monitoring activities in these common repositories.

Indeed, within the EU MTT network the same operational, meteorological and species/target-related parameters are taken into account in the effort to pursue a higher level of standardisation of data collection, and verifications and validations of data are performed at multiple stages during their processing to prevent data discrepancies; the adjustment of the final dataset, including the digitalisation of the data to excel files, within the MySQL database, in ArcGIS and in R, is carried out while and after structuring the final dataset.

The standardisation of data collection forms, including the use of the same fields and codes for data categorisation, and the development of a common data recording tool (AtSea on ODK open-source mobile data collection platform), is the result of the common desire of the involved partners to overcome the slight differences in the protocols and data formats and categorisation, and improve data standards. This allows the data from the network to be joined together for the purpose of large scale or regional analyses. In addition, a dedicated SQL-based database with a Web-GIS user-friendly interface was specifically designed within the Life CONCEPTU MARIS to gather all data from the Mediterranean partnership (i.e., FLT MED NET). The infrastructure is hosted in the National Network of Biodiversity (ISPRA, https://www.nnb.isprambiente.it) and currently stores all data from 2007 to 2023. This Geodatabase is an example of best practice of data harmonisation, being INSPIRE compliant, allowing database search and data extraction among the partners, but also interoperability with other GIS-based platforms and external databases (Di Stefano *et al,* 2023).

The EU MTT project provides a good example of a network of research institutes and non-profit organisations working to harmonise their protocols and databases in order to obtain comparable and valuable data, also with the aim to jointly contribute to the legal requirements of the EU biodiversity monitoring.

5. Data analysis to fill the requirements of the EU regulative environmental framework

As previously mentioned, a large framework of environmental legislation that operates at international, European, and regional level for the protection of the species and/or marine biodiversity requires the monitoring of the status of the species and of their interactions with environmental and anthropogenic parameters for conservation purposes.

Large-scale collaborative efforts are needed to respond to these legislation requirements and effectively protect large marine vertebrates, such as cetaceans and sea turtles, that move across national boundaries and whose ranges often extend beyond national waters. Indeed, to overcome these limitations, the recent policies for the protection of marine ecosystems have directed their efforts through area-based management measures, across national jurisdictions.

A list of the main legislative framework at international, European and regional level addressing the monitoring and conservation of large marine vertebrates can be found in the project report *Data analysis to fill the requirements of the EU regulative environmental framework* (Campana *et al,* 2024), where also specific policy requirements such as parameters and criteria needed by each EU Directive are explained in detail.

Thus, systematic data collected from large vessels along fixed routes, such as those obtained within the EU MTT project, are not only useful to monitor highly mobile marine species, but also to address the main requirements of European policies such as the Habitat Directive (HD), the Marine Strategy Framework Directive (MSFD) and the Maritime Spatial Planning (MSP) Directive, and produce the data needed to feed them. The most important and common parameters relevant to large marine vertebrates (i.e., Population, Range, Habitat) can in fact be assessed using the data obtained from such a large-scale and long-term monitoring project. Despite the differences in resolution and indicators applied by the various policies, the population size, distributional range, and habitat for the species can be deeply investigated using the robust information obtained from the long-term monitoring programmes involved in the EU MTT project. As well, long-term data series can be used to investigate relative trends of those parameters over time (e.g., Arcangeli *et al,* 2013, 2016, 2021, 2023b; Tepsich *et al,* 2020).

In terms of the types of analyses and indicators that can be specifically addressed through these data, the Encounter Rate (ER) and/or the Sightings per Unit of Effort (SPUE) are used as indices of abundance for the taxa/single species (e.g., Kiszka *et al,* 2007; Correia *et al,* 2015; Arcangeli *et al,* 2017; Di Méglio *et al,* 2018; Robbins *et al,* 2022), and represent the number of presences recorded

during the observation effort. Specific Occurrence Indices (proportions of the total ER) can be calculated by dividing the ER relative to each sub-region by the overall ER calculated for the entire study area at the same temporal scale (yearly/monthly). The species density is computed as the number of animals/sightings over the surveyed area (e.g., ESW, grid cells; Tepsich *et al,* 2020; Arcangeli *et al,* 2021; David *et al,* 2022). Changes in population abundance can be evaluated by considering the variations of both indicators, ER and density, between periods, such as the 6-years slots considered by the HD and by the MSFD (e.g., Tepsich *et al,* 2020; Arcangeli *et al,* 2021, 2023b). The spatial presence of a species population can be reported by mapping the distribution of sightings, i.e., their occurrence, over the studied area. Distribution is analysed as the number grid cells with sightings within the surveyed cells: the binary presence-absence of the sighting (i.e., occupancy) is computed only for cells covered by effort (MacLeod *et al,* 2009). When considering species groups or different taxa, the distribution of species richness can be an important tool to identify biodiversity hotspots, and propose marine conservation measures, such as Important Marine Mammal Areas (e.g., Arcangeli *et al,* 2017; Campana *et al,* 2022). Sighting counts can be converted to density for mapping purposes by dividing the number of sightings by the area of each cell. Data of wide-ranging marine species may be limited to just a set of presence values or extrapolated distribution. Finally, to analyse the habitat used by the species, which can be variable according to seasons or life stage, the mean values of the environmental variables (topographic and oceanographic) of the monitored tracks/cells with and without sightings can be compared and/or included in Species Distribution Models (e.g., Arcangeli *et al,* 2014, 2017, 2023b; Correia *et al,* 2020; Grossi *et al,* 2021; Campana *et al,* 2022; Robbins *et al,* 2022).

Additionally, data on potential threats (i.e., maritime traffic, pollution by marine litter) collected by the networks involved in the EU MTT project can be also analysed with respect to the EU legislative framework (e.g., MSP, MSFD) in order to identify priority conservation areas and seasons, and support effective mitigation actions (e.g., Correia *et al,* 2021; Gregorietti *et al,* 2021; Grossi *et al,* 2021; David *et al,* 2022; Scuderi *et al,* 2024).

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Annex

Practical guidelines for monitoring protocols

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STANDARD PROTOCOL FOR MARINE MEGAFAUNA MONITORING FROM LARGE VESSEL
Objectives To assess spatial distribution, abundance/density and habitat use of megafauna species at large scale.
Platform characteristics Large vessels (ferries, cargos, oceanographic vessels, etc.) with a deck height up to 30 m, and maximum speed up to 27 knots.
Staff required 3 dedicated observers with at least 1 experienced observer to coordinate the activity and data collection, flanked by other adequately trained people and volunteers/citizens.
Tools required - **To record the information of the transect and observations** A GPS is needed to record the transect track and mark the position of all sighted animals; their characteristics are recorded using either paper data collection sheets or a dedicated APP. - **To detect and identify the targets** The targets are usually detected by the naked eye and identified with the support of binoculars (7x50 magnification) and species identification sheets. The use of photographic cameras can be useful to confirm sightings. Where species identification cannot be confirmed, sightings are either downgraded to unidentified dolphin/whale, unidentified small/large cetacean, unidentified turtle, etc. - **To measure distance and angle of sightings** The distance of the target from the observers can be measured with a clinometer or with a rangefinder or measuring stick. The angle of the sightings can be defined with a compass or goniometer.
Position of the observers According to the type of ship and the visibility on the deck, observers should perform the monitoring from the highest accessible point, which is usually the command deck on both sides, with shifts each 60/90 minutes, in particular when monitoring is performed in the open air.
Observation area Observers should survey a 130° arc ahead of the ship on both sides. The line transect method is applied: this can provide an index of abundance expressed as sightings/unit of effort (linear distance monitored); alternatively, by recording the distance and angle of detection for all species, distance sampling analysis can be performed, allowing the calculation of species density, expressed as number sightings/monitored area.
Measurement of distance and angle of the target For each sighting, the distance from the ship at the first sight can be measured with different tools: a clinometer provides an angle which is converted to the actual distance using a conversion table; a stick range finder provides a measure that is based on the height and arm length of the observer, then converted to the actual distance using a standard calculation. The angle of the sighing must refer to the bow of the vessel and not to the position of the observer, and is measured with a compass or goniometer (to be noted: angle 0 should refer to animals sighted directly in front of the bow).
Duration/Timing of observation Marine megafauna monitoring should be performed constantly for the whole duration of the transect, when the sea state on the Beaufort scale is equal or less than 3. Observers should rotate positions every 60-90 minutes, in particular when monitoring is performed in the open air.

Weather conditions

Observation is performed with ≤ 3 of Beaufort scale and good visibility. The weather parameters potentially influencing the observations are recorded:

- **Wind (Beaufort scale)** Less or equal than 3.
- **Sea State (Douglas scale)** Less or equal than 3.
- **Wind direction** Indicate the cardinal direction.
- **Visibility** Indicate if scarce, mean, good or optimus.
- **Rain** Indicate if absent, mist, fine or drizzle (in this case stop the monitoring).
- **Cloud cover** Indicate as percentage or okta.
- **Sun Glare** Indicate the percentage.

Frequency of sampling/trips

The number of surveys should at least assure one survey per month. Five surveys for each season with at least one each month are required. The term "season" is intended as the entire three-month period (i.e., Summer: from the end of June to the end of September).

Implementation (data collection and recording)

The observers must prepare all the tools for setting the monitoring activity and position themselves at both sides of the ship. Once everything is ready, they should start the GPS (or APP) and take note of the starting point, metadata and other parameters related to the observation conditions (e.g., wind force, speed, etc.). For each change a waypoint should be marked on the GPS indicating the new conditions. Every time a species is detected, a waypoint should be marked on the GPS and the observer should communicate all the characteristics, as required by the data sheet (i.e., time, side, species, group size, etc.) or the mobile APP. At the end of the duration of observation, or when monitoring is stopped, parameters (time, latitude, longitude, etc.) should be recorded.

- **Metadata**

Metadata to be recorded include: Date; ID survey; ID transect; observers' names; ship's name; extra notes (type of protocols applied during the surveys, e.g., sea birds, marine litter).

- **Effort data**

The effort codification (COD Effort) includes within its name information of the route, survey number and section. Each time the survey begins and ends (also due to changes in the Beaufort sea state) is marked with BEG/END (for each new transect) or START/STOP (breaks/weather change). For each waypoint the observation conditions are recorded (route, mean speed, wind, sea state, visibility, rain, cloud cover). Observations made within a break/pause are indicated as off-effort.

- **Specific data collected for megafauna sightings**

Cetaceans:

-> State & behaviour: Travelling, Resting, Socialising/playing and Feeding/foraging.
-> Superficial behaviour: dorsal fin, blow, full leap, fluke, etc.
-> Speed-progress-Direction: fast, normal, slow, straight, zig zag, etc.
-> Minimum, Maximum, Best: exact number of animals, range or best estimate.

-> Number of juveniles
-> Response to ship: Approach, Escape, Indifferent.
-> Direct threats: Entanglement, Collision/Near miss.
-> Presence of maritime traffic: number and type of vessels (see dedicated factsheet).

Other species:

Same information as above is collected whenever possible for sea turtles, shearwaters, other marine species (seals, sharks, large fishes, jellyfish):
-> Superficial behaviour: Swimming, Resting, Breathing, Mating.
-> Minimum, Maximum, Best; species in groups (birds, jellyfish) are categorised into small (<10 individuals), medium (10- 100), and large (>100).
-> Response to ship: Escape, Indifferent.
-> Direct threats: Entanglement, Collision/Likely collision.
-> Only for sea turtles: estimated size, life stage (early juvenile, late juvenile, adult) and sex (male, unknown).

Other notes/relevant observations

- Any marine fauna that is sighted within the strip of the concurrent FMML monitoring should be also noted in the megafauna data collection sheets.
- **Be as precise as possible in the measures (distance and angles) and avoid rounding!**

STANDARD PROTOCOL FOR MARITIME TRAFFIC MONITORING FROM LARGE VESSEL
Objectives To provide real-time information on distribution, abundance and characteristics of maritime traffic and investigate the relationship between vessels presence and marine megafauna sightings.
Platform characteristics Large vessels (ferries, cargos, oceanographic vessels, etc.) with a deck height up to 30 m, and maximum speed up to 27 knots.
Staff required 2 dedicated observers with at least 1 experienced observer to coordinate the activity and data collection.
Tools required - **To detect and identify the targets** Vessels are detected combining naked eye and binoculars (7x50 magnification); counted and classified by their size in small (S<5m); medium (5m<M<20m); and large (L>20m) (to be noted: medium size vessels are also categorised in motor/sailing/fishing). - **To measure distance** All the vessels up to the horizon are counted. Vessels' data are collected inside and outside the range of the 2 nm. The 2 nm border could be estimated visually, by reticle binoculars and with the support of the nautical equipment of the bridge (e.g., ship's radar system). The distance of observers-megafauna can be estimated at the first sight in case of events of collision, near or likely collision with a clinometer or rangefinder or measuring stick. - **To record the information of the transect and observation** A GPS is needed to record the transect track and mark the position of all maritime traffic scans; the characteristics are recorded using either paper data collection sheets, or a dedicated APP.
Position of the observers According to the type of ship and the visibility on the deck, observers should perform the monitoring from the highest accessible point, which is usually the command deck on both sides, with shifts each 60/90 minutes, in particular when monitoring is performed in the open air.
Observation area Observers should survey 360° around the vessel.
Measurement (distance to the target) The systematic scan sampling includes all visible vessels from the observer point. Maritime traffic data (i.e., count and classification of the vessels) are collected separating vessels inside and outside of the range of 2 nm.
Duration/Timing of observation Observations should be performed constantly for the whole duration of the transect, when the sea state on the Beaufort scale is equal or less than 3. Maritime traffic scan is taken each time a cetacean is sighted (i.e., presence data) and a regular random scan is also undertaken at beginning and at the end of the survey, and in the absence of cetaceans sightings each 45/60 minutes or each 10 nm (to be noted: to keep at least 15 min interval between maritime traffic scans). Observers should rotate every 60-90 minutes, in particular when monitoring is performed in the open air.

Weather conditions

Observation is performed with ≤ 3 of Beaufort scale and good visibility. The weather parameters considered are:

- **Wind (Beaufort scale)** Less or equal than 3.
- **Sea State (Douglas scale)** Less or equal than 3.
- **Visibility** Not relevant (unless very low).
- **Rain** Not relevant.
- **Cloud cover** Not relevant.
- **Sun Glare** Not relevant.

Frequency of sampling/trips

The number of surveys should at least assure one survey per month. Five surveys for each season with at least one each month are required. The term "season" is intended as the entire three-month period (i.e., Summer: from the end of June to the end of September).

Implementation (data collection and recording)

The observers must prepare all the tools for setting and maintaining the position during the survey. Once everything is ready, they should start the GPS (or APP) and take note of the starting point, metadata and other parameters related to the observation conditions (e.g., wind force, speed, etc.). For each maritime traffic scan a waypoint should be marked on the GPS and the maritime traffic sheet should be filled. As well, each time a cetacean species is sighted, the maritime traffic data sheet should be filled (i.e., presence data). At the end of the survey, or when monitoring is stopped, parameters (e.g., time, latitude, longitude, weather conditions, etc.) should be recorded.

- **Metadata**

Metadata to be recorded include: Date; ID survey; ID transect; observers' names; ship's name; extra notes (type of protocols applied during the surveys, e.g., sea birds, marine litter).

- **Effort data**

The effort code (COD Effort) includes within its name information of the route, survey number and section. Each time the survey begins and ends (also due to changes in the Beaufort sea state) is marked with BEG/END (for each new transect) or START/STOP (i.e., breaks, weather changes). For each waypoint the observation conditions are recorded (route, mean speed, wind, sea state, visibility, rain, cloud cover). Observations are made only during the on-effort period.

- **Specific data collected**

Presence/Absence -> Maritime traffic data are collected in the presence or absence of cetacean sightings.

Distance from the observers -> Maritime traffic data are recorded splitting the vessels detected around the platform inside and outside a 2 nm range.

Size -> All vessels bigger than 5 m are counted and classified in small (S<5m); medium (5m<M<20m); and large (L>20m).

Type -> All vessels are classified into those that are motoring, sailing, or fishing. A sailing boat with lowered sails must be considered a motorboat.

Collision/ Near or likely collision -> Events are recorded on the marine megafauna data collection sheet:

Collision is a vessel strike between a vessel and a megafauna individual; Near collision is when megafauna is sighted at a minimum distance of 50 m in front of the bow and 25 m on the side, unaware of the approaching ship. The animal is taken by the boat vortex but remains floating on the side; Likely collision is the

same as near but when the animal disappears under the bow and doesn't emerge behind (e.g., for sea turtles).

Other notes/relevant observations

- Each time a cetacean species is sighted, maritime traffic data should be collected.
- To avoid replication, a minimum interval of around 15 minutes is defined between presence/random records to exclude re-sampling of the same vessels.
- In case of two very close consecutive cetacean sightings, information on maritime traffic must be collected only if detectable change in the composition of vessels occurred.
- In case of two close sightings involving one rarer species (e.g., pilot, sperm or Cuvier's beaked whales, Risso's and short-beaked common dolphin), the traffic data should be primarily collected concurrently with that sighting.

Maritime traffic
Naval data collection sheet

Transect CODE	Date	Ship name	Observers

GPS CODE	Cetacean **Pre**sence **Abs**ence	Time (local)	< 2 NM					> 2 NM					Ship position (only if GPS is not working)		Note
			Small	Medium			Big	Small	Medium			Big			
			< 5m	5m < X < 20m			> 20m	< 5m	5m < X < 20m			> 20m	Lat (Y)	Long (X)	
				Motor	Sailing	Fishing			Motor	Sailing	Fishing				

STANDARD PROTOCOL FOR FLOATING MARINE MACRO LITTER MONITORING FROM LARGE VESSEL
Objectives To assess spatial distribution, amount, composition, sources and pathways of FMML at large scale.
Platform characteristics Large vessels (ferries, cargos, oceanographic vessels, etc.) with a deck height up to 30 m, and maximum speed up to 27 knots in areas with low FMML density, up to 24 knots in areas of high FMML density.
Staff required 1 observer and possibly 1 data recorder for each strip. Data collection should be performed by experienced or adequately trained observers.
Tools required - **To measure distance/strip width** The strip width should be measured with a clinometer; alternatively, a range finder or measuring stick can also be used. - **To detect and identify the targets** The targets are detected by the naked eye and identified with the support of the MSFD joint master list and visual photographic catalogue of litter items. A transparent ruler can be used to measure the size of the items, which are then converted to the actual size using a conversion table. - **To record the information of the transect and observations** A GPS is needed to record the transect track and mark the position of all sighted FMML items; their characteristics are recorded using either paper data collection sheets, or a dedicated APP such as the one proposed by the EU JRC (Floating Litter Monitoring app).
Position of the observer(s) According to the type of ship and the visibility on the deck, observers should perform FMML observation from the side of the ship with the best visibility (i.e., less affected by the sun glare/reflection); if the positioning on the side is not possible, observer should monitor the strip from the front of the vessel. Observers shifts should be of maximum 60 minutes to avoid fatigue.
Observation area FMML is recorded using the strip transect method, in which density is expressed as number of items/monitored area. The formula for determining the area is the length of the transect x the width of the strip (generally 50 m). Only items falling within the strip are recorded.
Measurement (of the strip width/distance to the target) The strip width is measured before the beginning of the survey with a clinometer; it is then marked with a tape or ruler on the ship glass to keep it constantly in view during the transect and only record items within it. If monitoring is performed in the open air, the width can be marked on a pole/stick.
Duration/Timing of observation FMML monitoring should be performed continuously for the whole duration of the transect, when the sea state on the Beaufort scale is equal or less than 2. Observers should rotate every 60 minutes.
Weather conditions Observation is performed with ≤ 2 of Beaufort scale and good visibility. The weather parameters considered are:

- **Wind (Beaufort scale)** Less or equal than 2.
- **Sea State (Douglas scale)** Less or equal than 2.
- **Visibility** Not relevant (unless very low).
- **Rain** Not relevant (unless drizzle).
- **Cloud cover** Indicate as percentage or okta.
- **Sun Glare** Perform FMML monitoring on the side less affected by sun glare.

Frequency of sampling/trips

The number of surveys should at least assure one survey per month. Five surveys for each season with at least one each month are required. The term "season" is intended as the entire three-month period (i.e., Summer: from the end of June to the end of September).

Implementation (data collection and recording)

The observers must prepare all the tools for setting and maintaining the strip width and position themselves in order to see everything that passes within the strip (from the hull of the ship to the external limit of the strip). Once everything is ready, they should start the GPS (or APP) and take note of the starting point, metadata and other parameters related to the observation conditions (e.g., wind force, speed, etc.). For each change a waypoint should be marked on the GPS indicating the new conditions. Every time an item is detected within the strip, a waypoint should be marked on the GPS and the observer should communicate to the secretary all the characteristics, as required by the data sheet (i.e., category, size, colour, etc.) or the mobile APP. Each 60 minutes the observers shift, keeping the same GPS track and just inserting in the data sheet/APP the name of the new observer. At the end of the duration of observation, or when monitoring is stopped, parameters (time, latitude, longitude, etc.) should be recorded.

- **Metadata**

Metadata to be recorded include: Date; ID survey; ID transect; observers' names; ship's name; strip width (generally 50 m); mean speed; ship side (i.e., R/L/front).

- **Effort data**

The effort codification (COD Effort) includes within its name information of the route, survey number and section. Each time the survey begins and ends (also due to changes in the Beaufort sea state) is marked with BEG/END (for each new transect) or START/STOP (breaks/weather change). For each waypoint the observation conditions are recorded (mean speed, wind, sea state, cloud cover).

- **Specific data collected for FMML**

Source -> indicates if the item is surely derived from a land-based source (LAND), a sea-based source (SEA) or indeterminate.

Sector -> indicates the industry sector from which the item could proceed: Fishing related; Aquaculture; Food; Sanitary; Cosmetic; Agriculture; Clothes; Construction related; Smoking related; Recreation related; Vehicles; Hunting; Undefined.

Buoyancy -> indicates if the item is either floating or partially submerged: positive, neutral or negative.

Material -> indicates the main material of which the item is made: Artificial Polymer Materials; Glass/Ceramic; Processed wood; Metal; Textile/Clothes; Paper/Cardboard; Rubber; Chemical; FoodWaste; NaturalMatter.

General Name -> indicates the general name of the item, based on the joint masterlist provided within the MSFD guidance.

Size -> indicates the size category of the item: E=20-30; F=30-50; G>50; H>100. Only items larger than 20 cm are recorded: this broad category is assessed as

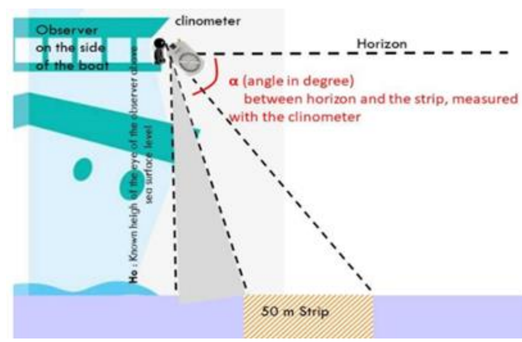
X>20 if the correct class could not be identified. **Colour** -> indicates the main colour of the item: White; Transparent; Colored; Red; Blue; Green; Grey; Yellow; Brown; Black; Pink; Orange; Other. **Object state** -> indicates if the item is Entire or a Fragment.
Other notes/relevant observations - Any item that could be associated to a FAD (Fishing Aggregation Devices) or FG (Fishing gears or other fishing related item) should be marked in a dedicated column to allow the assessment of the impact of active/discarded fishing gears to the marine fauna. Always specify if active or not! - Any marine fauna that is sighted within the strip width should also be noted (i.e., sea turtles, sunfish or other large fishes, etc.), along with relevant data such as number of individuals, behaviour, response to the ship, entanglement, collision or near collision events.

angle lu à l'inclinomètre

Hauteur d'obs.	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
13	74	67	61	56	52	49	45	43	40	38	36	34	32	31	29	28	27	26	24	23	23	22	21	20	19
14	79	72	66	61	56	52	49	46	43	41	38	36	35	33	31	30	29	27	26	25	24	23	22	22	21
15	85	77	71	65	60	56	52	49	46	44	41	39	37	35	34	32	31	29	28	27	26	25	24	23	22
16	91	82	75	69	64	60	56	52	49	46	44	42	40	38	36	34	33	31	30	29	28	27	26	25	24
17	96	87	80	74	68	63	59	56	52	49	47	44	42	40	38	36	35	33	32	31	29	28	27	26	25
18	102	93	85	78	72	67	63	59	55	52	49	47	45	42	40	39	37	35	34	32	31	30	29	28	27
19	108	98	89	82	76	71	66	62	58	55	52	49	47	45	43	41	39	37	36	34	33	32	30	29	28
20	113	103	94	87	80	75	70	65	62	58	55	52	50	47	45	43	41	39	38	36	35	33	32	31	30
21	119	108	99	91	84	78	73	69	65	61	58	55	52	49	47	45	43	41	39	38	36	35	34	32	31
22	125	113	104	95	88	82	77	72	68	64	60	57	54	52	49	47	45	43	41	40	38	37	35	34	33
23	130	118	108	100	92	86	80	75	71	67	63	60	57	54	52	49	47	45	43	41	40	38	37	35	34
24	136	123	113	104	96	90	84	79	74	70	66	63	59	57	54	51	49	47	45	43	42	40	38	37	36
25	142	129	118	108	100	93	87	82	77	73	69	65	62	59	56	54	51	49	47	45	43	42	40	38	37
26	147	134	122	113	104	97	91	85	80	76	71	68	64	61	58	56	53	51	49	47	45	43	42	40	39
27	153	139	127	117	108	101	94	88	83	78	74	70	67	64	61	58	55	53	51	49	47	45	43	42	40
28	159	144	132	121	112	104	98	92	86	81	77	73	69	66	63	60	57	55	53	51	48	47	45	43	42
29	164	149	136	126	116	108	101	95	89	84	80	76	72	68	65	62	59	57	55	52	50	48	46	45	43
30	170	154	141	130	120	112	105	98	92	87	82	78	74	71	67	64	62	59	56	54	52	50	48	46	44
31	176	159	146	134	124	116	108	101	95	90	85	81	77	73	70	66	64	61	58	56	54	52	50	48	46
32	181	165	151	139	128	119	112	105	98	93	88	83	79	75	72	69	66	63	60	58	55	53	51	49	47
33	187	170	155	143	132	123	115	108	102	96	91	86	82	78	74	71	68	65	62	60	57	55	53	51	49
34	193	175	160	147	136	127	119	111	105	99	93	89	84	80	76	73	70	67	64	61	59	57	54	52	50
35	198	180	165	152	140	131	122	114	108	102	96	91	87	82	79	75	72	69	66	63	61	58	56	54	52
36	204	185	169	156	144	134	126	118	111	105	99	94	89	85	81	77	74	71	68	65	62	60	58	55	53
37	210	190	174	160	148	138	129	121	114	107	102	96	92	87	83	79	76	73	70	67	64	62	59	57	55
38	216	195	179	165	152	142	133	124	117	110	104	99	94	90	85	81	78	75	71	69	66	63	61	59	56
39	221	201	183	169	156	146	136	128	120	113	107	102	97	92	88	84	80	77	73	70	68	65	62	60	58
40	227	206	188	173	160	149	139	131	123	116	110	104	99	94	90	86	82	79	75	72	69	67	64	62	59
41	233	211	193	178	164	153	143	134	126	119	113	107	101	97	92	88	84	80	77	74	71	68	66	63	61
42	238	216	198	182	168	157	146	137	129	122	115	109	104	99	94	90	86	82	79	76	73	70	67	65	62

Hauteur d'obs.	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
13	19	18	17	17	16	15	15	14	14	13	13	13	12	12	11	11	11	10	10	9	9	9	8	8	8	8
14	20	19	19	18	17	17	16	16	15	14	14	14	13	13	12	12	11	11	11	10	10	9	9	9	8	8
15	21	21	20	19	19	18	17	17	16	16	15	14	14	14	13	13	12	12	11	11	11	10	10	9	9	9
16	23	22	21	20	20	19	18	18	17	17	16	15	15	14	14	13	13	13	12	12	11	11	10	10	10	9
17	24	23	23	22	21	20	20	19	18	18	17	16	16	15	15	14	14	13	13	12	12	11	11	11	10	10
18	26	25	24	23	22	21	21	20	19	19	18	17	17	16	16	15	15	14	14	13	13	12	12	11	11	10
19	27	26	25	24	23	23	22	21	20	20	19	18	18	17	17	16	15	15	14	14	13	13	12	12	11	11
20	29	28	27	26	25	24	23	22	21	21	20	19	19	18	17	17	16	16	15	15	14	13	13	12	12	12
21	30	29	28	27	26	25	24	23	23	22	21	20	20	19	18	18	17	16	16	15	15	14	14	13	13	12
22	31	30	29	28	27	26	25	24	24	23	22	21	21	20	19	18	18	17	17	16	15	15	14	14	13	13
23	33	32	31	29	28	27	26	26	25	24	23	22	21	21	20	19	19	18	17	17	16	16	15	14	14	13
24	34	33	32	31	30	29	28	27	26	25	24	23	22	22	21	20	19	19	18	17	17	16	16	15	14	14
25	36	34	33	32	31	30	29	28	27	26	25	24	23	23	22	21	20	20	19	18	18	17	16	16	15	14
26	37	36	35	33	32	31	30	29	28	27	26	25	24	23	23	22	21	20	20	19	18	18	17	16	16	15
27	39	37	36	35	33	32	31	30	29	28	27	26	25	24	23	23	22	21	20	20	19	18	18	17	16	16
28	40	39	37	36	35	33	32	31	30	29	28	27	26	25	24	23	23	22	21	20	20	19	18	17	17	16
29	41	40	38	37	36	35	33	32	31	30	29	28	27	26	25	24	23	23	22	21	20	20	19	18	17	17
30	43	41	40	38	37	36	35	33	32	31	30	29	28	27	26	25	24	23	23	22	21	20	19	19	18	17
31	44	43	41	40	38	37	36	34	33	32	31	30	29	28	27	26	25	24	23	23	22	21	20	19	19	18
32	46	44	42	41	40	38	37	36	34	33	32	31	30	29	28	27	26	25	24	23	22	22	21	20	19	18
33	47	45	44	42	41	39	38	37	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	21	20	19
34	49	47	45	44	42	41	39	38	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	20
35	50	48	46	45	43	42	40	39	38	36	35	34	33	32	30	29	28	27	26	25	25	24	23	22	21	20
36	51	50	48	46	44	43	41	40	39	37	36	35	34	32	31	30	29	28	27	26	25	24	23	22	22	21
37	53	51	49	47	46	44	43	41	40	38	37	36	35	33	32	31	30	29	28	27	26	25	24	23	22	21
38	54	52	50	49	47	45	44	42	41	39	38	37	35	34	33	32	31	30	29	28	27	26	25	24	23	22
39	56	54	52	50	48	46	45	43	42	40	39	38	36	35	34	33	32	30	29	28	27	26	25	24	23	23
40	57	55	53	51	49	48	46	44	43	41	40	39	37	36	35	34	32	31	30	29	28	27	26	25	24	23
41	59	56	54	52	51	49	47	46	44	42	41	40	38	37	36	34	33	32	31	30	29	28	27	26	25	24
42	60	58	56	54	52	50	48	47	45	43	42	41	39	38	37	35	34	33	32	31	29	28	27	26	25	24

Size range classes
2.5 – 5 cm
5 - 10 cm
10 – 20 cm
20 – 30 cm
30 – 50 cm
>50 cm



Joint Code	General Name	Size class of entire item	
ARTIFICIAL POLYMER			
J1	Six pack rings	E	
J3	Shopping bags	F	
J4	Small plastic bags (es. Freezer bags)	D-E	
J7-8	Plastic drink bottles (specify if 1 or 0.5L)	E-F	
J16	Jerry cans	E-F	
J18	Plastic crates, boxes, baskets	F	
J21-23	Plastic caps/lids (specify if for drinks, chemicals detergents or other)	ALL	
J27	Cigarettes butts and filters	B	
J30	Plastic crisps packets/sweets wrappers	B-C-D	
J40-41	Plastic gloves (specify if household or professional)	E	
J45	Mussel oyster nets and bags	ALL	
J49	Plastic rope (diameter > 1cm)	ALL	
J53-54	Plastic nets and pieces of net	ALL	
J57	Fix boxes – hard plastic	F	
J58	Fix boxes – foam polystyrene	F	

MARINE MACRO FLOATING LITTER DATA COLLECTION SHEET – for FERRY and other LARGE VESSEL

Date	Observer		Type of platform
Speed	Sea State	% CLOUD COVER	Vessel name

COD Effort	BEG (lat-long)	Time:
Minimum Item size class considered	END (lat-long)	Time:
Strip width	Position of observation: left / right; side / front	
Height of observer eye (deck + observer height)		
Sector(s) of measurements of marine litter's size: limits of the sector(s) in degree _____ A _____....° _____ B _____....° _____ C _____....°		
For observation on the side	Angle(s) in degree for set strip width	
For observation on the front	Width of strip at the window	Distance eye-window (m)

Cod GPS	Buoyancy	Material Level 1										Use Level 2	Most common items Level 3										Specific item & Note	Nat.		Size[1]	Color	State
For pause specify: P-cod/time ; R- cod/time	I + 0	ARTIF. POLYMER	GLASS /CERAMIC	PROC. WOOD	PAPER /CARTBOARD	METAL	CLOTHES/ TEXTILE	RUBBER	CHEMICAL	FOOD WASTE	NATURAL MATTER	AGriculture Aquaculture CLothing COnstruction Food Consume Fishieries HY pers hygiene Hunting Medical Recreational SMoking VK vehicle NN Undefined	Plastic sheets, industrial packaging	Plastic shop./carrier/grocery bags	Fish boxes - foamed polystyrene	Plastic drink bottle (>0.5 or < 0.5l ?)	Plastic food containers polystyrene	Foamed plastic packaging	Plastic jerry cans	Wooden pallets	Can sp if Food. Drink. NN	Rubber balloons	Tetrapak Sp. if Milk-Nomilk	• Specify item (then refer to the MSFD Joint-list for J code) • Changing on weather condition, speed, sea state, cloud cover, observer • Pause STOP – START P-cod/time; R-cod/time • PATCH – still insert as many items as possible and indicate a raw number of items observed • **FAD,** Windrows, **SN** Sea snot	Seaweed/m. plant	Logs/plants parts	Cm: B 2,5-5 C 5-10 D 10-20 E 20-30 F 30-50 G 50-100 H >100	Opaque Transp. Color: White Red Black BLue Green GRey Yellow Orange BRown OTher	Entire - Fragment

1 *For measuring the exact size of items from large vessels use the Practical Guide 2 or the reference items for class size reported in the protocol*

NOTE: