How can the impacts of an operating wind farm on marine mammals be assessed?

Bulletin n°4

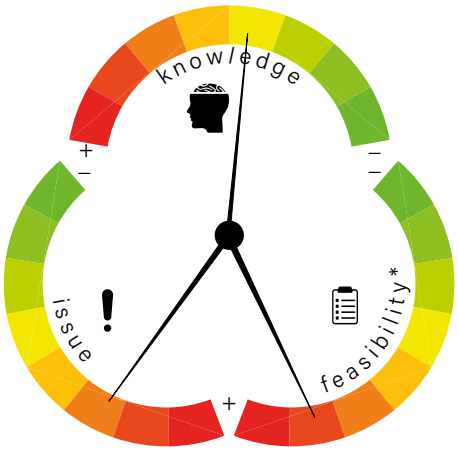
March 2022

COMET3T

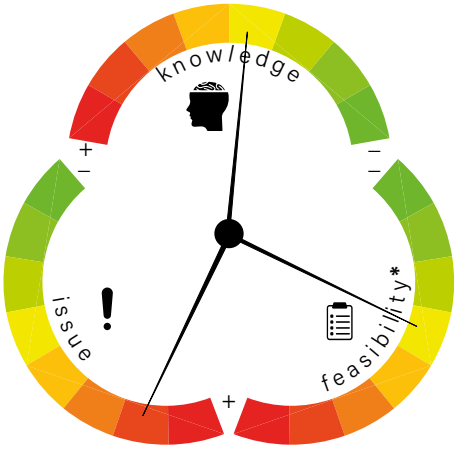
COME3T, a committee of experts for environmental issues related to offshore renewable energies, brings together neutral, independent experts to provide scientific knowledge and recommendations in response to environmental issues associated with offshore renewable energy.

The experts identified three main issues for the assessment and monitoring of the impacts of operating offshore wind farms on marine mammals:

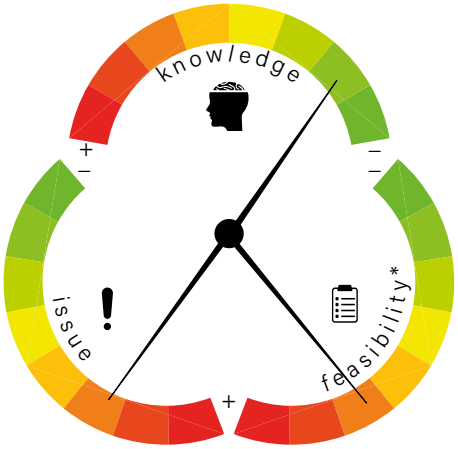
Acoustics



Habitats and resources



Disturbance[1]



*feasibility of impact assessment and monitoring with regard to existing knowledge, resources and tools

Scientific experts

Cécile Vincent - Pinniped ecology - CEBC (CNRS/La Rochelle University)

Hélène Labach - Cetology - MIRACETI

Jean-Luc Jung - Marine ecology - ISYEB (Brest University/MNHN/CNRS/Sorbonne University)

Charlotte Curé - Bioacoustics - UMRAE (CEREMA/Gustave Eiffel University)

Ludivine Martinez - Marine ecology - Cohabys (ADERA/La Rochelle University)

Coordination, compilation and drafting

Lydie Couturier - France Energies Marines

With the participation of

Cécile Bon, Karine Heerah, Sybill Henry, Maëlle Nexer and Jehanne Prevot (France Energies Marines)

[1] Anthropogenic disturbance of a species due to disruption of activities essential to its life cycle (feeding, resting, breeding).

Introduction

In France, marine mammals are heritage species which face major conservation challenges and are liable to be impacted by the installation and operation of offshore wind farms.

For this bulletin, the experts focused on the methods and monitoring implemented in order to assess the impacts of an operating offshore wind farm on marine mammals. The operational phase of an offshore wind farm can last up to 25 years and represents the majority of its life cycle. It is also the phase for which the impacts on marine mammals are least well known.

© Mickaël Buanic / Office français de la biodiversité (OFB)

Definitions

Fig. 1 *Conceptual diagram of the different terms used in this bulletin*

Anthropogenic pressure

Manifestation of human activities in the environment that may take the form of a change in status, in space or time, of the physical, chemical and/or biological characteristics of the environment[2] (for example, noise generated by marine traffic). The area of influence of this pressure is the geographical zone within which this pressure is exerted. It is dependent on the environmental compartment affected.

Effects

Objective consequences of the introduction of one or more pressures liable to generate impact on the marine living environment[2] (for example a change to the soundscape).

Impact

Transposition of an effect on the different compartments of the marine ecosystem taking into account their sensitivity[2] (here, marine mammal management units).

Cumulative impacts

Spatial and/or temporal combination of several impacts that can be cumulated as additive, antagonistic or synergistic effects on the management unit (case of noise generated by ship traffic and by wind turbines for examples).

Sensitivity

The sensitivity of a species (or management unit), defined by its capacity (or incapacity) to tolerate changes to the environment (resistance), and the time required for it to recover following these changes (resilience)[2]. The more a species is sensitive to change, the less it is tolerant/resistant. Sensitivity is dependent on the biology of the species and the extent, duration and frequency of the environmental change.

Population

Historically, populations are often defined as a group of individuals of the same species, living in the same geographical area and capable of interbreeding. Considerable caution should be taken when applying this type of definition to marine mammals. For example, individuals of the same species do not all have the same chances of interbreeding. This can give rise to the existence of groups of individuals of the same species that are more or less isolated from each other, and yet can be present in the same place.

Management unit

A group of individuals of the same species that experience the same pressure and are sufficiently isolated from other groups of this same species to require specific management.

[2] Definition taken from the work of the working group on cumulated effects under the French Ministry in charge of the environment and derived from the French order of 17 December 2012 relating to the definition of good ecological status.

How can the issues relating to anthropogenic activities be assessed?

1. Identifying the marine mammals concerned in France

The marine mammals of mainland France have several biological and ecological characteristics in common:

- They breathe air and therefore need to come up to the surface regularly;
- They are homeothermic (or warm-blooded, i.e. their body temperature must be maintained at around 37°C) and females have mammary glands to feed their young;
- They have a long life expectancy (generally several decades) and females usually only produce one offspring per gestation (they are said to be uniparous);
- They feed in the marine environment and are mainly carnivores;
- They are sensitive to sounds and all species can hear. However, their auditory sensitivity (capacity to perceive sounds ranging from high-pitched – high frequencies, to low-pitched – low frequencies) and the frequency of the sounds emitted by individuals differ from one species to another.

In France, marine mammals belong to two main distinct taxonomic groups:

Phocids (seals)

- spend on average 20% of their time on land;
- have fur;
- produce sounds mainly for communication during the breeding season (therefore seasonally);
- are very faithful to breeding sites;
- are most sensitive to disturbance during two critical periods: breeding and moulting;
- travel around at sea to move from one colony to another, hunt or breed;
- use their perception of vibrations, capacity to detect chemical molecules in water (known as chemoreception) and sight to hunt.

Cetaceans

- are purely aquatic;
- use sounds as their main method of communicating and collecting information about their environment;
- produce sounds to communicate, hunt, locate themselves and navigate;
- are sociable species which can organise themselves into communities or groups of individuals (which often vary in time and space);
- are generally very mobile and have large home ranges. Certain species migrate between different functional areas.

© Cécile Gicquel / Office français de la biodiversité

Did you know?

Cetaceans are divided into two groups

Odontocetes, which include the common dolphin and the sperm whale, are toothed whales which practice targeted hunting and use echolocation.

A common bottlenose dolphin

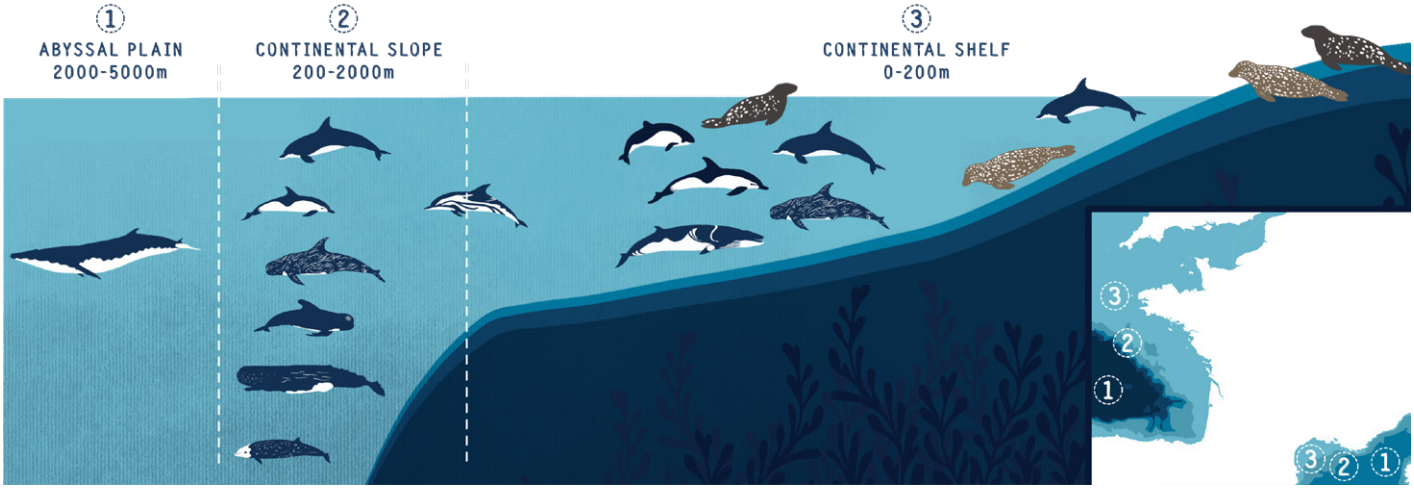
Mysticeti, such as the fin whale, are baleen whales. These species are filter-feeders and are generally migratory.

A fin whale

All the species present in the waters of mainland France are liable to interact with offshore renewable energy farms. Species that mainly use the continental shelf and slope are more likely to encounter these offshore infrastructures during their lifetime than other species (Fig. 2).

As a reminder, from a regulatory perspective, all marine mammals are protected in France. Certain species enjoy a European protection status under the Habitats Directive[3]. This is the case of the common bottlenose dolphin, the harbour porpoise, the grey seal and the harbour seal. We note that the harbour porpoise, the minke whale and the two seal species are not present in the Mediterranean.

[3] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.



© Siegrid Design

Fig. 2 ***Preferred habitats in mainland France****: all species are liable to enter an ORE farm as they move around, but species that mainly use the continental shelf and slope are more likely to than others. This diagram provides an overview of the preferred habitats of each species. However, distributions may vary from one area to another and all species are liable to be observed occasionally in other habitats.*

Fin whale
Balaenoptera physalus

Sperm whale
Physeter macrocephalus

Minke whale
Balaenoptera acutorostrata

Cuvier's beaked whale
Ziphius cavirostris

Long-finned pilot whale
Globicephala melas

Risso's dolphin
Grampus griseus

Harbour porpoise
Phocoena phocoena

Common bottlenose dolphin
Tursiops truncatus

Common dolphin
Delphinus delphis

Striped dolphin
Stenella coeruleoalba

Grey seal
Halichoerus grypus

Harbour seal
Phoca vitulina

2. Knowing the baseline

The study of the effects and impacts of an operating offshore wind farm relies on good knowledge of the baseline of the area concerned. This is why it is necessary to plan appropriate monitoring of marine mammals and to establish an appropriate baseline before construction work commences. In France, since 2018 it is the State that conducts environmental studies prior to the development of offshore wind farms at the selected sites and in their area of influence[4]. The experts provide here a number of general recommendations for establishing this baseline.

Preliminary study

- Identify the species and management units concerned;
- Define, wherever possible, the functional role of the area of interest (hunting, feeding, breeding, socialising, etc.) as well as the frequency of visits (year-round, seasonal or occasional resident);
- Characterise the auditory sensitivity of the species present;
- Characterise the social and behavioural context (identification of areas for feeding, resting, etc.) of the species present;
- Determine the use of the acoustic environment by marine mammals in the area (carry out an inventory of vocal behaviour and the sound environment, for example);
- Identify the conservation status of the management unit concerned;
- Identify and collect existing data for the area (including scientific publications, grey literature and field knowledge) in order to perform a knowledge analysis and identify possible gaps.


© Mickaël Buanic / OFB

Although marine mammals are, generally speaking, highly mobile, certain species are faithful to specific habitats (for example in the Mediterranean, the common bottlenose dolphin is mainly found on the continental shelf, whereas the fin whale prefers the waters of the abyssal plain).

The biological cycle of marine mammals is characterised by the alternation of key periods such as breeding, a temporary increase in feeding (in certain species), moulting (seals) and migration in the case of certain species.

Each of these periods of the biological cycle represents different contexts and needs and therefore potentially different habitat use patterns. The sensitivity to a given pressure, connected to the physiology of each species, can therefore generally vary according to these life periods (for instance, seals are more sensitive to disturbance on land during moulting and breeding periods). For marine mammals, the areas frequented can thus have a functional role for breeding, feeding, moulting, resting and/or socialising, but also as a migratory or transit corridor.

The monitoring frequency during the operational phase will be defined based on the baseline established and the issues identified for the species concerned.

[4] French ESSOC law of 10 August 2018 for a State serving a trusted society

Recommendations to define the spatial and temporal scale of the baseline:


© Anette Bjerg / Pixabay

- Ensure that the baseline covers the different phases of the biological cycle, the different uses of the habitat and interannual variables (with monitoring over a minimum of 2 years);
- Consider the spatial extent of the pressure exerted by the wind farm in order to ensure sufficient spatial coverage;
- Define a representative area that covers all potential pressures generated by the ORE activities and the area frequented by the management unit concerned;
- Determine the use of the areas of interest within the large home ranges identified for management units;
- Identify the anthropogenic activities that may have an impact on the management unit in another part of its home range. In this case we talk about cumulative effects:

    ▹ identify the activities with direct (collision, disturbance, etc.) and indirect (noise pollution, resource reduction, etc.) impacts on the physical, acoustic, biological and chemical environment. For instance, ship traffic can generate noise disturbance, while fisheries can cause incidental catches of small mammals;

    ▹ identify surrounding current and future, professional and/or leisure activities at sea;

    ▹ identify anthropogenic activities that could potentially be relocated;

    ▹ take into account the recurrent or more occasional movements of the management unit between the different areas studied.

3. Potential pressures of an offshore wind farm

An offshore wind farm can generate a variety of pressures which could potentially have an impact on marine mammals. The figure below (Fig. 3) illustrates the pressures associated with the operational phase of an offshore wind farm according to the type of structure (floating or fixed windfarms) and activities (helicopter flights, vessel traffic for farm maintenance, etc.). According to the selected technologies (foundation type, etc.), the pressures exerted by the offshore electric substation (which receives the power produced by the turbines and transmits it to the grid) are similar to those generated by a wind turbine with a jacket foundation[5] and its cable.

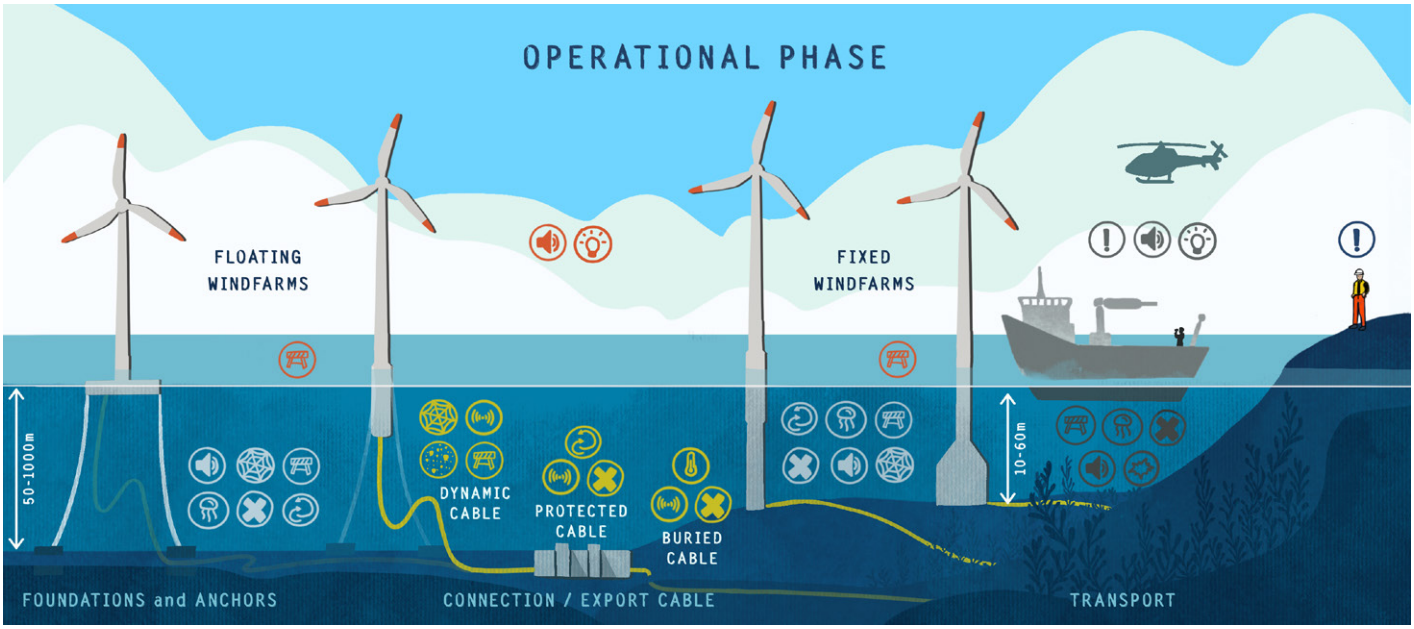


Fig. 3 *Pressures generated by the presence of an offshore wind farm (in white: subsea parts of floating and fixed windfarms; in orange: aerial and surface parts of floating and fixed windfarms; in yellow: various cables; in grey: air and vessel traffic).*

PHYSICAL PRESSURES

- Habitat loss or change
- Turbidity
- Temperature change
- Light emission
- Noise emission
- Electromagnetic field

BIOLOGICAL PRESSURES

- Collision
- Entanglement
- Obstacle to movements
- Species introduction
- Disturbance
- Pollution

[5] Steel lattice structure.

How can the impact of ORE farms on marine mammals be monitored over time?

The effects generated by the pressures described in the previous figure can have impacts on marine mammals at individual level with consequences at management unit level (Fig. 4).

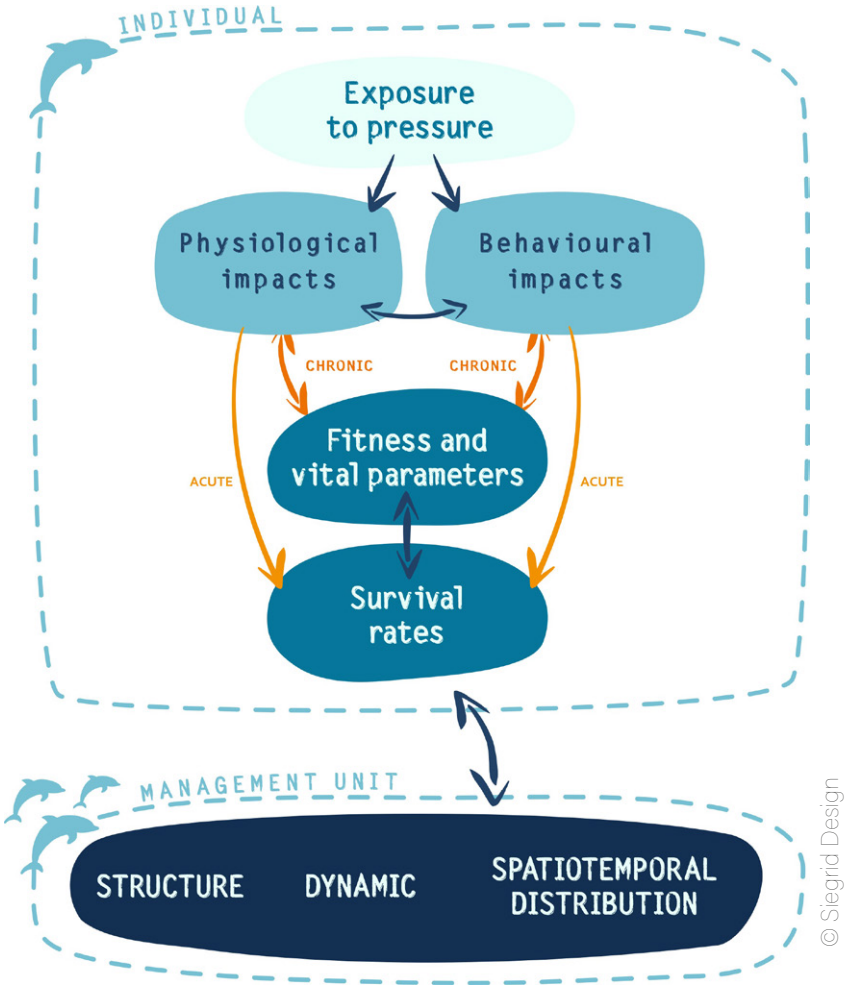


Fig. 4 *Existing relationships between pressures on individuals, impacts on marine mammals and consequences at individual and management unit levels*

The experts identified several potential impacts associated with the presence of an operating offshore wind farm at different scales, which can be assessed by different monitoring tools and methods. The figure below (Fig. 5) illustrates the different existing methods to assess and monitor these potential impacts on marine mammals.

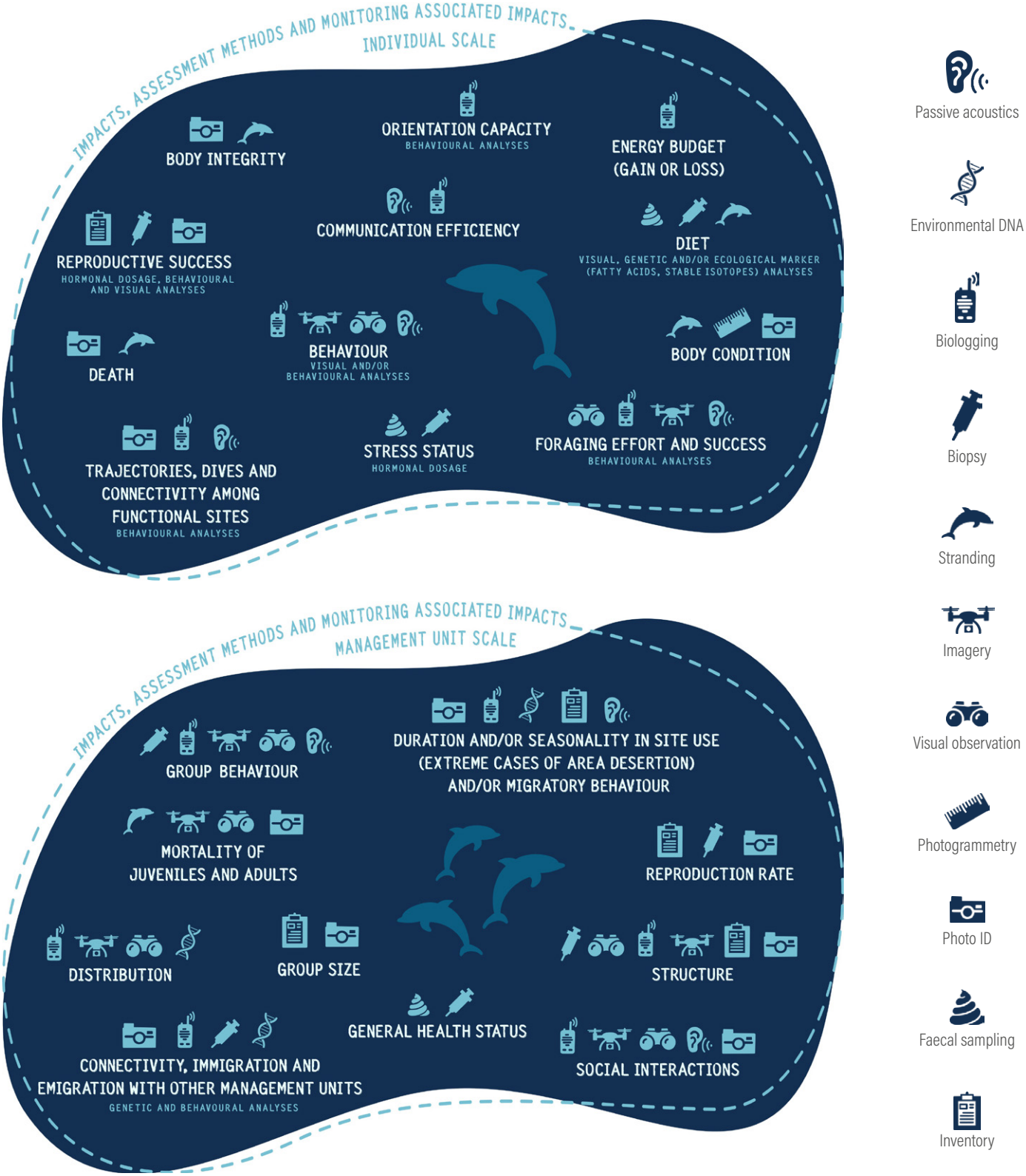


Fig. 5 *Potential impacts (text in white) of pressures on marine mammals and associated impact assessment and monitoring methods (pictograms) at individual level (top) and management unit level (bottom). The details of the analyses and studies associated with the impact assessment and monitoring methods are indicated in pale blue.*

The figure below (Fig. 6) illustrates the different existing methodologies and their application in the assessment and monitoring of marine mammals.

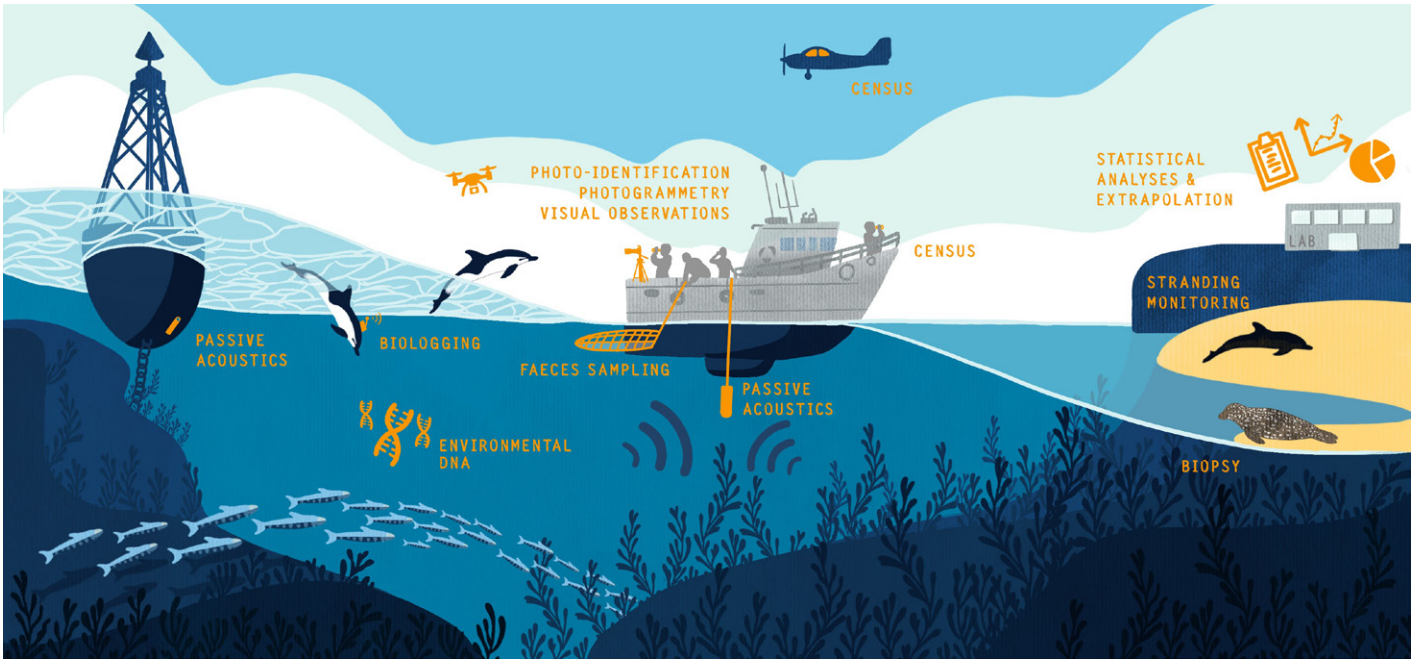


Fig. 6 *Existing methodologies used to study marine mammals*

The analysis of the general sensitivity of the management unit requires good knowledge of the status of each of the previously mentioned parameters (physical condition, breeding success, etc.) and can only be performed after analysing the dynamics of the management unit, the species distribution across all the functional sites, and the health status of each individual, based on all the monitoring methods shown in Figure 5.

Only scientific and technological aspects have been considered in the marine mammal monitoring tools and methods put forward in this bulletin. Financial aspects are not taken into consideration here. The monitoring methods deployed should take into account the different characteristics of the various species of marine mammals, of the environment and of the project. Future marine sensors and observatories envisaged within certain offshore wind farms will improve the understanding of the effects of wind farms on marine ecosystems and will be **complementary** to existing monitoring initiatives.

Description of the different methods

Photo-identification

On the basis of photos or videos taken from the coast, the sea or from aerial overflights, photo-identification aims to use visible, permanent, unique, natural markings (scars, notches, blemishes, shapes, etc.) to identify different individuals in the same management unit. It can also generally be used to determine group composition, and the movement patterns and behavioural contexts (resting, socialising, feeding, etc.) of each individual and management unit.

Photogrammetry

Comprises all the techniques designed to determine the size and physical characteristics of individuals from imagery analysis.

Biologging

A set of sensors (video cameras, hydrophones, etc.) attached to animals to monitor their geographical position, their behaviour and certain environmental parameters (temperature, salinity, etc.) over a variable time period. The data collected provides a better understanding of the animals' migratory routes and behaviour (at the surface, under water and on land).

Passive acoustics

Used to listen to and study sounds specific to an environment via a fixed sensor (e.g. a hydrophone in the marine environment). This technique can be used to study the frequency of site visits by one or more species of interest.

Biopsy

Operation that consists in extracting cells and fragments of tissue or organ. This type of monitoring can be performed on marine mammals for example to conduct genetic analyses, identify isotopic signatures, or measure hormone levels. Biopsies help to determine the health status, diet markers and genetic structure (specificity within the species, difference with other management units, kinship, etc.) of a management unit.

Statistical extrapolation

Calculations methods used to estimate an unknown value or a theoretical evolution from a concrete set of field data. These methods are used in particular to estimate the status, behaviour or evolution of a management unit from a set of individual data.

Environmental DNA

Technique for identifying species from traces of DNA present in the environment. Environmental DNA is used to conduct inventories and to estimate the genetic differences between different groups of the same species.

Inventory

Counting of individuals in a predefined area or group (population, management units, etc.). The inventory can be conducted by directly counting individuals in the field or by analysing imagery (photos, videos, etc.).

Limits and recommendations

Limits

Given the number of parameters to be taken into account and assessed to optimise the monitoring of an individual or management unit, various marine mammal monitoring methods and tools are required.

The first limit to marine mammal monitoring lies in the fact that it involves **assessing a wide range of parameters over time**.

The level of knowledge of functional sites and/or species is also very variable. The estimation of impacts is therefore difficult where data is **lacking or absent**.

The main challenge in assessing the impacts of offshore wind farms on marine mammals is estimating species sensitivity and the degree of severity of the impacts on marine mammals. This requires **an integrated, long-term approach** to all aspects of monitoring inherent to a management unit (structure, behaviour, etc.).

Recommendations

While it is difficult to put forward precise, quantified recommendations given the variability of sites and parameters to be considered, some general recommendations can be made by the experts in order to optimise the assessment of impacts on marine mammals during the operational phase of an offshore wind farm:

- Implement an integrated approach to monitoring: the sensitivity of a species or management unit can only be determined by monitoring all the parameters of the marine ecosystem;
- Implement specific, regular, long-term monitoring at a relevant scale adapted according to the characteristics of each species. A sufficiently large scale must be defined that should not be restricted to the farm area but rather should take into account species mobility;
- Implement a multidisciplinary approach involving complementary methodologies to help overcome the limitations of each of the methods taken individually;
- Take into account the evolution of cumulative impacts in the area of interest and across all the home ranges;
- Be vigilant about measures that appear to have a positive effect in the short term on the management unit. While they may seem positive over a given period, the same measures may have a negative effect in the long term:
  - ▷ This is the case for example for the artificial reef effect created by offshore wind farms. In the short term, the artificial reef effect may appear positive as it leads to a local increase in biomass which may be attractive in terms of food resources for marine mammals. However, in the long term, this artificial reef effect may cause changes in feeding behaviour and the spatial distribution of individuals, which in turn may affect the structure of the whole management unit;
- Take into consideration pre-existing pressures (vessel traffic, fisheries, etc.).

Bibliography

Brignon J.M., Lejart M., Nexer M., Michel S., Quentric A., Thiebaud L., (2021). A risk-based method to prioritize cumulative impacts assessment on marine biodiversity and research policy for offshore wind farms in France. In Environmental Science and Policy 128. 264-276Buckland, S.T., Anderson, D.R., Burnham, K.P., & Laake, J.L., (2005). Distance Sampling. In Encyclopedia of Biostatistics. John Wiley & Sons, Ltd. https://doi.org/10.1002/0470011815.b2a16019

Jung, J.-L. & Madon, B., (2019). Protection des mammifères marins face aux activités humaines et nouvelles connaissances issues des études de l'ADN, in Actes du colloque « Le transport maritime et la protection de la biodiversité », Brest, 12 & 13 December 2019. Nicolas Boillet & Betty Queffelec Eds, Edition Pedone, Paris France, In press.

Palsbøll, P.J., Bérubé, M., Allendorf, F.W., (2007). Identification of management units using population genetic data. In Trends in Ecology & Evolution, Volume 22 – Issue 1, pp11-16. https://doi.org/10.1016/j.tree.2006.09.003.

Savouré-Soubelet, A., Aulagnier, S., Haffner, P., Moutou, F., Van Canneyt, O., Charrassin, J.B., & Ridoux, V., (coord.). (2016) Atlas des mammifères sauvages de France. Vol 1 : Mammifères marins. Muséum national d'Histoire naturelle, Paris. IRD, Marseille. 480p. (Patrimoines naturels ; 74)

Würsig, B., & Jefferson, T.A., (1990). Methods of Photo-Identification for Small Cetaceans. In Report of the International Whaling Commission Special Issue. Cambridge, UK. 448p.

Please cite this document as follows:
Couturier L., Curé C., Labach H., Martinez L., Vincent C., Jung J.-L.
How can the impacts of an operating wind farm on marine mammals be assessed?
COME3T Bulletin n°04
Plouzané: France Energies Marines, 2022, 20 pages.
Published: March 2022

Legal deposit upon publication.
Layout: Ronan Rousseau - France Energies Marines
Graphic design of figures: Siegrid Design
Traduction : Alba traduction

COME3T

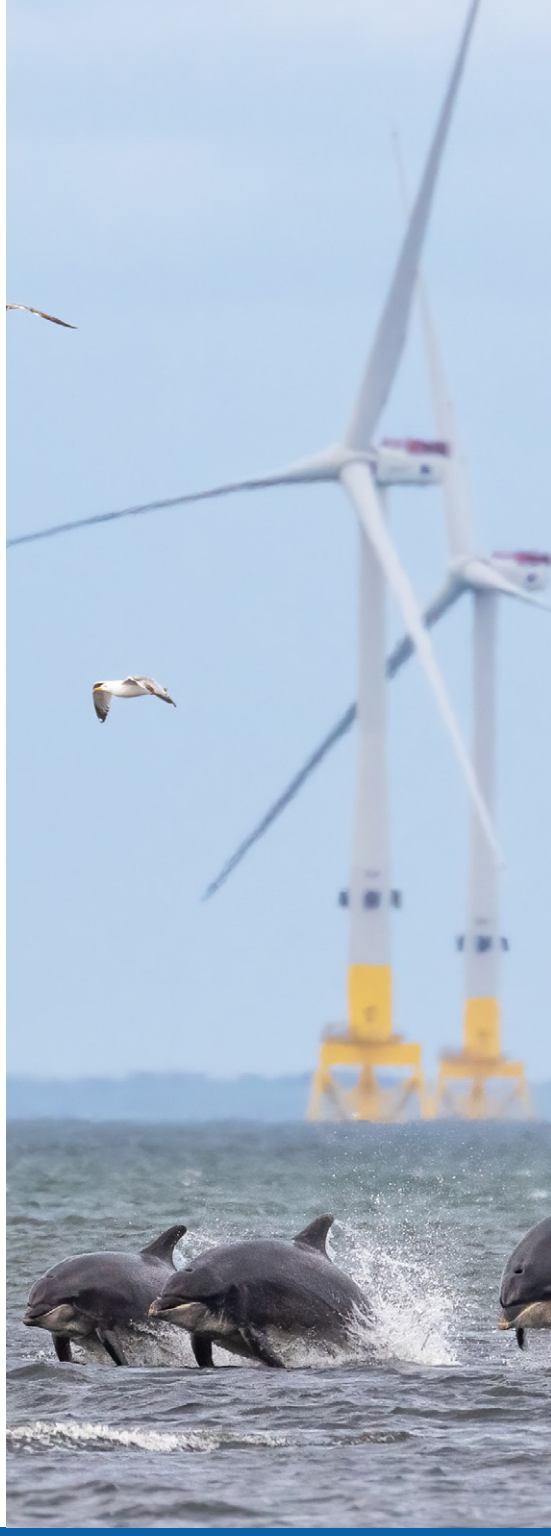
COME3T is an initiative that brings together a panel of national and regional stakeholders (universities, industrial firms, consultants, regions, State services, etc.) within a steering committee that puts forward questions, based on public concerns and key environmental issues identified by the stakeholders, to committees of neutral, independent experts. For each topic, a committee of experts is established following a call for applications and provides information, summaries and recommendations on the environmental issues associated with offshore renewable energy.

https://www.france-energies-marines.org/projets/come3t/

An initiative coordinated by France Energies Marines.

FRANCE ENERGIES MARINES

France Energies Marines is the Institute for Energy Transition dedicated to offshore renewable energies. Its missions: to define, set up and apply the scientific and technical environment required to overcome the obstacles related to the development of ORE technologies while ensuring optimal environmental integration. Built on a public-private partnership, the Institute is at the interface between institutional (local authorities, regions, etc.), academic, scientific and industrial (project developers and leaders) stakeholders.



Bâtiment Cap Océan
Technopôle Brest Iroise
525, Avenue Alexis De Rochon
29280 Plouzané, France
+33 (0)2 98 49 98 69
www.france-energies-marines.org

ISSN 2743-6942