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Gulf of Lions case study – France and Spain: Planning the offshore Gulf of Lions in regards with ecosystems

D2.4 Knowledge synthesis about ecological stakes related to seabirds, marine mammals, sea turtles and canyon deep habitats

OFB and IEO (CSIC)

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Introduction

The MSPMED case study entitled “France and Spain: Planning the offshore Gulf of Lions in regards with ecosystems” encompasses a cross-border area between France and Spain, lying from Marseille to Barcelona in its broader definition (Figure 1). It is an outstanding area concerning marine biodiversity (e.g. marine birds, marine mammals, pelagic ecosystems) and it is an important area for economic development (e.g. maritime traffic, offshore renewables). However, the Gulf of Lions still suffers from a strong lack of knowledge on species and habitats.

The **sub-task 2.2.1** of this case study aimed at providing planners with information on ecological stakes in the study area, through the mobilization of information and expertise from the two sides of the border. Carried out work was led by the Office Français de la Biodiversité (OFB).

The work described in this report was conducted in strong interactions with sub-task 2.2.2 (leading partner: OFB, in collaboration with France Energies Marines – FEM and the Instituto Español de Oceanografía – IEO (CSIC)), as the same expert groups were solicited within joint sequences of transboundary technical meetings. Sub-task 2.2.2 targeted the identification and characterization of potential interactions between marine ecosystems and activities related to windfarm development in the Gulf of Lions.

Finally, connections also appeared with sub-task 2.2.3, led by the IEO (CSIC), and consisting in the development of underwater noise propagation models, i.e. noise generated by human at-sea activities in the Gulf of Lions area coming from maritime traffic and offshore windfarms, along with the evaluation of potential impacts on cetacean populations.

This report gathers the elements collected (July 2020-January 2022) to provide a knowledge synthesis about ecological stakes relative to cetacean, sea turtle, seabird species and canyon deep habitats in the Gulf of Lions case study area (sub-task 2.2.1).

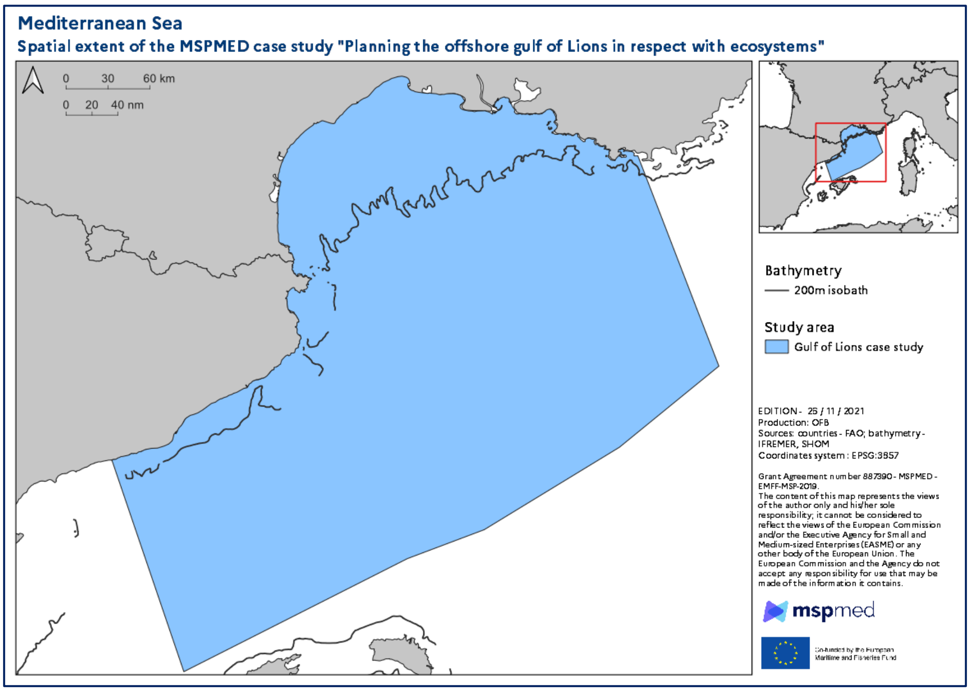

Figure 1: Spatial extent of the MSPMED case study “Planning the offshore gulf of Lions in respect with ecosystems. Credits: OFB.

Objectives of the task

In line with the importance of conducting a coordinated and coherent transboundary MSP process in Spain and France, task 2.2.1 allowed the mobilization of existing knowledge in order to provide an updated cross-border view of ecological stakes in the Gulf of Lions. For this purpose, the OFB and IEO team, in collaboration with France Énergies Marines (FEM), animated exchanges among the scientific community bringing together French and Spanish scientific experts within technical meetings. Along with this close collaboration with scientific experts, existing data, methods and results were identified in the study case area.

The process conducting to this knowledge synthesis targeted several objectives:

- boosting knowledge and methodology sharing **to complete an updated view of ecological stakes at the Gulf of Lions scale;**
- **highlighting important knowledge gaps** to be bridged, and perspectives or solutions;
- informing the way **evaluation** and **MPA designations mobilize existing knowledge,** in order to support MSP processes in Spain and France;
- encouraging **cross-border cooperation** to inform ecological stakes relative to cetaceans, sea turtles, seabirds, and canyon deep habitats.

Background: ecological components under study

While the task initially targeted cetaceans, seabirds and deep habitats in the Gulf of Lions area, it rapidly appeared that sea turtles were also an important component to address, specifically within the transboundary context of this task (valuable knowledge sharing between Spanish and French experts). Sea turtles were thus also addressed by experts during the technical meetings conducted within this task. Inversely, because very recent work from the project: *Implementation of the MSFD to the Deep Mediterranean Sea* (IDEM project[1]) had provided valuable and integrative information relatively to deep habitats (existing data, knowledge gaps, etc.), MSPMED objective was lowered on this component, finally targeting key references and metadata in order to provide a synthetic view of ecological functionalities of canyon deep habitats.

Following paragraphs briefly introduce the ecological component addressed within task 2.2.1.

Cetaceans and sea turtles (tables 1 and 2)

The Mediterranean Sea hosts an important number of sub-surface megafauna species. Eight cetacean species, included in the annexes of Habitats Directive, are common in this marine subregion. They have all been attributed a preoccupant IUCN status[2], partly due to a lack of data ("data deficient": Cuvier's beaked whale – *Ziphius cavirostris*, Long-finned pilot whale – *Globicephala melas*, Risso's dolphin – *Grampus griseus*), and partly referring to "vulnerable" (Fin whale – *Balaenoptera physalus*, Sperm whale – *Physeter macrocephalus*, Common bottlenose dolphin – *Tursiops truncatus*, Striped dolphin – *Stenella coeruleoalba*) or "endangered" (Short-beaked common dolphin – *Delphinus delphis*) species. Among the eight marine turtle species existing at the global scale, three of them are present in the Mediterranean

[1] IDEM project (2019-2021): http://www.msfd-idem.eu/

[2] IUCN 2021. The IUCN Red List of Threatened Species. Version 2021-1. https://www.iucnredlist.org. Downloaded on 26-04-2021.

Sea: the loggerhead sea turtle (*Caretta caretta*, the most frequent sea turtle species in the area), the green sea turtle (*Chelonia mydas*) and the leatherback sea turtle (*Dermochelys coriacea*). These three species are considered as vulnerable (*Caretta caretta* and *Dermochelys coriacea*) or endangered (*Chelonia* mydas) at the global scale, and even critically endangered in several oceanic sub-regions (*Dermochelys coriacea*).

Table 1: Status of cetacean species in the study case area. Credits: IEO/OFB

Common name	Scientific name	IUCN status
Cuvier's beaked whale	*Ziphius cavirostris*	Data deficient
Long-finned pilot whale	*Globicephala melas*	Data deficient
Risso's dolphin	*Grampus griseus*	Data deficient
Fin whale	*Balaenoptera physalus*	Vulnerable
Sperm whale	*Physeter macrocephalus*	Vulnerable
Common bottlenose dolphin	*Tursiops truncatus*	Vulnerable
Striped dolphin	*Stenella coeruleoalba*	Vulnerable
Short-beaked common dolphin	*Delphinus delphis*	Endangered

Table 2: Status of sea turtle species in the study case area. Credits: IEO/OFB.

Common name	Scientific name	IUCN status
Loggerhead sea turtle	*Caretta caretta*	Vulnerable
Leatherback sea turtle	*Dermochelys coriacea*	Vulnerable
Green sea turtle	*Chelonia mydas*	Endangered

All these megafauna species are known to be highly mobile, from sub-regional scale (Mediterranean basins) to regional or oceanic scale (e.g. Atlantic-Mediterranean exchanges, cross-Atlantic movements). Indeed, the Mediterranean Sea includes important areas for cetaceans such as "migratory" routes, breeding and feeding areas, e.g. in the north-western Mediterranean (Gulf of Lions, Balearic Sea). In addition, the western Mediterranean is also identified as an important foraging area for loggerhead sea turtle juveniles from both Atlantic and Mediterranean populations.

Seabirds (table 3)

The Mediterranean Sea hosts a large number of seabird species, including endemic taxa, either during all or a part of their life cycle (Rufray et al., 2015; UNEP-MAP-RAC/SPA, 2013).

Conservation status (IUCN 2021[2]) of seabird species encountered in the Gulf of Lions vary from least concern (e.g. Scopoli's shearwater - *Calonectris diomedea* (EU, GL[3]), Yelkouan shearwater - *Puffinus yelkouan* (EU), European storm-petrel - *Hydrobates pelagicus* (EU, GL), Gull-billed tern - *Gelochelidon nilotica* (EU, GL), Sandwich tern - *Thalasseus sandvicensis* (EU, GL), Common tern - *Sterna hirundo* (GL), Little tern - *Sternula albifrons* (GL), Audouin's gull - *Ichthyaetus audouinii* (EU), Black-headed gull - *Chroicocephalus ridibundus* (EU, GL), Lesser

[3] Geographic scope of the evaluation: EU=Europe, GL=Global

Black-backed gull - *Larus fuscus* (EU, GL), Mediterranean gull - *Ichthyaetus melanocephalus* (EU, GL), Yellow-legged gull - *Larus michahellis* (EU, GL), Slender-billed gull *Larus genei* (GL, EU)), to vulnerable (e.g. Black-legged kittiwake - *Rissa tridactyla* (EU, GL)) or even critically endangered (Balearic shearwater - *Puffinus mauretanicus* (EU, GL)).

Table 3: Status of seabird species in the case study area. Credits: IEO/OFB.

Common name	Scientific name	IUCN status
Scopoli's shearwater	*Calonectris diomedea*	Least concerned
Yelkouan shearwater	*Puffinus yelkouan*	Least concerned
European storm-petrel	*Hydrobates pelagicus*	Least concerned
Gull-billed tern	*Gelochelidon nilotica*	Least concerned
Sandwich tern	*Thalasseus sandvicensis*	Least concerned
Common tern	*Sterna hirundo*	Least concerned
Little tern	*Sternula albifrons*	Least concerned
Audouin's gull	*Ichthyaetus audouinii*	Least concerned
Black-headed gull	*Chroicocephalus ridibundus*	Least concerned
Lesser Black-backed gull	*Larus fuscus*	Least concerned
Mediterranean gull	*Ichthyaetus melanocephalus*	Least concerned
Yellow-legged gull	*Larus michahellis*	Least concerned
Slender-billed gull	*Larus genei*	Least concerned
Black-legged kittiwake	*Rissa tridactyla*	Vulnerable
Balearic shearwater	*Puffinus mauretanicus*	Critically endangered

Among other Mediterranean areas, the Gulf of Lions represents a hotspot of productivity and offers good conditions for foraging seabirds. However, as home ranges of many seabird populations are much larger than the Gulf of Lions continental shelf, seabirds may face numerous threats, all along their life cycle, that are rarely considered from an integrated or cumulative view.

Canyon benthic habitats

The continental slope of the Gulf of Lions is structured into a series of submarine canyons deeply incising the continental shelf.

Canyons facilitate coastal and deep waters exchanges and represent important functional areas for species of several trophic levels. Some of these canyons host vulnerable marine ecosystems (communities of Scleractinia *Desmophylum pertusum* and *Madrepora oculata*, Pennatulacea *Funicala quadrangularis*, and Alcyonacea *Isidella elongata*, Fabri et al., 2014). Some of these species are included in the Annex I of the Habitats Directive, e.g.1170 reef habitats.

Despite the exploration efforts conducted during the six last decades, canyon benthic habitats remain partly unknown. Monitoring such habitats implies significant technical and financial investments, adding difficulties to improve or update knowledge about their ecological state. The synthesis provided within this report aims at referencing key documents and information to draw a global view of existing data and identified functionalities of canyon habitats.

Content of the report

The first part of this report provides an overview of existing data types - regarding cetaceans, seabirds, sea turtles and deep habitats - pointed out in the MSPMED case study area, with a specific focus on geo-located data. Associated references (projects, scientific publications or reports, or online databases) are indicated when available.

The second part of the report particularly dedicated to knowledge gaps identified by scientific experts in respect with cetacean, sea turtle and seabird distributions and demographics in the Gulf of Lions and the Northwestern Mediterranean Sea. Perspectives to bridge those gaps are presented and discussed.

An intermediate conclusion synthesizes the way knowledge can be mobilized to inform ecological parameters. It provides a schematic view of “data-method-results” chains identified from several sources.

The third part of the report illustrates the knowledge mobilization required within evaluation or in its application to Marine Spatial Planning national processes, through specific examples discussed with experts during technical meetings.

1. From data to knowledge

1.1. Methodology

The first step of this synthesis work was to identify existing geo-located data, analysis methods and resulting parameters informing seabirds, marine mammals, sea turtles and deep habitats within the case study area. The collection of information relied upon several resources:

- Scientific literature (mainly from *Google Scholar*[4], *ResearchGate*[5] and upon personal request).
- Grey literature: technical/expertise/evaluation reports.
- Websites referencing maritime scientific surveys in French and Spanish waters (see 1.2.2. Community-based data in cetaceans, sea turtles and seabirds).
- Online databases or referenced databases (see annexe IV. Consulted data platforms).
- Direct exchanges with scientific experts during technical meetings (see 2.1. Methodology).

Those resources allowed to inform (i) metadata, (ii) methods used to analyse the identified data and (iii) final "products" of analysis, as presented below, but also (iv) data limitations and complementarity.

1.1.1. Identification of existing data

The different pieces of information that have been gathered during the dataset identification process:

- are described in Table 4 and reported in data sheets (IX. Data sheets: identified aerial and boat-based surveys in the case study area);
- correspond to location, year and type of data for canyon benthic habitats (annexe III. Identified data acquisition campaigns within canyons in the North-Western Mediterranean Sea).

All the collected spatial information (e.g. datasets, their spatial extent, or scanned maps) have been processed with QGIS 3.10.8.

[4] https://scholar.google.ch/
[5] https://www.researchgate.net/

*Table 4: Collected information about existing datasets informing seabirds, cetaceans, sea turtles and/or canyon deep habitats, in the Gulf of Lions case study area. This information appears in data sheets (*IX. Data sheets: identified aerial and boat-based surveys in the case study area*).*

Data type	The data type refers to the tool and strategy used to obtain data, e.g. observations, video, countings, acoustics, etc.
Spatial extent	The minimum convex hull of each set of geolocated data has been: • Either obtained directly from data owners upon request and/or on agreement • Or calculated from geolocated data obtained from data owners upon request and/or on agreement • Or scanned, georeferenced and calculated from publications.
Temporal extent	The temporal extent (years, and when available, months) has been deduced directly from datasets or related publications.
Protocol	The protocol used for each data acquisition is shortly described through information collected from publications.
Short description	The short description of datasets refers to data producers/institutions, the context/objectives of data acquisition, etc.
Reference	When available, the direct link to datasets or metadata is reported. If not, main references where datasets are used are reported.
Complementary information	When identified, the availability of data or the link to some publications making use of the dataset are reported.

1.1.2. Identification of analysis methods and results

The different pieces of information that have been gathered during the methods & results identification process are described in the Table 5 and reported in annexe (V. Data to knowledge: reviewed information and references).

Table 5: Collected information about commonly used methods and related results from identified datasets about seabirds, cetaceans, sea turtles and/or canyon deep habitats.

Ecological component	The ecological component refers to groups of species or habitats, e.g. cetaceans, seabirds, sea turtles or canyon deep habitats.
Data type	The data type refers to the tool and strategy used to obtain data, e.g. observations, video, countings, acoustics, etc.
Measured parameter (first analytical step)	The measured parameter stands for the primary results that can be deduced from data within a first analytical step (e.g. descriptive statistics of data).
Methods (second analytical step)	Methods refer to the analytical framework or tool used to analyse data and produce the final results.
Resulting product/parameter	The resulting product/parameter stands for the final result reported in bibliographic references that were used to inform previous elements.
References	References used to inform previous elements are reported. References were mainly selected because of the spatial scale of relative data and results, located either in the Gulf of Lions or the Western Mediterranean. When references were suggested by experts participating to technical meetings (see 2.1. Methodology) and could be reported here, they were included in the synthesis.

1.2. Overview of identified data, methods and resulting knowledge

The identification of datasets specifically targeted geo-located data and common methodologies implemented to process them. When possible, references have been chosen to provide examples of data or results located in the study area.

Other online resources (databases, metadata or referencing tools) are listed in annexe (IV. Consulted data platforms).

1.2.1. Individual-based data in cetaceans, sea turtles and seabirds

Telemetry

Table 6: Examples of telemetry datasets encompassing the case study area. Credit: OFB/IEO.

Catalogue or reference	Link to website or reference	Marine ecological components informed
Seabird Tracking Database	http://www.seabirdtracking.org/mapper/index.php	Seabirds
Movebank	https://www.movebank.org/cms/movebank-main	Megafauna
CEREMA, 2021. Etude avifaune en Méditerranée - Valorisation des données télémétriques. 79pp.	link to viewer link to report	Seabirds (and terrestrial birds)
CRAM (Centro de Recuperación de Animales Marinos)	https://cram.org	Sea turtles (*Caretta caretta, Chelonia mydas*)
CESTMed (Centre d'Etude et de Sauvegarde des Tortues marines de Méditerranée)	https://www.cestmed.org/	Sea turtles
Ifremer - SELPAL project	Link to presentation	Sea turtles
Panigada et al., 2017	https://www.nature.com/articles/s41598-017-03560-9	Fin whales (*Balaenoptera physalus*)

Bio-logging, including telemetry data (see Table 6), is used worldwide and on diverse taxa. In regards with seabirds, sea turtles and cetaceans, and depending on the technology (geo-locators and additional captors) used and the targeted spatial and temporal scales, telemetry data could inform on different types of parameters : **navigation and large-scale migration, connectivity, phenology, habitat use and functional areas, fine-scale behaviour or activity, day/night activity, flight altitude, interactions with human activities at sea, environmental parameters encountered by tracked individuals, ecophysiology, etc.** (Bentivegna, 2002; Boyd et al., 2004; Casale et al., 2013; Meier et al., 2015; Panigada et al., 2017; Péron & Grémillet, 2013; Revelles et al., 2007; Reyes-González et al., 2017; Ropert-Coudert et al., 2009, 2012).

Bio-logging intrinsically relies on the capturability/reachability of equipped individuals. This can result in, for example, (i) concentrating equipment effort on some seabird colonies, (ii) tagging breeding seabird (and few to no juveniles) in colonies, (iii) tagging by-caught sea turtles released directly at sea, (iv) tagging sea turtles from rescue centers, etc. Such sampling strategies induce a bias in acquired data that may not be considered as representative of the targeted populations (Pers. Comm. 2021).

However, with the major increase of tracking data in the last years (including the western Mediterranean, especially in seabirds) combined with methodological developments, representativeness of data can be assessed (e.g. Lascelles et al., 2016) and reached (Pers. Comm. 2021) at the population level. Regarding seabirds, telemetry data is still limited for small species because of technological limitations, while efforts are conducted to develop miniature geo-location tags (e.g. GEOBIRD[6] project). To our knowledge, very few telemetry data exists in cetaceans in western Mediterranean (but see Panigada et al., 2017).

Photo-identification

Table 7: Examples of photo-identification catalogues or sources within the study case area.

Catalogue / reference	Institution or referent organism	Link (if available)
Photo-identification within AHAB project	SUBMON	Link to website
Catalogue centralizing photo-identification data from French MPAs and associations.	MIRACETI	
INTERCET	INTERCET	Link to website
Photo-Identification Project: Whales and dolphins along the Catalan coast	Associació cetàcea	Link to website
Bottlenose Dolphin Photo-identification catalogue	Associació cetàcea	Link to website
Risso's Dolphin Photo-identification catalogue	Associació cetàcea	Link to website
Photo-identification within Proyecto Rorcual	Associació cetàcea	Link to website
Catalogue of photo-identification data from EcoOcéan Institut. Partly uploaded on Intercet platform (see above). (Sperm whale/Risso's dolphin/Bottlenose dolphin/ Fin whale)	EcoOcéan Institut	

Photographs of distinctive marks in cetacean individuals can be conducted either opportunistically or systematically, resulting in many pictures acquired over time. Long time series gathered from different sources (institutes, citizens, etc.) imply a considerable analysis effort (matching pictures of the same individual) but offer great analytical perspectives. Indeed, photo-identification of cetaceans (along with age-class determination, re-sightings, etc.) can inform diverse **behavioural parameters** such as their **displacement over marine regions, habitat use, functional areas, or even abundance** (e.g. AHAB[7] and TURSMED[8] projects, and see Table 7).

In the case of the common bottlenose dolphin (*Tursiops truncatus*), the important photo-identification effort that has been conducted in last years allowed the development of demographic models and the estimation of the species' abundance at several spatial scales (Di-Méglio et al., 2015; Gnone et al., 2011; Labach et al., 2021). A fine study of re-sightings revealed different social groups (groups of individuals found in association) in the Gulf of Lions, as well as their differential use of the area (Di-Méglio et al., 2015).

[6] https://www.france-energies-marines.org/en/projects/geobird/
[7] https://www.submon.org/en/who-is-who-photo-identifying-cetaceans-in-the-ahab-project/
[8] https://ofb.gouv.fr/actualites/tursmed-2-mieux-connaitre-le-grand-dauphin-en-mediterranee-pour-mieux-le-proteger

For sperm whales (*Physeter macrocephalus*), photo-identification has documented site-fidelity (feeding areas, Drouot-Dulau & Gannier, 2007) and large-scale movements (Carpinelli et al., 2014; Drouot-Dulau & Gannier, 2007; Rendell et al., 2014) in the western Mediterranean Sea.

Bird ringing programs

In France, capture, ringing and re-sightings data are centralised in the information system of the *Centre de Recherches sur la Biologie des Populations d'Oiseaux*[9] (CRBPO; participatory science). The CRBPO authorizes, coordinates, animates, structures, archives and analyses bird monitoring through ringing (capture-mark-recapture).

In Spain, the Migratory Species Office[10] depending on the Directorate General for Biodiversity, Forests and Desertification coordinates the ringing and monitoring of different groups of migratory species. It is in charge of distributing rings, managing the ringing data bank, and exchanging information with foreign ringing offices, all members of EURING (regulatory body for ringing in Europe[11]) – including CRBPO mentioned above.

Among numerous French and Spanish actors in (sea)bird ringing effort, one can cite the *Sociedad Española de Ornitología*[12], the *Instituto Catalán de Ornitología*[13], or the *Tour du Valat*[14] within the case study area.

Ringing data and their analysis at large scale are highly valuable to inform and quantify **demographic parameters such as dispersal, emigration, and connectivity in birds** (e.g. Cam et al., 2004; Thorup et al., 2014).

1.2.2. Community-based data in cetaceans, sea turtles and seabirds

Aerial and boat-based surveys

[9] Centre de Recherches sur la Biologie des Populations d'Oiseaux (CRBPO) - https://crbpo.mnhn.fr/
[10] Oficina de Especies Migratorias (OEM) - https://www.miteco.gob.es/es/biodiversidad/temas/inventarios-nacionales/inventario-especies-terrestres/oficina-de-especies-migratorias/default.aspx
[11] www.euring.org
[12] Sociedad Española de Ornitología (SEO/Birdlife) - www.seo.org
[13] Instituto Catalán de Ornitología (ICO) - www.ornitologia.org
[14] Tour du Valat - https://tourduvalat.org/

Table 8: Synthesis of identified aerial and bot-based surveys informing cetaceans and/or sea turtles and/or seabirds within the Gulf of Lions case study area.

Data type	Program	Institution or referent organism	Year(s)	Marine ecological components informed	Metadata in annexes
Aerial surveys	Proyecto Mediterráneo	BAS & Univ.Barcelona	2001-2002	Cetaceans	PROYECTO-MEDITERRANEO-2000-2002-MM-plane
	Provence Grand Large	EDF Renouvelables	2011-2013	Megafauna	PGL-2011-2013-MM-MT-SB-MB-BH
	PACOMM - SAMM1	Observatoire Pelagis	2011-2012	Megafauna	SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF
	EFGL / EOLMED	ENGIE / Qair	2017-2018	Megafauna	EFGL-2017-2018-MM-MT-SB-MB-BH / EOLMED-2016-2017-MM-MT-SB-MB-BH
	ACCOBAMS Survey Initiative	ACCOBAMS	2018	Megafauna	ASI-2018-PLANE-MM-MT-SB-EB-SF
	SAMM2	Observatoire Pelagis	2019	Megafauna	SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF
Boat-based surveys	TOP-HABITAT	EcoOcéan Institut	1992-Present	Megafauna	TOPHABITAT-1992-Present-MM-MT-SB
	PELMED	IFREMER, EPHE, IEO, ICM, ICRAM	1993	Megafauna	PELMED-1993-Present-MM-MT-SB
	MEDITS	IMEDEA (CSIC-UB)	1994-Present	Seabirds	MEDITS-1994-Present-SB
	PELMED	IFREMER, EPHE	1994-2010	Megafauna	PELMED-1993-Present-MM-MT-SB
	ECOMED	IEO	2003-2008	Seabirds	ECOMED-2003-2008-SB
	Proyecto Mediterráneo	BAS & Univ.Barcelona	2000-2002	Cetaceans	PROYECTO-MEDITERRANEAO-2000-2002-MM-boat
	MCV	BREACH, AAMP	2007-2010	Cetaceans	BREACH-2007-2010-MM
	MEDSEACAN	EcoOcéan Institut, AAMP	2008-2010	Megafauna	MEDSEACAN-2008-2010-MM-SB
	INDEMARES	SUBMON	2010	Cetaceans	INDEMARES-2012-MM
	INDEMARES - CREUS	CSIC	2009	Seabirds	CSIC-CREUS-2009-SB
	MEDIAS	IEO	2009-Present	Seabirds	MEDIAS-2009-Present-SB
	JUVALION	Ifremer	2007, 2009	Megafauna	JUVALION-2007-2009-MM-MT-SB
	PELMED	EcoOcéan Institut	2011	Megafauna	PELMED-1993-Present-MM-MT-SB
	Provence Grand Large	EDF Renouvelables	2011-2013	Megafauna	PGL-2011-2013-MM-MT-SB-MB-BH
	FLT Mediterranean Network	EcoOcéan Institut, AAMP/AFB/OFB	2011-Present	Megafauna	FLT-2011-Present-MM-MT-SB-SF
	PELMED	IFREMER, CEFE	2012-2015	Seabirds	PELMED-1993-Present-MM-MT-SB
	PACOMM - GDEGeM	BREACH, EcoOcean Institut, GECEM	2013-2015	Cetaceans	GDEGeM-2013-2015-MM

Data type	Program	Institution or referent organism	Year(s)	Marine ecological components informed	Metadata in annexes
	Grampus	SUBMON	2014	Cetaceans	GRAMPUS-2014-MM
	PELMED	IFREMER, CEFE	2016	Megafauna	PELMED-1993-Present-MM-MT-SB
	EOLMED	Qair	2016-2017	Megafauna	EOLMED-2016-2017-MM-MT-SB-MB-BH
	Delfines de Tramuntana	SUBMON	2017-2020	Cetaceans	DDT-2017-2020-MM
	EFGL	ENGIE	2017-2018	Megafauna	EFGL-2017-2018-MM-MT-SB-MB-BH
	PELMED	IFREMER, Observatoire Pelagis	2017-Present	Megafauna	PELMED-1993-Present-MM-MT-SB
	ACCOBAMS Survey Initiative	ACCOBAMS	2018	Megafauna	ASI-2018-BOAT-MM-MT-SB-EB-SF
	MegaObs	EcoOcéan Institut, AFB	2018	Megafauna	MEGAOBS-MM-MT-SB-EB-SF-2018-Present
	Grand dauphin en Occitanie	EcoOcéan Institut, DREAL Occitanie	2019-2020	Cetaceans	TT-OCCITANIE-2019-2020-MM-SB
	MegaObs	PNMGL/OFB	2019-2020	Megafauna	MEGAOBS-MM-MT-SB-EB-SF-2018-Present
	AHAB	SUBMON	2020	Cetaceans	AHAB-2020-MM
	TURSMED	MIRACETI, OFB	2020	Cetaceans	TURSMED-2020-2023-MM

Informing the distribution of marine megafauna at the community scale often relies upon visual data acquisition:

- at a large spatial scale, in relation with the high mobility of species (e.g. cetaceans, sea turtles and seabirds);
- in a short time, so as to ensure the compatibility of observations in the surveyed area (homogeneous weather condition, same season and year, avoidance of multiple counts of mobile individuals, etc., e.g. Forcada et al. 2004, Dorémus et al. 2020);
- within time ranges that are representative of habitat use – at sea-surface - by each species (i.e. considering seasonal variability, phenology, etc.);
- with a sufficient precision to inform observed taxa (at the group, family and when possible species levels), the number of individuals in detected groups, or even the behavior of individuals.

In that sense, many at-sea surveys (either aerial or boat-based campaigns) have been conducted following standardized protocols (see Table 8). In the Gulf of Lions, data acquisitions mainly followed a line-transect protocol with distance sampling (all observations are collected with a distance estimated between the observation and the observer, Buckland et al., 2001), while strip-transect protocol is also often used, especially for collecting seabird observations (all detected individuals within a strip of commonly 300 to 500 m from the platform are recorded).

Standardized data acquisition protocols allowed the increasing homogenization of ecological data and support many analysis, informing parameters such as **encounter rates** (number of individuals or number of observations per length unit, e.g. Laran et al., 2017), **species relative densities** (number of individuals per surface unit; e.g. (Forcada & Hammond, 1998; Laran, Pettex, et al., 2017; Lauriano et al., 2011), or allowing **habitat modelling and predicted densities** (predicted number of individuals per surface unit, in link with environmental characteristics and conditions; see e.g. Cañadas et al., 2018; Lambert et al., 2017; Laran et al., 2021).

The recording of direction, behavior and age-class of detected individuals can inform the **habitat use and functional areas** of observed species (e.g. Di-Méglio et al., 2015).

Apart from observers' ability to detect individuals (perception bias), at-sea observations have to be acquired in good detection conditions (i.e. favourable light, weather, sea state, characteristics of the observation platform, etc.). Consequently, observations do not inform the presence and distribution of cetaceans, sea turtles or seabird (i) at night, or (ii) in bad weather conditions – that can be critical to address when planning maritime activities (e.g. seabirds and offshore windfarms). Thus, knowledge about the distribution of individuals at sea is incomplete under a range of environmental and oceanographic conditions, especially if data from boat-based and aerial surveys are analysed singly, apart from other sources of complementary data. For example, visual surveys do not inform about distribution at night, neither for the migrating individuals (terrestrial birds or seabirds), nor for the seabirds foraging (e.g. Audouin's gull - *Ichthyaetus audouinii*, Scopoli's shearwater - *Calonectris diomedea*; Arcos Pros, 2001; Rufray et al., 2015). In addition, the limited sampling of some environmental/oceanographic conditions has been highlighted by Mannocci et al. (2018) from the analysis of diverse at-sea surveys in the Mediterranean Sea. Authors conclude that an additional sampling effort shall be conducted in several Mediterranean regions, such as the northern Mediterranean Sea during non-summer months (specifically, in the Gulf of Lions in April, when waters are colder than in other Mediterranean regions).

Data acquisition at sea are conditioned by the probability of encountering individuals (availability bias), which can be low for some species either rarer or whose behavior engenders a rather low presence rate at the sea surface. This is the case of deep-diving cetaceans (e.g. sperm whale - *Physeter macrocephalus*, Cuvier's beaked whale - *Ziphius cavirostris*; e.g. Drouot et al. 2004, Soto et al. 2006) that are less present at the sea surface - relatively to the duration and frequency of their dives - than other cetacean species. Consequently, it is admitted that visual data obtained from at-sea surveys is biased and under-estimate densities of deep-diving cetacean species (Dorémus et al., 2020), especially when acquired from plane, due to the higher speed of this kind of observation platform (Mannocci, Roberts, & Halpin, 2018). Besides, analysis are limited by the low number of deep-diving species observations. Finally, observations of deep-diving individuals at the surface inform partially their habitat use.

Some individuals (notably during aerial surveys) may not be identified at the species level (e.g. small delphinids or small shearwater species). Subsequent analysis and products (density estimates, maps, etc.) often group those observations at a higher taxa level, sometimes gathering species of different conservation status for which a distinct analysis should have been required, thus limiting results interpretation (Dorémus et al., 2020; Pettex et al., 2017).

Aerial surveys cover large areas in a limited time; in that sense, they provide an "instantaneous" view of the distribution of megafauna species (Dorémus et al., 2020). Usually, one boat-based or aerial survey is conducted within a limited time span that does not reflect the diurnal activity of species – while the latter can vary along the day (e.g. foraging activity in seabirds, Pers. Comm. 2021).

Finally, seabird and cetacean species are known to display different avoidance or attraction behaviors to boats (either fishing or in transit), what challenges observers (ACCOBAMS, 2021; Tasker et al., 1984). Compared to aerial and boat-based surveys mentioned above, censuses of seabirds' attendance to boats are producing different a kind of data, as they intrinsically include the interactions between human activities at sea and observed animals. Seabird and dolphin attendance to fishing boats (including research vessels of halieutic surveys) is well known worldwide, as much as in the Mediterranean Sea (e.g. Balearic shearwater - *Puffinus mauretanicus* - Louzao et al., 2011; common bottlenose dolphin - *Tursiops truncatus* – Pers. Comm. 2021). Inversely, some species are known to avoid vessels (e.g. Risso's dolphin - *Grampus griseus* - ACCOBAMS, 2021; seabird species - Borberg et al., 2005).

Video surveys

Airborne imagery, either obtained from manned or unmanned aircraft, is emerging as a promising technology to collect megafauna observations over large spatial and temporal scales (Buckland et al., 2012; Fiori et al., 2017; Garcia-Garin et al., 2020; Mannocci et al., 2021; see also SEMMACAPE project[15]).

Image quality is strongly influenced by weather conditions and acquisition characteristics such as altitude (Mannocci et al., 2021). However, species identification from photography or video has proven to be efficient for cetaceans, sea turtles, seabirds (either at sea or at colonies, see Chabot & Francis, 2016) and other marine megafauna (e.g. Garcia-Garin et al., 2020).

[15] https://www.france-energies-marines.org/en/projects/semmacape/

Obtained images can be either analysed *a posteriori* by trained photo-interpreters (e.g. Garcia-Garin et al., 2020) or, more recently, through powerful analytical tools such as deep learning methods using neural networks (e.g. Boudaoud et al., 2019; Mannocci et al., 2021). For the latter, models may be only valid at a local scale because of the strong influence of individuals' surroundings on their detection and on species identification (Ferreira et al., 2020; Mannocci et al., 2021).

Deep learning models require large datasets allowing sufficient training databases to achieve high accuracy. As a consequence, those methods are even more challenging for rare or uncommon species which are less observed and recorded in databases. As mentioned by Mannocci et al. 2021, "*this issue is exacerbated for marine megafauna species that occur in low numbers, range over vast areas, and spend most of their time underwater*". Besides, the presence of individuals either underwater, at the surface or flying above surface may also lead to an heterogenous efficiency of photo-interpretation between cetaceans and seabirds (Garcia-Garin et al., 2020).

Recently, deep learning algorithms using convolutional neural networks have also been applied in cetacean automatic detection from high-resolution satellite imagery (e.g. Borowicz et al., 2019), which highlights great perspectives in monitoring marine megafauna at large spatial and temporal scales.

Passive acoustics

Table 9: Examples of passive acoustics data sources acquired in the Gulf of Lions.

Program	Institution or referent organism	Year(s)	Reference
GREC Mediterranean Surveys	GREC	1997-2005	Gannier et al., 2002; Praca et al., 2009
INDEMARES	SUBMON	2009	Chicote et al., 2010
MOOSE and DEWEX PAM glider missions	CNRS-Sorbonne Universités-IRD-MNHN and partners	2012-2014	Cauchy et al., 2020
ACCOBAMS Survey Initiative	ACCOBAMS	2018	ACCOBAMS Survey Initiative, 2018
EOLMED	Qair		
EFGL	ENGIE		*To be determined*
Provence Grand Large	EDF Renouvelables		

Passive acoustics can be obtained from several sources, such as boat-based acoustic surveys (e.g. ACCOBAMS, 2021; Gannier et al., 2002), stationary monitoring stations (Frasier et al., 2021) or even opportunistic gliders (Cauchy et al., 2020; see Table 9).

Stationary passive acoustic monitoring can provide locally high temporal resolution data along time. Complementarily, boat-based acoustic surveys (either deploying a towed hydrophone array – e.g. ACCOBAMS, 2021 - or conducting stationary recordings along a track – e.g. Chicote et al., 2010) are often combined with visual surveys (e.g. ACCOBAMS, 2021; Gannier et al., 2002). Acoustic sampling may allow the prior detection of cetacean species, then confirmed visually by onboard observers.

Acoustic data is notably relevant to inform the **distribution of deep-diving species** (e.g. sperm whale *Physeter macrocephalus*, Cuvier's beaked whale *Ziphius cavirostris*) and to estimate their **densities** in the prospected area. As mentioned in ACCOBAMS (2021), the detection probability of a sperm whale on a track-line has been estimated to be lower for aerial (visual) surveys (bubble-windows, 100 kt), than boat-based [visual] surveys (5 kt) and even higher for boat-based acoustic surveys (Fais et al., 2016; Mannocci, Roberts, & Halpin, 2018). Sightings and acoustic detections can feed habitat models so as to study **species' habitat suitability** (e.g. Praca et al., 2009).

However, such data is not exploitable if levels of background noise are high and/or levels of bio-acoustic signals are low (ACCOBAMS, 2021). Thus, acoustic surveying is not possible in sectors where noisy marine human activities are intense (e.g. maritime traffic, fishing activities; Gannier et al., 2002). In addition, acoustic surveys using towed hydrophone arrays are limited in shallow waters, as minimum depth (e.g. 50m, 100m depending on the hydrophone array length) is required. As a consequence, this exclusion of shallower or coastal waters may influence estimations of species densities (Gannier et al., 2002), especially compared to visual-based surveys (either boat-based or aerial).

The acoustic detection range of the hydrophone array is conditioned by several environmental and sampling parameters such as the vessel speed, the engine revs, wind speed and direction, water temperature, sea state, rain condition, etc. (ACCOBAMS, 2021). Contrarily to visual surveys, acoustic data can inform the foraging behaviour of deep-diving species, which occurs throughout the day-night cycle (Watkins et al., 2002). In addition, while visual surveys are conducted with wind speeds up to Beaufort 3, acoustic data can be acquired with wind speeds up to 4 to 5 Beaufort, which enlarges the range of sampled environmental conditions.

Passive acoustic techniques can be used to estimate individual's body lengths (Drouot et al., 2004b; Goold, 1996) and **behaviour in sperm whales** – *Physeter macrocephalus* (e.g. Drouot et al., 2004a). Sperm whales' vocalization rates have been shown to depend on their activity and social structure (e.g. Drouot et al., 2004a; Gannier et al., 2012; Wahlberg, 2002). The interpretation of acoustic data and subsequent results, e.g. density estimates, are thus conditioned by the different vocalization behaviors, especially in large-scale surveys where individuals may display different activities and either isolate individuals or social groups may be detected. Similarly, partly because individuals within a same group may not adopt concomitantly the same behavior (not all the animals may be involved in diving (clicking), Gannier et al., 2002), one limitation relies in the determination of the number of individuals within a social group.

Considering seabirds, acoustic data are also collected from the coast and at sea within the MIGRALION project (2021-2023) aiming at characterizing the use of the Gulf of Lions by seabirds, migratory bats and birds. Acoustic data will help to identify species that would be detected by radar (see 2.3.2. Acquiring new data, for complementary information).

Opportunistic sightings and citizen science

Numerous participatory science initiatives are conducted in the western Mediterranean to inform marine megafauna observations, and rely either on standardized protocols or opportunistic information. As an example, opportunistic sightings from volunteers are reported in several online platforms (e.g. iNaturalist[16], Observadores del Mar[17], Ornitho[18], Natusfera[19],

[16] https://www.inaturalist.org/
[17] www.observadoresdelmar.es
[18] https://www.ornitho.cat/

Meridionalis[20]) along with opportunistic observations from professionals collected on board research vessels (e.g. IEO (CSIC), see Torreblanca et al., 2019) or within databases collecting both standardized and opportunistic observations (e.g. ObsEnMer[21]). A large amount of data has thus been collected since years, but is still insufficiently analysed (Pers. Comm. 2021), partly because the data produced by professionals is generally preferred to data acquired by volunteers, while a potential different accuracy between both sources has not been conclusively shown (Lewandowski & Specht, 2015).

When the sampling effort can be estimated, citizen science data may be used to inform the **distribution of marine species** (such as loggerhead sea turtle - *Caretta caretta*, Casale et al., 2020), preliminarily to further investigation and maritime spatial planning measures.

In western Europe, data obtained in regards with Balearic shearwater (*Puffinus mauretanicus*) from citizen science initiatives has recently been analysed along with satellite imagery to inform **migratory patterns** (predicted abundance and distribution during migration, Martín et al., 2020) and appeared to offer a "*powerful and cost-effective tool for the long-term spatial monitoring of the migratory patterns in sensitive marine species*".

Analysis of opportunistic sightings of cetacean species in the western Mediterranean also showed to offer interesting research perspectives to study their **habitat use** in space and time (e.g. fin whale *Balaenoptera physalus,* Torreblanca et al., 2019).

Finally, in line with the current effort to build on Big Data in Ecology research, data archived in several internet sources such as social media (Mannocci et al., 2021) is increasingly used ("iEcology", Jarić et al., 2020).

Countings at colonies

Censuses at seabird colonies are conducted in Spain[22] and France[23] within the MSFD framework and appear as one of the targets of improved cooperation (see 2.3.1. Sharing and analysing existing data and results).

Even if such censuses are geo-located, they do not directly inform the at-sea distribution of monitored species. Censuses of breeding pairs and reproductive success rather allow to estimate **demographic parameters** (at the colony or population scales), which are critical to be considered in evaluation processes and subsequent management measures.

Radar

Meteorological and ornithological radar technologies are increasingly used worldwide to inform migratory flows of birds or chiropterans. In the Gulf of Lions, radar data will be acquired within EFGL monitoring program[24] and MIGRALION project (both inshore and at-sea data acquisitions) in order to document (i) **flight heights**, (ii) **at-sea distribution**, (iii) **phenology and circadian cycle of seabirds**, **terrestrial migratory birds and bats**.

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[19] https://natusfera.gbif.es/
[20] https://www.faune-lr.org/
[21] https://www.obsenmer.org/
[22] By the Sociedad Española de Ornitología (SEO/Birdlife) - www.seo.org
[23] By the Groupement d'Intérêt Scientifique Oiseaux Marins (GISOM) - https://sextant.ifremer.fr/record/f342abdd-c299-4a56-a72d-bd33ac1f05c6/
[24] https://info-efgl.fr/

1.2.3. Data informing benthic habitats in canyon areas

Oceanographic campaigns contributing to the identification of benthic species and habitats in canyon and their vicinity are listed in annex III. Identified data acquisition campaigns within canyons in the North-Western Mediterranean Sea).

Apart from these campaigns, several sources offer a review of existing datasets:

- The seabed substrate database from a compilation of sediment samples taken during oceanographic campaigns carried out in the Gulf of Lion by Ifremer, CEFREM, IRSN, CEREGE, FOB, MIO, LECOB, The Conseil Général de l'Hérault and Rhône-Méditerranée-Corse Water Agency (Augris C. et al., 2013).
- The review and collection of the available datasets on indicators and human pressures/impacts on the Mediterranean deep-sea ecosystems within the IDEM project (Ciuffardi et al., 2018).

Complementary information on existing data collected within canyons area of the Gulf of Lions is available in annex VIII. Synthesis of identified information in regards with submarine canyons in the Gulf of Lions.

2. Knowledge gaps and perspectives

2.1. Methodology

As tasks 2.2.1 (knowledge synthesis about ecological stakes) and 2.2.2 (evaluation of interactions between floating windfarms and ecosystems components) rely upon the expertise of scientists and managers involved in data acquisition, analysis and evaluation processes in the case study area, their workflows have been merged into a sequence of several **online technical meetings** that are presented thereafter. Depending on each tasks' expectations, technical meetings were either conducted at a transboundary level (French and Spanish experts) or national level (French experts). Each of the 4 technical meetings detailed bellow were carried out several times with different expert groups dedicated to each of the Mediterranean ecosystem components: cetaceans, sea turtles, seabirds, migratory birds and bats; pelagic component (plankton and pelagic fishes); benthic habitats. Results presented above gather outputs from meetings about all ecological components addressed.

The sequence of four technical meetings has been organized as following (in blue, work dedicated to task 2.2.1, in grey, work dedicated to task 2.2.2):

- Technical meetings 1 (June 2021): these first technical meetings were dedicated to **the identification of knowledge gaps** at the Gulf of Lions [transboundary] scale, especially regarding at-sea distribution and abundance of mobile species, i.e. habitat use, functional areas, predictability (*Ecological components addressed: cetaceans, sea turtles, seabirds*). This meeting also targeted the initiation of a procedure of **selection and grouping species and/or habitats** ("Ecological receptors") to be studied further when addressing interactions with offshore floating windfarm development (*Ecological components addressed: cetaceans, sea turtles, seabirds, bats, migratory birds, other pelagic species, benthic habitats of the continental shelf*).

- Technical meetings 2 (September 2021): the second technical meetings aimed at **validating the ecological receptors** (species, groups, etc.) to be further considered into the characterization of interactions between the Gulf of Lions ecosystems and offshore floating windfarm development related activities. Furthermore, this technical meeting allowed the preliminary **association of pressures and ecological receptors**, as a basis for the subsequent characterization of pressures and receptors interactions (*Ecological components addressed: cetaceans, sea turtles, seabirds, bats, migratory birds, pelagic species and benthic habitats of the continental shelf*).

- Technical meetings 3 (Oct./Nov. 2021): the third technical meetings addressed the **current limitations** (data-induced, methodological, scale-induced, etc.) to **inform ecological criteria** used to feed evaluation processes (MSFD) and spatial designations (e.g. SPAMIs) in the Gulf of Lions, at the transboundary level and especially for highly mobile species of cetaceans, sea turtles and seabirds. Concomitantly, discussions allowed the drawing of several perspectives to overcome these limitations. In addition to this, a **scoring method** including, among other criteria, the knowledge level associated to pressures and receptors associations, was presented in order to initiate the classification work of **potential interactions** between the development offshore floating windfarms and ecological components (*Ecological components addressed: cetaceans, sea turtles, seabirds, bats, migratory birds*).

- Technical meetings 4 (Nov//Dec. 2021): the fourth technical meeting allowed to assess sensitivity and knowledge levels of potential interactions between offshore floating windfarms and ecosystems and offered a **concluding discussion of the whole methodology**. It also allowed to provide recommendations in order to consider potential interactions in every step of offshore floating windfarm development and within appropriate temporal and spatial scales. Perspectives aimed at bridging remaining knowledge gaps about offshore floating windfarm-ecosystems interactions were also discussed.

All along this sequence, information from literature and experts' contributions were compiled to feed final reports and meet other punctual needs (e.g. inform managers about existing data and/or initiatives).

During the first technical meetings – dedicated to the identification of knowledge gaps in regards with distribution and abundance of cetaceans and sea turtles, and seabirds in the Gulf of Lions- experts were asked to provide their appreciation of knowledge gaps about:

- **Distribution in the case study area** (spatial scale, temporal scale, group of species, 3D distribution);
- **Functional areas** (foraging areas, migratory paths, etc.);
- **Predictability** of cetacean/sea turtle/seabird distribution at sea (weather conditions, environmental variables, resource distribution, interactions with other predators, etc.);
- **Abundance** of seabird species and trends;
- Other topic (free expression).

Contributions were collected on the online brainstorming tool *digistorm*[25]: There were briefly analysed in order to conduct a guided discussion in the second part of the meeting, where experts were asked to provide more details about knowledge gaps collectively identified. The guided discussion was animated through a mindmap concomitantly with experts' oral contributions. The discussion also allowed to draw several perspectives to bridge identified knowledge gaps.

During the third technical meetings – dedicated to experience sharing about the evaluation of ecological parameters used in spatial planning processes – experts had the opportunity to draw complementary perspectives in order to overcome current limitations (e.g. knowledge gaps). The methodology used during the third technical meetings is detailed in 3.1. Methodology.

2.2. Identified knowledge gaps

[25] https://digistorm.app/

Knowledge gaps highlighted by experts during technical meetings are reported in detail in annexe VI. Reports of technical meetings 1 (June 2021).

The Figure 2 synthesizes through four categories the main knowledge gaps identified for cetaceans, sea turtles and seabirds in regards with their at-sea distribution and its predictability, their functional areas, as well as population demographics and trends.

2.2.1. At-sea distribution and functional areas of megafauna species

According to experts, the at-sea distribution of cetacean, sea turtle and seabird species, as well as the location of their functional areas, remain incompletely known. This global appreciation was commented during technical meetings in respect with the different taxa and scales (Figure 2).

Despite the numerous data acquisition campaigns and data sources identified in the Gulf of Lions case study area, the distribution and functional areas of such highly mobile species -which shall be also considered at larger scales (e.g. western Mediterranean basin)- is limited by unsampled areas and poorer knowledge in offshore waters and during non-summer months. An important gap remains in the **understanding of seasonal distribution variability in cetacean species**. As noticed in 1.2.2. Community-based data in cetaceans, sea turtles and seabirds, the short time span of large-scale surveys such as aerial monitoring programmes does not allow to inform the variability of seabirds' activity at sea during day, and excludes any information during night. As a consequence, such surveys may miss specific schedules of presence/absence of individuals in the area and thus provide incomplete data. Experts mentioned the lack of fine scale data - temporally and spatially - needed to describe the distribution and functional areas of cetacean, sea turtle and seabird species. In addition, experts underlined the existence of small-scale and large-scale monitoring efforts and subsequent results, while meso-scale patterns and the link between those nested scales remains undescribed.

More specifically, within the marine mammal group of commonest species in the study area[26], knowledge is poorest about deep-diving cetaceans (especially Cuvier's beaked whale - *Ziphius cavirostris*). According to experts, no baseline information exists about the at-sea distribution of sea turtles (loggerhead sea turtle - *Caretta caretta*) in the Gulf of Lions, while many data (e.g. from telemetry, aerial surveys) have been obtained in the Balearic region. While the Gulf of Lions may appear as a marginal area for loggerhead sea turtle at the western Mediterranean scale, experts stressed that it has to be considered meanwhile as a significant area for this species, partly in light of the recent unprecedented nesting events in Spanish and French coasts (Abalo-Morla et al., 2018; Loisier et al., 2021). **Regarding seabirds, experts mentioned a lack of knowledge about the at-sea distribution of small species** (e.g. storm petrel *Hydrobates pelagicus*) and **seabird nocturnal behaviours**. Except for Scopoli's shearwater (*Calonectris diomedea*), the 3D distribution, i.e. including flight heights, is unknown for all seabird species in the case study area.

For all of the species group under study, experts highlighted **remaining knowledge gaps about functional areas** in the western Mediterranean, and at the Gulf of Lions scale. The spatial plasticity (residency, movements at the transboundary scale, or between functional areas, etc.) of cetaceans and sea turtles is incompletely known. As mentioned before, uncertainty is even increasing in the context of changing functional (nesting) areas of sea

[26] Common bottlenose dolphin – *Tursiops truncatus,* Striped dolphin – *Stenella coeruleoalba*, Risso's dolphin - *Grampus griseus*, Cuvier's beaked whale – *Ziphius cavirostris*, Long-finned pilot whale *Globicephala melas*, Sperm whale – *Physeter macrocephalus*, Fin whale – *Balaenoptera physalus.*

turtles. Regarding seabirds, **connectivity models are lacking and the potential differences in habitat use between colonies are still poorly documented**. This knowledge gap has been considered as major in the context of impact assessment of at-sea human activities, and particularly offshore floating windfarms development.

2.2.2. Megafauna distribution predictability

Knowledge gaps regarding "predictability" are similar between cetacean, sea turtle or seabird distributions, both in the Gulf of Lions or at larger scales (Figure 2). On one side, experts stressed the **lack of appropriate environmental data necessary to build predictive habitat models**. More specifically, 3D environmental data, such as deep oceanography or wind patterns, are critically lacking in an accessible way.

On the other side, experts recognized the **lack of homogeneous ecological data** (e.g. appropriate scales of surveys and homogeneous protocols) to build predictive habitat models from, despite data acquisition efforts are increasingly standardized. For sea turtles that are insufficiently informed by visual surveys in the Gulf of Lions area, satellite tracking may be more relevant to consider for habitat modelling.

The predictability of species distributions appears even more difficult to obtain in the **currently changing environment** (global warming and its effect on distribution and functional areas). In that sense, experts mentioned the need to update regularly predictive models.

In link with distribution predictability, **interactions between megafauna species and at-sea human activities** were suggested as important factors to be considered. As an example, experts confirmed that the attraction of shearwaters and dolphins to fishing boats is known in the study area and that it may significantly influence the distribution and behaviour of concerned species. Other attraction behaviour displayed by different seabird species, such as resting on floating infrastructures or foraging in fish farms, have also been documented in the western Mediterranean (e.g. gulls, gannets, terns, shags feeding on waste, on tuna feeding resource or on surrounding fish; Pers. Comm. 2021). If interactions between megafauna and several maritime human activities are known, they are still mostly unquantified (except through evaluations from monitoring of strandings and by-catch; and see also Abelló et al., 2003) and their effects on species distribution and fitness has to be evaluated.

Inversely, the attraction or avoidance of offshore floating windfarm infrastructures by seabirds seems insufficiently documented, especially during night (light emissions) or under different wind conditions encountered in the Gulf of Lions.

2.2.3. Population demographics and trends

The demographics of sea turtles are unknown at the Gulf of Lions scale (Figure 2). In regards with cetaceans, existing data allowed to assess abundances of several species, but experts underlined the need to conduct complementary assessments and to **strengthen results**.

Regarding seabirds, despite significant efforts are conducted -within the MSFD framework- in **monitoring seabird colonies** (e.g. number of breeding pairs, reproductive success, etc.) and **documenting mortalities** (e.g. by-catch), experts mentioned a limited knowledge because of few baseline demographic data. Some colonies are still to be discovered or documented (e.g. for the European storm-petrel - *Hydrobates pelagicus*). **Demographic data is still insufficient to implement models and to detect demographic trends**, and **connectivity processes** between colonies. Moreover, populations are still not quantified. This knowledge gap was characterized as critical to be addressed, especially in the context of increasing threats to seabirds with the development of new maritime activities.

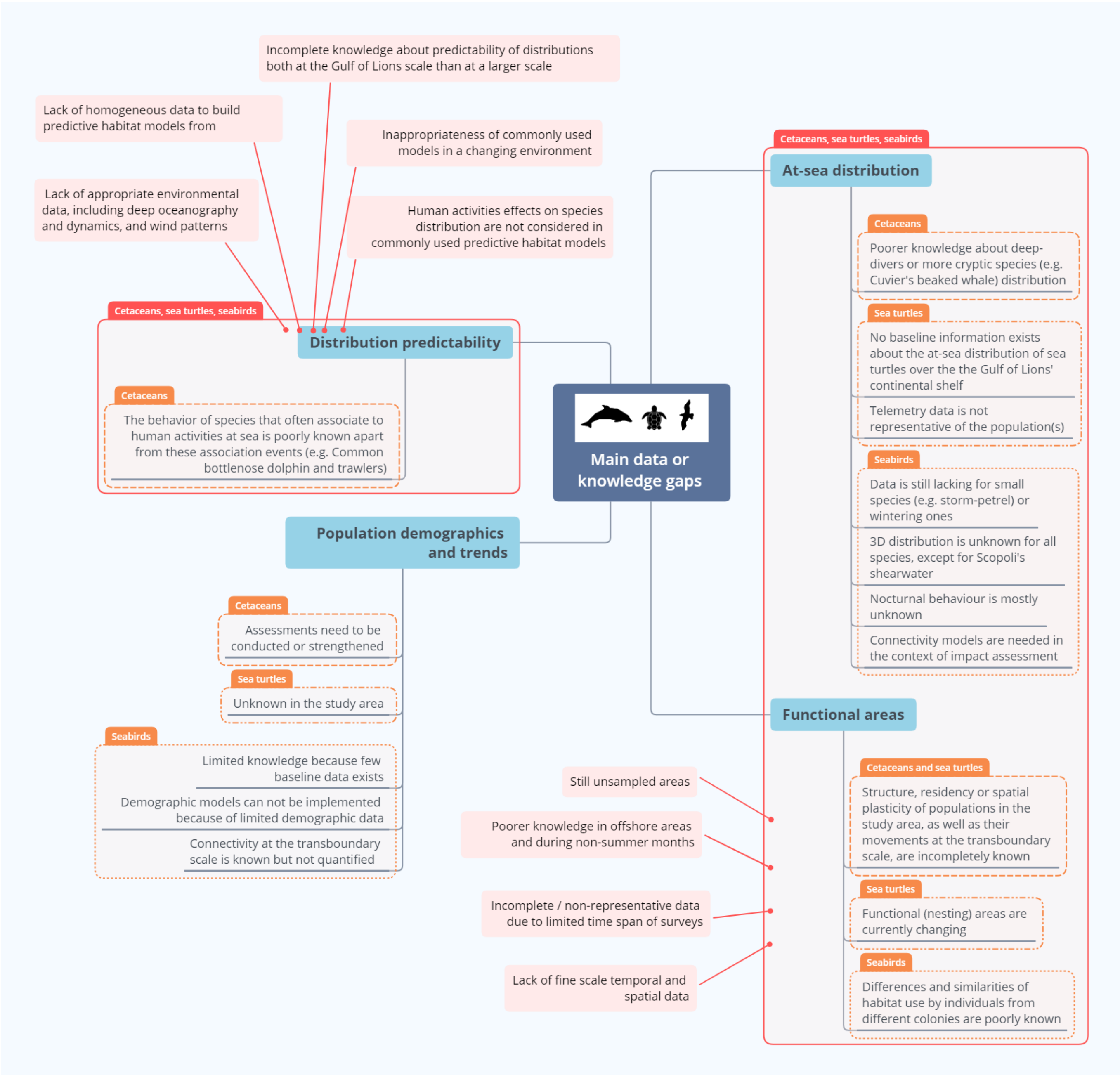

Figure 2: Mindmap of the main knowledge gaps identified in regards with cetaceans, seabirds and sea turtles in the Gulf of Lions area. Knowledge gaps highlighted by experts during technical meetings are reported in detail in annex VI. Reports of technical meetings 1 (June 2021). Credits: OFB.

2.3. Bridging knowledge gaps

Along with identifying knowledge gaps, perspectives to overcome those limitations were discussed with experts. From these exchanges, two main axis (described below) appeared: the importance of sharing and analysing existing data and results, and the need of acquiring new data.

2.3.1. Sharing and analysing existing data and results

Meta-analysis of existing data

The work conducted within the task 2.2.1 of the MSPMED "Gulf of Lions" case study allowed to identify many existing datasets produced from different initiatives and technologies (see 1.2. Overview of identified data, methods and resulting knowledge).

In technical meetings, when Spanish and French experts were asked about perspectives to bridge identified knowledge gaps, one major topic emerged to be ecological **data sharing**. In regards with seabird populations in western Mediterranean, experts acknowledged the need to share and analyse together census data from colonies, **at a larger scale than national scales** (at least transboundary, but even largely) in order to improve abundance estimates, to better inform the connectivity between colonies at a relevant scale, and to detect potential demographic trends. As mentioned before, the large-scale connectivity between seabird colonies and populations is suspected or known, but still not quantified: the global sharing and analysis of existing census data could support the development of dedicated demographic models. The structure, residency and spatial plasticity of cetacean populations could be informed through strengthen photo-identification data sharing and a dedicated analysis at the western Mediterranean scale. According to experts, **data sharing has to be facilitated through online dedicated platforms, such as ACCOBAMS[27] and INTERCET[28] initiatives**. Experts also underlined their interest in sharing sea turtle sightings data at the transboundary scale to better inform sea turtle distribution in the Gulf of Lions.

From the exchanges held during technical meetings, it also appeared that the amount of existing data would be sufficient to bridge some knowledge gaps, but the associated and necessary **analytical effort** is either not funded or sometimes underestimated by administration bodies. As an example, to our knowledge, observation data acquired during annual halieutic surveys (MEDIAS[29], PELMED[30]) over the continental shelf have not been analysed jointly, while they represent both a long timeseries and an extensive prospected area.

As another example, the large number of telemetry data obtained from seabirds in the case study area (e.g. from shearwater colonies in the Balearic Islands, Port-Cros and Frioul Islands, in Corsica, etc.) would deserve a global analysis to inform functional areas of monitored species and thus their sensitivity to the development of maritime activities. At a much larger scale, a dedicated framework has recently been developed by Carneiro et al. (2020). Similarly, a significant effort is dedicated to intercalibrate and analyse different datasets together, to **capitalize on data** and inform poorly known species distributions (e.g. Cañadas et al., 2018; Virgili et al., 2019). Despite such an effort may rely on -time-consuming- methodological

[27] https://accobams.org/about/introduction/
[28] http://intercet.it/
[29] Example of MEDIAS 2019 : https://csr.seadatanet.org/report/20195589
[30] https://campagnes.flotteoceanographique.fr/series/19/

developments, data combination and modelling approaches allow to **maximize outcomes of ecological monitoring** (Lauret et al., 2019).

As mentioned before (see 2.2. Identified knowledge gaps), the predictability of cetacean, sea turtles and seabird distributions and densities through habitat modelling is limited by the insufficient resolution of available environmental data. High-resolution environmental data (e.g. deep oceanography, weather, etc.) are expensive and thus may be difficult to obtain. In the context of global change, in line with the requirements, for example, (i) to update frequently predictive habitat models or (ii) to understand species distribution under diverse weather conditions (e.g. seabird distribution and manoeuvrability in different wind patterns), experts highlighted the crucial need to **access high resolution environmental data**.

Complementarily to meta-analysis of existing data, perspectives remain in **making use of under-exploited data**. For example, experts mentioned **citizen science** as a significant data source to be more importantly consider in scientific analysis. Citizen science can follow standardized protocols and offer low-cost data acquisition, thus provides a lot of exploitable information (e.g. Martín et al., 2020). In addition to standardized data, opportunistic sightings at sea are poorly analysed today, even though catalogues are increasingly incremented in the western Mediterranean. Nevertheless, opportunistic data has proven to be useful to inform species presence (e.g. Raga & Pantoja, 2004) and habitat use (Torreblanca et al., 2019). As mentioned in 1.2.2. Community-based data), a large amount of data also resides in social media platforms and offer opportunities to address biodiversity conservation challenges (Toivonen et al., 2019).

Improving communication about results

According to experts, "*scientific results must be shared massively in order to increase the general awareness about sensitive areas, especially in the context of offshore windfarm planning*" (Pers. Comm. 2021). This recommendation refers more specifically to results obtained from meta-analysis, informing seabird functional areas, but it shall be considered more generally for Mediterranean ecosystems. Indeed, experts highlighted the need to keep (and improve) communication towards managers and MSP authorities about ecologically important areas. Besides, experts acknowledged the need for scientists to better get informed about existing data.

In addition to this, experts stressed the importance of a better communication about the **analytical effort required** to inform planning issues, e.g. in studies on human activities' impacts on marine ecosystems. The necessary analytical effort (especially when merging different datasets to produce more integrative results, e.g. Ministère de la Transition Ecologique, 2021[31]) can be underestimated, while it is considerable.

Finally, experts highlighted that the results should be systematically communicated **along with discussion elements** (confidence index, standard deviation, etc.). For example, a risk map should be associated with an uncertainty map that would relate spatialized uncertainty due to data dispersion or quality, method limitations, etc., in order to avoid any misinterpretation of results and to define the results' significance/validity range.

2.3.2. Acquiring new data

[31] Readable and downloadable: https://eos.debatpublic.fr/wp-content/uploads/EOS-DMO-Etude-bibliographique-Environnement-Maritime.pdf

Completion of temporal and spatial gaps

As mentioned previously (see 2.2. Identified knowledge gaps), the knowledge about cetacean, sea turtle and seabird distributions remains incomplete in winter period and in offshore areas. In addition, the link between distributions at several nested scales is insufficiently described. Considering this, apart from analysing existing datasets jointly (see 2.3.1. Sharing and analysing existing data and results), one perspective relies on acquiring new data in the case study area.

In line with the MSFD monitoring and evaluation cycle, **large-scale surveys are expected to occur in summer and winter seasons in the western Mediterranean**, thus informing better the distribution and abundance of megafauna during non-summer months and documenting their potential inter-annual variability. According to experts, effort should be made to ensure that **monitoring surveys' protocols are homogenous** at all spatial and temporal scales (including transboundary scale), to allow the compatibility of data for further analysis. Experts specified that data acquisitions and methodologies for analysis are currently being standardized globally (e.g. within several projects such as ECOSYSM-EOF[32], TURSMED 2[33]).

Furthermore, experts mentioned recent technologies that could be used to compensate the inappropriateness of large-scale boat-based or aerial surveys in documenting specific ecological parameters or the distributions of species under certain weather conditions. As an example, drones have been suggested as devices allowing more temporal flexibility that planes, thus potentially being appropriate to document seabirds' activity at several times of the day. However, experts specified that drones would be even more relevant for bigger species (e.g. cetaceans) and focal surveys.

Radar technology stands for another complementary data type, since it offers a view of aerial objects (including chiropterans, seabirds, and terrestrial birds) under a wide range of environmental conditions (e.g. except heavy rain) and independently of the time of the day/night. Radar data collected from the coasts (fixed radar) or at sea (on-board radar, e.g. within the MIGRALION project; but see other remote examples in Assali et al., 2017; Hüppop et al., 2006) allows to inform about the distribution of the bird community continuously (if the radar is used in horizontal scanning mode), as well as flying altitude of detected individuals (if the radar is used in vertical scanning mode), along with complementary species identification (acoustics, observations). This technology is also developed to be installed on monitoring buoys (e.g. http://www.akrocean.com/flyrsea_).

While **standardized surveys provide information about distributions and abundances, dedicated innovative protocols are to be tested in order to document the connectivity between colony and sea in seabirds** (GPS tagging of individuals equipped directly at sea from boat[34]). Finally, small bird species distribution is to be complemented with recent miniaturized geo-location technologies.

Input from multi-approach monitoring and joint analysis

Either because some technologies are more appropriate to monitor particular species (e.g. deep-divers, small birds) or because they allow to document different ecological parameters (behaviour, distribution, etc.), **multi-approach data acquisitions stand for an interesting perspective to bridge identified knowledge gaps**.

[32] https://www.france-energies-marines.org/en/projects/ecosysm-eof/
[33] https://ofb.gouv.fr/actualites/tursmed-2-mieux-connaitre-le-grand-dauphin-en-mediterranee-pour-mieux-le-proteger
[34] https://info-efgl.fr/des-mesures-de-suivis-de-lavifaune-innovantes/

In line with reviews and projects that consider multiple data sources (e.g. Raga & Pantoja, 2004; Reyes-González et al., 2017), recent initiatives are conducted to acquire complementary data types within the same spatial and temporal ranges (e.g. MIGRALION, ASI[35], INDEMARES[36], OWFSOMM[37], SEMMACAPE[38]). Multi-approach data acquisitions have allowed, for example, to inform the habitat suitability for sperm whales - *Physeter macrocephalus* (visual and acoustic detections from boat, see Praca et al., 2009), or to develop deep-diving cetacean distribution models (visual detection from boat and stationary passive acoustic monitoring at fixed sites, see Frasier et al., 2021).

In the specific case of MIGRALION project (2021-2023), several technologies are simultaneously deployed in order to characterize the use of the Gulf of Lions by seabirds, migratory bird and bat species. The combination of telemetry data (GPS, GLS), radar surveys on the coast and at sea, at-sea visual and acoustic campaigns, inshore visual surveys, acoustics and ringing programs, offer an unprecedented opportunity to inform the spatial distribution of species, migratory flows, flight heights, and functional areas in the Gulf of Lions. Indeed, while at-sea campaigns and inshore surveys will produce data at the community scale, ringing and telemetry will complete the global vision by adding individual-based and behavioral data. One significant advantage of such a program is the **simultaneous** acquisition of these **complementary data sources**, offering many analytical perspectives so as to maximize ecological outputs. A dedicated workpackage targets the development of a methodological framework to analyze together all the different sources of information cited above.

In fact, the combination of different data types requires methodological developments, such as those based on machine learning (e.g. random-forest regression models, Martín et al., 2020; neural networks, Mannocci et al., 2021) in the context of Big Data acquisition and joint analysis. Data sharing and multi-approach data acquisition and analysis shall rely on transboundary collaborations and coordination (see 3.3. Recommendations and perspectives at the transboundary scale).

In line with the current effort to monitor megafauna by-catch (e.g. observers on board fishing boats, logbooks) and strandings (national networks) within the MSFD framework, experts mention the need – and the challenge (e.g. Peltier et al., 2019) to **quantify interactions between ecosystems and maritime human activities**. These data are valuable sources to estimate demographic implications of anthropogenic pressures on megafauna populations. More specifically, the identification, characterization and quantification of interactions between marine ecosystems and offshore windfarms seem critical to be collectively addressed by experts and MSP authorities at larger scales than national plans (see 3.3. Recommendations and perspectives at the transboundary scale). Experts recognized that strengthening cooperation between at least Spain, France and Italy – and even largely with Greece, North-African countries – is crucial in regards with highly mobile species addressed in the MSPMED Gulf of Lions case study.

[35] https://accobams.org/main-activites/accobams-survey-initiative-2/accobams-survey-initiative/
[36] https://www.indemares.es/
[37] https://www.france-energies-marines.org/en/projects/owfsomm/
[38] https://www.france-energies-marines.org/en/projects/semmacape/

Conclusion of part 1 and 2: synthesis of “data-methods-results” chains

Figure 3 reports the synthetic view of identified data, method and resulting information concerning megafauna ecology within the Gulf of Lions area and the western Mediterranean Sea. This list is non-exhaustive (compared to the diversity of data and methods used worldwide) and rather reports the common data types and tools used to understand the ecology of cetacean, sea turtle and seabird species in the study area. Scientific literature informing these “data-method-results” chains are reported in annexe V. Data to knowledge: reviewed information and references).

The synthetic scheme reports:

- [Figure 3, in green] Data types that have been commonly acquired in the case study area. This list reports data types informing megafauna ecology (i) at the **community scale** (aerial and boat-based surveys, passive acoustics, airborne or satellite imagery, opportunistic sightings, radar, countings at colonies; see 1.2.2. Community-based data for details), (ii) at the individual scale (telemetry, photo-identification, biological samples, ringing; see 1.2.1. Individual-based data for details). Furthermore, data intrinsically referring to interactions between megafauna and maritime human activities (boat-based attendance, strandings and ship strikes, by-catch) is also identified (Figure 3).
- [Figure 3, in yellow] Primary results (or measured parameters) that can be obtained from data. This step allows the description of datasets and may be useful to evaluate potentials for further analysis.
- [Figure 3, in orange] Methods and tools deployed further to analyse data. Methods reported here can be descriptive or predictive (modelling) and are commonly used in ecology research. Other methods and tools exist but are not referenced here as they may have been considered as non-operational at this stage (e.g. knowledge gaps identified for implementing connectivity models and demographic models) within the Gulf of Lions area.
- [Figure 3, in red] Final results and targeted information. These results are then broadly used to inform environmental evaluation processes or spatial designations in respect with cetacean, sea turtle and/or seabird species.

Table 10 transposes Figure 3 in order to detail how ecological topics can be addressed by the mobilization of tools and data. This representation was useful to feed exchanges during technical meetings 3, since while a parameter was mentioned, the animator could ask specific questions about required methodologies/data/sampling strategies.

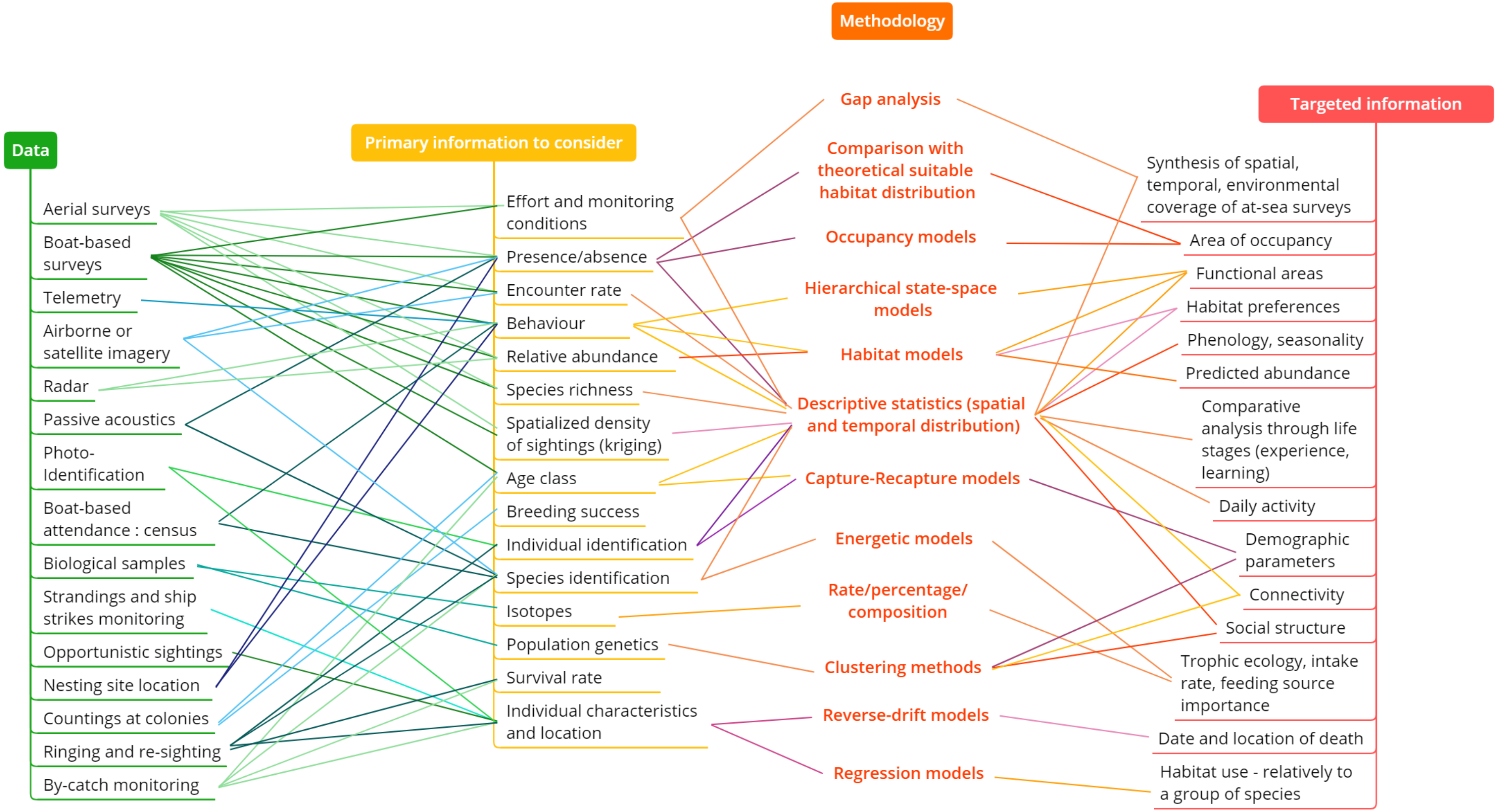

Figure 3: Scheme illustrating connections between data, methods and resulting information, identified from references relative to cetacean, sea turtle and seabird species in the western Mediterranean Sea. Credits: OFB.

Table 10: Examples of methods and data mobilization to inform ecological parameters relative to cetacean, sea turtle or seabird species in the western Mediterranean Sea. Credit: OFB.

Targeted information	Examples of methodology used	Examples of primary information to consider	Data acquisition methods	Examples of initiatives, programs, or campaigns	Examples of recommendations
Synthesis of spatial, temporal, environmental coverage of at-sea surveys	Descriptive statistics Gap analysis	Effort and monitoring conditions	Metadata from aerial and boat-based surveys	e.g. data acquisition campaigns as INDEMARES, Proyecto Grampus, SAMM 1, Univ. Valencia	Enlarging the range of sampled environmental conditions (ex: bad weather, night, offshore, winter,etc.)
Area of occupancy	Occupancy models	Presence/absence in a site	Aerial or boat-based surveys Airborne or satellite imagery Passive acoustics	Research programs	Sharing and analyzing together existing data to maximize outcomes of ecological monitoring efforts
Functional areas	Descriptive statistics Hierarchical state-space models Habitat models	Encounter rate Relative Abundance Spatialized density of sightings Behaviour Age class Species identification	Aerial or boat-based surveys Telemetry Airborne of satellite imagery Passive acoustics Photo-Identification Nesting site location	e.g. information targeted within IMMA designation process	- Sharing and analyzing together existing data to maximize outcomes of ecological monitoring efforts - Acquiring new data from multi-approach campaigns - Updating habitat models in the context of a changing environment
Habitat preference	Descriptive statistics Habitat models	Relative abundance Behaviour Species identification	Aerial or boat-based surveys Telemetry Airborne of satellite imagery Passive acoustics	Research programs	Sharing and analyzing together existing data to maximize outcomes of ecological monitoring efforts
Habitat use - relatively to a group of species	Regression models	Individual characteristics and location Species identification	Opportunistic sightings	Research programs	Analyzing new data sources such as opportunistic sightings, which require methodological developments

Targeted information	Examples of methodology used	Examples of primary information to consider	Data acquisition methods	Examples of initiatives, programs, or campaigns	Examples of recommendations
Phenology, seasonality	Descriptive statistics	Presence/absence in a site Relative abundance Species identification Individual characteristics and location Behaviour	Aerial or boat-based surveys Passive acoustics Countings at colonies Ringing and re-sighting Telemetry	e.g. information targeted within MIGRALION project	Acquiring new data and/or maintaining monitoring effort
Daily activity	Descriptive statistics	Behaviour Species identification	Passive acoustics Telemetry	Research programs	Selecting appropriate spatial and temporal scales and resolution of data acquisition
Comparative analysis through life stages (experience, learning)	Descriptive statistics	Behaviour Encounter rate Species identification Presence/absence	Aerial or boat-based surveys Telemetry Boat-based attendance census	e.g. PACOMM	Comparing the interactions of individuals from different age-classes with at-sea human activities, such as windfarm development
Predicted abundance	Habitat models	Relative abundance Species identification	Aerial or boat-based surveys Passive acoustics	e.g. SAMM 1 and 2, ASI	- Updating habitat models in the context of a changing environment - Tending to standard and coordinated visual data acquisition protocols
Demographic parameters	Capture-Recapture models Clustering methods	Age class Individual identification Breeding success Population genetics	Aerial or boat-based surveys Photo-identification Countings at colonies Biological samples	e.g. TOP-HABITAT program, information targeted within French MSFD evaluation process (D1)	Sharing and analyzing together existing data to maximize outcomes of ecological monitoring efforts
Connectivity	Clustering methods Descriptive statistics	Population genetics Behaviour	Biological samples Telemetry	e.g. information targeted within MIGRALION project (telemetry)	- Sharing and analyzing together existing data to maximize outcomes of ecological monitoring efforts - Acquiring complementary data (ex: directly at sea for seabirds)

Targeted information	Examples of methodology used	Examples of primary information to consider	Data acquisition methods	Examples of initiatives, programs, or campaigns	Examples of recommendations
Date and location of death	Reverse-drift models	Individual characteristics and location Species identification	Strandings and ship strikes monitoring	e.g. information targeted within French MSFD evaluation process (D1)	Sharing data to feed predictive models
Trophic ecology	Energetic models Rate/percentage/composition	Species identification Isotopes	Biological samples	Research programs	Monitoring potential interactions with at-sea human activities

3. Knowledge mobilization about cetaceans, sea turtles and seabirds in the Gulf of Lions: examples from evaluation and spatial designation processes

3.1. Methodology

The work described in part 3 relies on experts' contributions to technical meetings 3 (see 2.1. Methodology) as well as on background information collected previously from various sources (see 1.1. Methodology), and especially knowledge mapping as presented before (see Conclusion of parts 1 and 2).

Maritime spatial designations (see the work conducted within the SIMWESTMED project, providing the list of Marine Protected Areas in the western Mediterranean sea (De Magalhaes & Alloncle, 2018) and the analysis of their conservation objectives towards ecological components such as cetaceans and seabirds (Giffon et al., 2018) rely upon various criteria. Among them, ecological criteria encompass several characteristics of marine ecosystems, relative to their uniqueness, functionalities, integrity, natural representativeness, biological diversity, biological productivity, naturalness or fragility (e.g. SPAMI[39], EBSA[40], PSSA[41], VME[42] criteria).

Besides, within the MSFD framework (Directive 2008/56/EC), the achievement of the Good Environmental Status ("*the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive*"[43] (Article 3)) is evaluated through eleven descriptors. Descriptor 1 "Biodiversity" is declined into six distinct criteria.

In order to complete the knowledge synthesis about ecological stakes relative to cetaceans, sea turtles and seabirds in the Gulf of Lions area, the objective of technical meetings 3 was to better understand the way knowledge (ecological parameters, methods and data) is/can be mobilized to inform ecological criteria commonly used in MSP and MSFD processes (see annexe *VII. Reports of technical meetings 3* (October 2021)).

On the collaborative MURAL[44] platform, experts were proposed a list of 10 ecological criteria selected from the descriptor 1 of the Good Environmental Status (GES) targeted by the MSFD, or commonly used to inform Marine Protected Area (MPA) designation (Table 11):

[39] Specially Protected Areas of Mediterranean Importance (SPAMIs) - SPA/BD Protocol - Barcelona Convention - http://www.rac-spa.org/sites/default/files/annex/annex_1_en.pdf

[40] Ecologically or Biologically Significant Areas (EBSAs) - Convention on Biological Diversity (annex I, decision IX/20) - https://www.cbd.int/doc/decisions/cop-09/cop-09-dec-20-en.pdf

[41] Particularly Sensitive Sea Areas (PSSAs) - International Maritime Organization - https://www.imo.org/en/OurWork/Environment/Pages/PSSAs.aspx

[42] Vulnerable Marine Ecosystem (VME) – Food and Agriculture Organization of the United Nations - https://www.fao.org/in-action/vulnerable-marine-ecosystems/criteria/en/

[43] https://ec.europa.eu/environment/marine/good-environmental-status/index_en.htm

[44] https://www.mural.co/

Table 11: Criteria submitted to experts during technical meeting 3.

MPA designation	Uniqueness	The area contains unique or rare ecosystems, or rare or endemic species.
	Representativeness	The area has highly representative ecological processes, or community or habitat types or other natural characteristics.
	Diversity	The area has a high diversity of species, communities, habitats or ecosystems.
	Naturalness	The area has a high degree of naturalness as a result of the lack or low level of human-induced disturbance and degradation.
	Critical habitats	The area hosts habitats where any impact represents a high potential risk for endangered, threatened or endemic species.[45]
MSFD – Good Environmental Status evaluation	D1C1	The mortality rate per species from incidental by-catch is below levels which threaten the species, such that its long- term viability is ensured.
	D1C2	The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.
	D1C3	The population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity, and survival rates) of the species are indicative of a healthy population which is not adversely affected due to anthropogenic pressures.
	D1C4	The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions.
	D1C5	The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species.

Experts were firstly asked to vote for 5 out of 10 the topics to be addressed during the meeting, considering two decision rules relative to the relevance of the criterion (i) to informing MSP in the case study area, (ii) to be addressed at the transboundary scale. Experts associated a level of knowledge (high/sufficient, medium/incomplete, low/insufficient) to these topics, in regards with either the baseline data or the evaluation method used to inform the criterion.

Secondly, technical meetings 3 encouraged experience sharing about the current limitations related to the selected topics, the perspectives to overcome those difficulties, and recommendations to transfer information to decision-makers of the MSP. Diverse input information was available to the experts:

- the list of identified knowledge gaps in order to build on previous results obtained during technical meetings 1 (knowledge gaps were thus completed, clarified or detailed along exchanges);
- the overview of existing data and tools (Figure 3: Scheme illustrating connections between data, methods and resulting information, Figure 3) in order to feed discussions about solutions to bridge knowledge gaps or evaluation difficulties, and draw concrete perspectives.

[45] Adapted from the SPAMI criteria « Presence of habitats that are critical to endangered, threatened or endemic species." in order to integrate the "risk" approach.

3.2. Findings

3.2.1 MPA designations in regards with cetaceans, sea turtles and/or seabirds

While literature provide evidence of the valuable input of several data sources to inform the designation of ecologically important areas for seabirds (Lascelles et al., 2016; Louzao et al., 2009; Péron et al., 2013; Reyes-González et al., 2017) and cetaceans (Raga & Pantoja, 2004; and see North Western Mediterranean Sea, Slope and Canyon System Important Marine Mammal Area[46], Shelf of the Gulf of Lion Important Marine Mammal Area[47]), one aim of technical meeting 3 was to (i) illustrate knowledge mobilization to inform ecological criteria in the Gulf of Lions area, (ii) highlight limitations (methodological issue, missing data, etc.) within this process, and (iii) draw perspectives to overcome these limitations.

We report here a focus on one ecological criterion used to designate SPAMIs and selected by experts during technical meetings 3. Figure 4 illustrates the example of knowledge (ecological parameters, methods or data) mobilization to inform this criterion in regards with cetaceans, sea turtles or seabirds. When limitations were mentioned, solutions to bridge those constraints were discussed. The detailed reports of technical meetings 3 are available in annexe VII. Reports of technical meetings 3 (October 2021).

[46] https://www.marinemammalhabitat.org/wp-content/uploads/imma-factsheets/Mediterranean/North-Western-Mediterranean-Sea-Slope-and-Canyon-System-Mediterranean.pdf
[47] https://www.marinemammalhabitat.org/wp-content/uploads/imma-factsheets/Mediterranean/Shelf-of-the-Gulf-of-Lion-Mediterranean.pdf

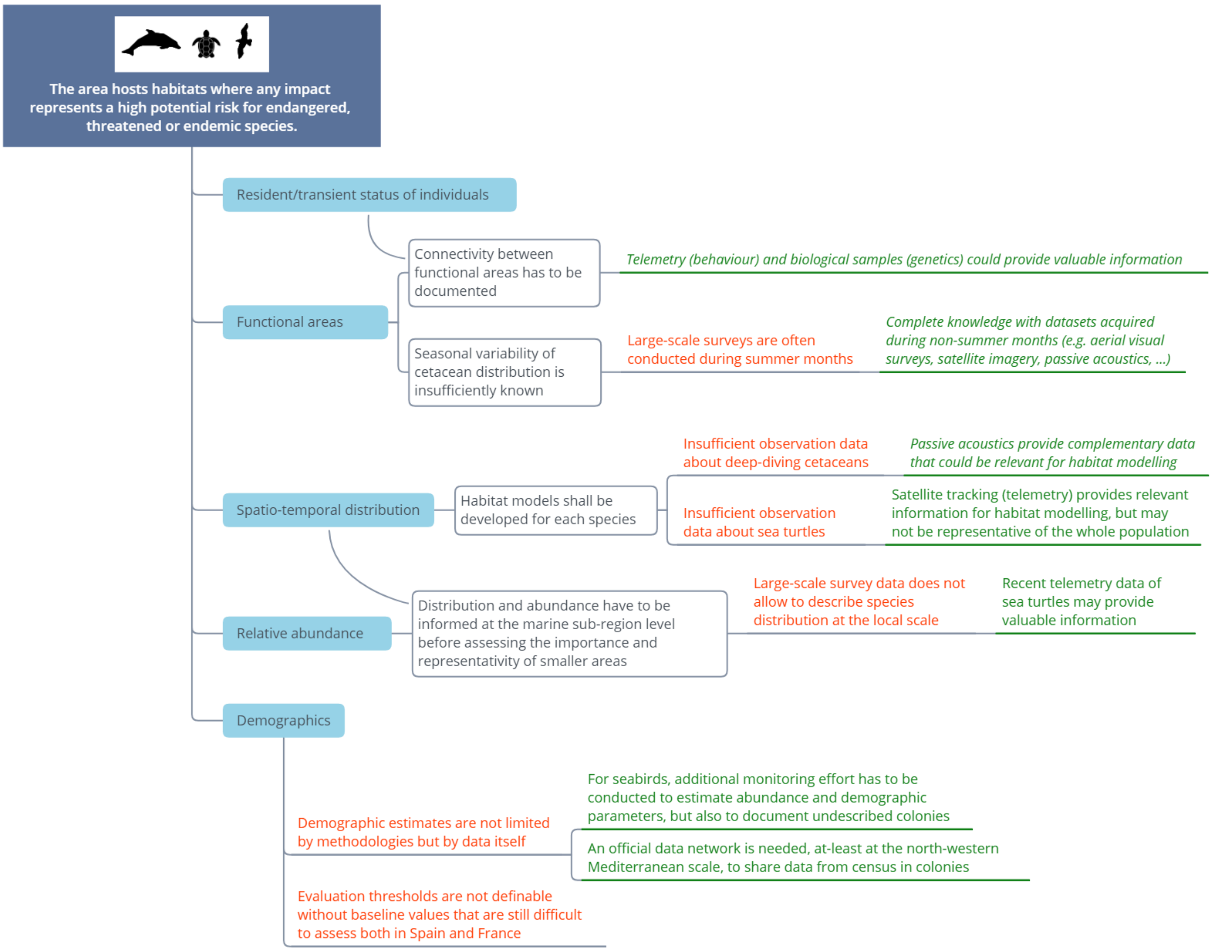

Figure 4: Results of technical meetings 3. Schematic view of knowledge mobilization to inform the ecological criterion "The area hosts habitats where any impact represents a high potential risk for endangered, threatened or endemic species" in regards with cetacean, sea turtle and seabird species encountered in the Gulf of Lions. Blue boxes refer to ecological parameters mentioned by experts, in link with the main criterion; white boxes refer to scientific targets or knowledge gaps; orange sentences stand for current limitations; and green sentences report solutions suggested by experts during technical meetings 3 (regular text) or provided by complementary sources from literature (italics). Credits: OFB.

3.2.2 Descriptor 1 of the Good Environmental Status – MSFD for megafauna species

Public reports allow to document the mobilization of data and their analysis in order to evaluate the Good Environmental Status of cetaceans, sea turtles and seabirds in Mediterranean reporting units of Spain (MITERD, 2020[48] see *fichas de evaluación initial por descriptor*) and France (Simian et al., 2018; Simian & Artero, 2018; Spitz et al., 2018). As mentioned above, one aim of technical meeting 3 was to (i) illustrate knowledge mobilization to inform evaluation criteria in the Gulf of Lions area, (ii) highlight limitations (methodological issue, missing data, etc.) within this process, and (iii) draw perspectives to overcome these limitations.

We report here (Figure 5 and Figure 6) a focus on two ecological criteria used to inform Descriptor 1 "Biodiversity" (MSFD), and selected by experts during technical meetings 3 (see detailed reports in annexe VII. Reports of technical meetings 3 (October 2021).

[48] Reports are available in : https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/

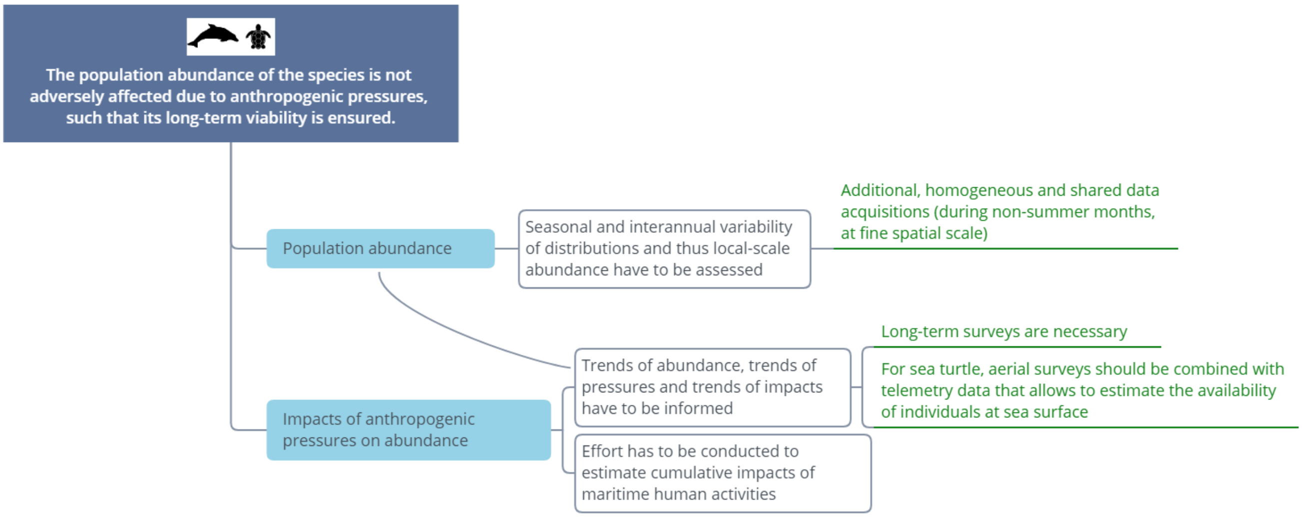

Figure 5: Results of technical meetings 3. Schematic view of knowledge mobilization to inform the ecological criterion "The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured" in regards with cetacean and sea turtle species encountered in the Gulf of Lions. Blue boxes refer to ecological parameters mentioned by experts, in link with the main criterion; white boxes refer to scientific targets or knowledge gaps; and green sentences report solutions suggested by experts during technical meetings 3. Credits: OFB.

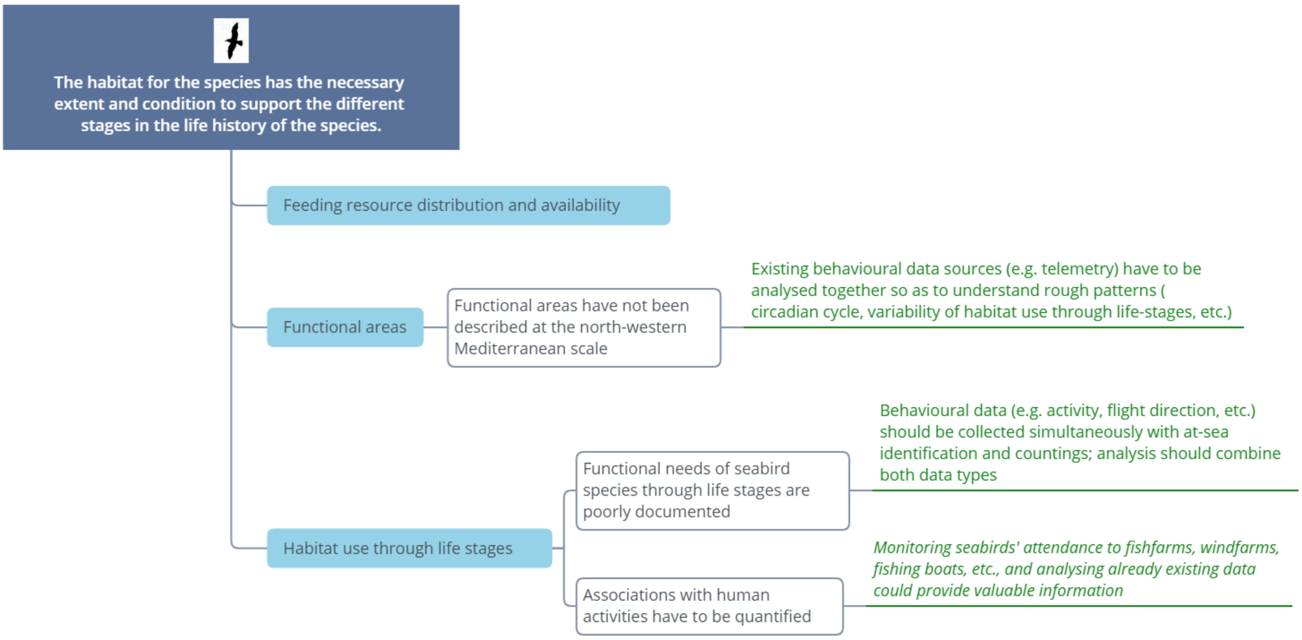

Figure 6: Results of technical meetings 3. Schematic view of knowledge mobilization to inform the ecological criterion "The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species" in regards with seabird species encountered in the Gulf of Lions. Blue boxes refer to ecological parameters mentioned by experts, in link with the main criterion; white boxes refer to scientific targets or knowledge gaps; and green sentences report solutions suggested by experts during technical meetings 3 (regular text) or provided by complementary sources from literature (italics). Credits: OFB.

3.3. Recommendations and perspectives at the transboundary scale

Paragraphs below synthesize the different perspectives emerging from the collective work conducted with scientific experts all along the MSPMED task 2.2.1.

3.3.1. Data sharing

- While data sharing is promoted by experts, the work conducted within the MSPMED "Gulf of Lions" case study did not aim at designing data sharing frameworks at the transboundary scale. In order data sharing to be effective, experts underline the need of support (dedicated platform, funds, conventions) from administrations.
- Data sharing encompasses ecological data (e.g. raw data from at-sea surveys) and fine-scale environmental data (e.g. wind, sea surface temperature, etc.) required to produce habitat models and predicted densities of megafauna species.
- Data sharing would allow valuable meta-analysis (e.g. merging telemetry data of seabirds) that could bridge some knowledge gaps (e.g. at-sea functional areas in the study area).

3.3.2. New data acquisition

Standardizing data acquisition

- Campaigns informing canyon deep habitats are often non-recurring, and deployed technologies or methodologies may not be comparable. Consequently, future data acquisition effort has to be standardized so as to allow the compatibility/comparability of datasets and strengthen baseline data required for the evaluation processes.
- Similarly, experts highlight the need to standardize megafauna monitoring protocols at all scales (local, national, transboundary scales).

Diversifying technologies and sampling strategies

- As described in this report, multi-approach data acquisition produces complementary data (e.g. passive acoustics, visual surveys, telemetry, radar). The synchronicity of data acquisitions through different technologies thus offers integrative results.
- Furthermore, diversifying sampling strategies to better inform megafauna distribution in offshore areas, during non-summer months, at night, and under bad weather conditions, is valuable to the ecological knowledge of these species, and critical in the context of impact assessment.

Long-term monitoring

- Long-term monitoring of canyon deep habitats and associated benthic fauna has to be ensured, as well as monitoring of cetacean, sea turtle and seabird species.
- More specifically, the characterization of deep habitats ecological state and the monitoring of megafauna species have to be conducted along with the characterization of

anthropogenic pressures and related impacts (Fréjefond et al., 2020; Pers. Comm. 2021).

3.3.3. Going on the analytical effort

Both data sharing and data acquisition imply a considerable analytical effort that shall not be underestimated. Among perspectives that emerged from technical meetings, experts mentioned:

- The regular updates of habitats models, in the context of the currently changing environment;
- The need to quantify interactions between ecosystems and human activities, including their cumulative effects;
- The need to quantify demographic parameters, as a crucial information for evaluations;
- The need to quantify the connectivity at several scales, e.g.: between seabird colonies, at the transboundary to the Mediterranean scale for cetacean, sea turtle and seabird species, and even broader scale for migratory bird species.
- The input of complementary data acquisition to better understand relationships between environmental conditions and species habitat use, which is critical in the context of at-sea activities spatial planning (e.g. interactions between windfarms and seabirds);
- The potentials of analysing opportunistic data and citizen science through novel methodologies and technologies.

3.3.4. Knowledge sharing

Increase awareness about identified ecological stakes

Relatively to benthic habitats of canyons, awareness of the existence, location, and specificities of Vulnerable Marine Ecosystems[49] at the transboundary scale and the Fisheries Restricted Area[50] in the Gulf of Lions shall be increased. VME represent a valuable baseline information to inform coordinated management measures in Spain and France (and at a larger scale).

Comparing analysis and results at the transboundary scale

- Point data collected to inform deep habitats can be analysed through different interpolation/extrapolation methods. In link with the acquisition of standardized datasets, effort shall be conducted to (i) compare analytical methods at the transboundary scale, (ii) evaluate the inter-comparability of results, (iii) tend to homogenize methods.
- Similarly, sharing feedback about monitoring and evaluation methodologies is encouraged, encompassing technologies (innovative tools), sampling strategies, and evaluation limitations, with the final goal of homogenizing evaluation processes on both sides of the border.

[49] https://www.fao.org/in-action/vulnerable-marine-ecosystems/criteria/en/

[50] Fisheries Restricted Areas (FRAs) – General Fisheries Commission for the Mediterranean - https://www.fao.org/gfcm/data/maps/fras/en/

Highlighting the analytical effort and uncertainty associated with results

Experts acknowledge the importance of making results easily available and understandable to a broad public.

- In order not to misinterpret results, experts underline the importance to systematically discuss them in the light of the associated uncertainty/confidence indices, notably within communications to a non-scientific audience.
- Besides, experts mention that the analytical effort required to process data and produce useful information for impact assessments are often underestimated.

Sharing questions

- While a significant effort has been made so as to identify existing data and review knowledge about deep habitat of canyons and their evaluation (see IDEM WebGIS tool[51], Fréjefond et al., (2020), Würtz (2012)), such effort shall be continued regularly at the transboundary scale.
- Experience sharing about evaluation limitations is encouraged, for any of the ecological component under study in this work.
- Sharing questions from both sides of the Spanish-French border may also trigger the implementation of collaborative projects at relevant scales.

All these perspectives presuppose **cooperation** and **coordination**, allowing to share efforts and competences, to ensure scientific coherence in the implementation of monitoring strategies, and to improve evaluation processes at transnational scales (Authier et al., 2017).

[51] http://gismarblack.bo.ismar.cnr.it:8080/mokaApp/apps/idem/index.html?null

Conclusion

The work conducted within the MSPMED task 2.2.1 of the Gulf of Lions case study allowed to identify data sources, methods and resulting ecological parameters in regards with cetaceans, sea turtles and seabirds in the study area. Rather than an overview of “knowledge” relative to the Gulf of Lions ecological stakes, this report targets the identification of remaining “knowledge gaps” in regards with MSP requirements. Thanks to the involvement of Spanish and French scientific experts, this work provides a synthesis of knowledge mobilization potentials, from data to knowledge and, inversely, from questions to scientific resources.

In the context of a shared Spanish and French responsibility towards ecological stakes relative to cetaceans, sea turtles, seabirds and canyon deep habitats in the Gulf of Lions, recommendations have been emitted so as to support MSP, in the light of reinforced transboundary cooperation and coordination.

Supplementary contributions: supporting MSP in the Mediterranean Sea

All along the conduction of this task, the collected information, methods and results of technical meetings have been shared and allowed to:

- Support mapping desk analysis during the French public debate on the commercial windfarm development within the Gulf of Lions (Note - *Compléments de discussion : apports et limites des données d’observations de la mégafaune marine analyse dans l’Etude bibliographique environnementale du Projet d’éoliennes flottantes en méditerranée (MTES, 2021), October 2021,15p.*)
- Contribute to the PSSA workshop held the 18th and 19th of October 2021 (Oral presentation - *Planning offshore activities in the Gulf of Lion in respect with ecosystems: cetaceans focus in the MSPMED transboundary case study*)
- Facilitate the animation and elaboration of recommendations towards the implementation of a national observatory of offshore windfarms in France (MTES) within the Windfarm Scientific Council of the *Conseil Maritime de Façade* (22nd of November, 2021).

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Annexes

I. Identified data acquired from aerial and boat-based surveys in the case study area, in regards with cetaceans and sea turtles

Table 1A: List of aerial (grey cells) and boat-based (white cells) surveys conducted within the case study area and informing cetacean and sea turtle distributions. When available, months during which surveys were conducted are indicated (yellow cells). When not found, month cells contain '-'. Last column refers to data sheets in annex IX of this report. Credits: OFB.

				Months												
Program	**Dataset**	**Institution**	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Reference in data sheets**
PELMED	PELMED93	IFREMER, EPHE, IEO, ICM, ICRAM	1993													PELMED-1993-Present-MM-MT-SB
PELMED	PELMED94	IFREMER, EPHE, COM	1994													PELMED-1993-Present-MM-MT-SB
PELMED	PELMED95	IFREMER, COM	1995													PELMED-1993-Present-MM-MT-SB
PELMED	PELMED96	IFREMER, EPHE, COM	1996													PELMED-1993-Present-MM-MT-SB
PELMED	PELMED98	IFREMER, COM	1998													PELMED-1993-Present-MM-MT-SB
PELMED	PELMED99	IFREMER, EPHE	1999													PELMED-1993-Present-MM-MT-SB
PELMED	PELMED2M	IFREMER, EPHE	2000													PELMED-1993-Present-MM-MT-SB
Proyecto Mediterráneo	GRUMM	GRUMM	2000	-	-	-	-	-	-	-	-	-	-	-	-	PROYECTO-MEDITERRANEO-2000-2002-MM-boat
Proyecto Mediterráneo	GRUMM	GRUMM	2001	-	-	-	-	-	-	-	-	-	-	-	-	PROYECTO-MEDITERRANEO-2000-2002-MM-boat
Proyecto Mediterráneo	Forcada2004	BAS & Univ.Barcelona	2001													PROYECTO-MEDITERRANEO-2000-2002-MM-plane
PELMED	PELMED02	IFREMER, EPHE	2002													PELMED-1993-Present-MM-MT-SB
Proyecto Mediterráneo	GRUMM	GRUMM	2002	-	-	-	-	-	-	-	-	-	-	-	-	PROYECTO-MEDITERRANEO-2000-2002-MM-boat
Proyecto Mediterráneo	Forcada2004	BAS & Univ.Barcelona	2002													PROYECTO-MEDITERRANEO-2000-2002-MM-plane
PELMED	PELMED03	IFREMER, EPHE	2003													PELMED-1993-Present-MM-MT-SB
PELMED	OBIS_1405	IFREMER, EPHE	2004													PELMED-1993-Present-MM-MT-SB
PELMED	OBIS_1405	IFREMER, EPHE	2005													PELMED-1993-Present-MM-MT-SB
PELMED	OBIS_1405	IFREMER, EPHE	2006													PELMED-1993-Present-MM-MT-SB
JUVALION	JUVALION07	Ifremer	2007													JUVALION-2007-2009-MM-MT-SB

				Months												
Program	**Dataset**	**Institution**	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Reference in data sheets**
MCV	MCV	BREACH	2007													BREACH-2007-2010-MM
PELMED	OBIS_1405	IFREMER, EPHE	2007													PELMED-1993-Present-MM-MT-SB
MCV	MCV	BREACH	2008	-	-	-	-	-	-	-	-	-	-	-	-	BREACH-2007-2010-MM
MEDSEACAN	MEDSEACAN	EcoOcéan Institut, AAMP	2008													MEDSEACAN-2008-2010-MM-SB
PELMED	OBIS_1405	IFREMER, EPHE	2008													PELMED-1993-Present-MM-MT-SB
INDEMARES	INDEMARES	SUBMON	2009													INDEMARES-2012-MM
JUVALION	JUVALION09	Ifremer	2009													JUVALION-2007-2009-MM-MT-SB
MCV	MCV	BREACH	2009	-	-	-	-	-	-	-	-	-	-	-	-	BREACH-2007-2010-MM
MEDSEACAN	MEDSEACAN	EcoOcéan Institut, AAMP	2009													MEDSEACAN-2008-2010-MM-SB
PELMED	OBIS_1405	Observatoire Pelagis	2009													PELMED-1993-Present-MM-MT-SB
INDEMARES	INDEMARES	SUBMON	2010													INDEMARES-2012-MM
MEDSEACAN	MEDSEACAN	EcoOcéan Institut, AAMP	2010													MEDSEACAN-2008-2010-MM-SB
FLT MED Net	FLT	EcoOcéan Institut	2011	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MarineRenewables	PGL	BIOTOPE	2011													PGL-2011-2013-MM-MT-SB-MB-BH
MarineRenewables	PGL	BIOTOPE	2011													PGL-2011-2013-MM-MT-SB-MB-BH
PACOMM	SAMM1	Observatoire Pelagis	2011													SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF
PELMED	PELMED11	EcoOcean Institut	2011													PELMED-1993-Present-MM-MT-SB
FLT MED Net	FLT	EcoOcéan Institut	2012	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MarineRenewables	PGL	BIOTOPE	2012													PGL-2011-2013-MM-MT-SB-MB-BH
PACOMM	SAMM1	Observatoire Pelagis	2012													SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF
FLT MED Net	FLT	EcoOcéan Institut	2013	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MarineRenewables	PGL	BIOTOPE	2013													PGL-2011-2013-MM-MT-SB-MB-BH
MarineRenewables	PGL	BIOTOPE	2013													PGL-2011-2013-MM-MT-SB-MB-BH
PACOMM	GDEGeM	BREACH	2013													GDEGeM-2013-2015-MM
PACOMM	GDEGeM	EcoOcean Institut	2013													GDEGeM-2013-2015-MM
PACOMM	GDEGeM	GECEM	2013													GDEGeM-2013-2015-MM

				Months												
Program	**Dataset**	**Institution**	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Reference in data sheets**
FLT MED Net	FLT	EcoOcéan Institut	2014	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
Grampus	Grampus	SUBMON	2014	-	-	-	-	-	-	-	-	-	-	-	-	GRAMPUS-2014-MM
PACOMM	GDEGeM	BREACH	2014													GDEGeM-2013-2015-MM
PACOMM	GDEGeM	EcoOcean Institut	2014													GDEGeM-2013-2015-MM
PACOMM	GDEGeM	GECEM	2014													GDEGeM-2013-2015-MM
FLT MED Net	FLT	EcoOcéan Institut	2015	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
PACOMM	GDEGeM	BREACH	2015													GDEGeM-2013-2015-MM
PACOMM	GDEGeM	EcoOcean Institut	2015													GDEGeM-2013-2015-MM
PACOMM	GDEGeM	GECEM	2015													GDEGeM-2013-2015-MM
FLT MED Net	FLT	EcoOcéan Institut	2016	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MarineRenewables	EOLMED	BIOTOPE	2016													EOLMED-2016-2017-MM-MT-SB-MB-BH
PELMED	PELMED16	CEFE	2016													PELMED-1993-Present-MM-MT-SB
Delfines de Tramuntana	DDT	SUBMON	2017	-	-	-	-	-	-	-	-	-	-	-	-	DDT-2017-2020-MM
FLT MED Net	FLT	EcoOcéan Institut	2017	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MarineRenewables	EFGL	BIOTOPE	2017													EFGL-2017-2018-MM-MT-SB-MB-BH
MarineRenewables	EFGL	BIOTOPE	2017													EFGL-2017-2018-MM-MT-SB-MB-BH
MarineRenewables	EOLMED	BIOTOPE	2017													EOLMED-2016-2017-MM-MT-SB-MB-BH
MarineRenewables	EOLMED	BIOTOPE	2017													EOLMED-2016-2017-MM-MT-SB-MB-BH
PELMED	PELMED17	Observatoire Pelagis	2017													PELMED-1993-Present-MM-MT-SB
ACCOBAMS	ASI	Various	2018													ASI-2018-BOAT-MM-MT-SB-EB-SF
ACCOBAMS	ASI	Various	2018													ASI-2018-BOAT-MM-MT-SB-EB-SF
ASI	ASI	ACCOBAMS	2018													ASI-2018-PLANE-MM-MT-SB-EB-SF
Delfines de Tramuntana	DDT	SUBMON	2018	-	-	-	-	-	-	-	-	-	-	-	-	DDT-2017-2020-MM
FLT MED Net	FLT	EcoOcéan Institut	2018	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MarineRenewables	EFGL	BIOTOPE	2018													EFGL-2017-2018-MM-MT-SB-MB-BH
MarineRenewables	EFGL	BIOTOPE	2018													EFGL-2017-2018-MM-MT-SB-MB-BH

				Months												
Program	**Dataset**	**Institution**	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Reference in data sheets**
PELMED	PELMED18	Observatoire Pelagis	2018													PELMED-1993-Present-MM-MT-SB
suivi MegaObs	MegaObs	EcoOcéan Institut, AFB	2018													MEGAOBS-MM-MT-SB-EB-SF-2018-Present
DCSMM	SAMM2	Observatoire Pelagis	2019													SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF
Delfines de Tramuntana	DDT	SUBMON	2019	-	-	-	-	-	-	-	-	-	-	-	-	DDT-2017-2020-MM
FLT MED Net	FLT	EcoOcéan Institut	2019													FLT-2011-Present-MM-MT-SB-SF
Grand dauphin en Occitanie	TtOccitanie	EcoOcéan Institut, DREAL Occitanie	2019	-	-	-	-	-	-	-	-	-	-	-	-	TT-OCCITANIE-2019-2020-MM-SB
PELMED	PELMED19	Observatoire Pelagis	2019													PELMED-1993-Present-MM-MT-SB
suivi MegaObs	MegaObs	PNMGL	2019													MEGAOBS-MM-MT-SB-EB-SF-2018-Present
AHAB	AHAB	SUBMON	2020	-	-	-	-	-	-	-	-	-	-	-	-	AHAB-2020-MM
campagne TURSMED	TURSMED	OFB	2020													TURSMED-2020-2023-MM
Delfines de Tramuntana	DDT	SUBMON	2020	-	-	-	-	-	-	-	-	-	-	-	-	DDT-2017-2020-MM
FLT MED Net	FLT	EcoOcéan Institut	2020	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
Grand dauphin en Occitanie	TtOccitanie	EcoOcéan Institut, DREAL Occitanie	2020	-	-	-	-	-	-	-	-	-	-	-	-	TT-OCCITANIE-2019-2020-MM-SB
PELMED	PELMED20	Observatoire Pelagis	2020													PELMED-1993-Present-MM-MT-SB
suivi MegaObs	MegaObs	PNMGL	2020													MEGAOBS-MM-MT-SB-EB-SF-2018-Present

II. Identified data acquired from aerial and boat-based surveys in the case study area, in regards with seabirds

Table 2A: List of aerial (grey cells) and boat-based (white cells) surveys conducted within the case study area and informing seabird distribution. When available, months during which surveys were conducted are indicated (yellow cells). When not found, month cells contain '-'. Last column refers to data sheets in annex IX of this report. Credits: OFB.

				Months												
Program	**Dataset**	**Institution**	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Reference in data sheets**
PELMED	PELMED93	EPHE,IEO,ICM,ICRAM,IFREMER	1993													PELMED-1993-Present-MM-MT-SB
MEDITS	MEDITS1994	IMEDEA (CSIC-UB)	1994													MEDITS-1994-Present-SB
MEDITS	MEDITS1995	IMEDEA (CSIC-UB)	1995													MEDITS-1994-Present-SB
MEDITS	MEDITS1996	IMEDEA (CSIC-UB)	1996													MEDITS-1994-Present-SB
MEDITS	MEDITS1997	IMEDEA (CSIC-UB)	1997													MEDITS-1994-Present-SB
MEDITS	MEDITS1998	IMEDEA (CSIC-UB)	1998													MEDITS-1994-Present-SB
MEDITS	OBIS334 - MEDITS	IMEDEA (CSIC-UB)	1999													MEDITS-1994-Present-SB
MEDITS	OBIS334 - MEDITS	IMEDEA (CSIC-UB)	2000													MEDITS-1994-Present-SB
MEDITS	OBIS334 - MEDITS	IMEDEA (CSIC-UB)	2002													MEDITS-1994-Present-SB
JUVALION	JUVALION07	Ifremer	2007													JUVALION-2007-2009-MM-MT-SB
MEDITS	MEDITS - OBIS334	IMEDEA (CSIC-UB)	2007													MEDITS-1994-Present-SB
PELMED	PELMED08	EPHE	2008													PELMED-1993-Present-MM-MT-SB
MEDSEACAN	MEDSEACAN	EcoOcéan Institut, AAMP	2008													MEDSEACAN-2008-2010-MM-SB
MEDSEACAN	MEDSEACAN	EcoOcéan Institut, AAMP	2009													MEDSEACAN-2008-2010-MM-SB
INDEMARES	CSIC-CREUS	CSIC	2009													CSIC-CREUS-2009-SB
JUVALION	JUVALION09	Ifremer	2009													JUVALION-2007-2009-MM-MT-SB
MEDIAS/INDEMARES	MEDIAS	IEO	2009													MEDIAS-2009-Present-SB
PELMED	PELMED09	EPHE	2009													PELMED-1993-Present-MM-MT-SB

Program	Dataset	Institution	Year	Months												Reference in data sheets
				1	2	3	4	5	6	7	8	9	10	11	12	
MEDSEACAN	MEDSEACAN	EcoOcéan Institut, AAMP	2010													MEDSEACAN-2008-2010-MM-SB
MEDIAS/INDEMARES	MEDIAS	IEO	2010													MEDIAS-2009-Present-SB
PELMED	PELMED10	EPHE	2010													PELMED-1993-Present-MM-MT-SB
FLT MED Net	FLT	EcoOcéan Institut	2011	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MEDIAS/INDEMARES	MEDIAS	IEO	2011													MEDIAS-2009-Present-SB
PELMED	PELMED11	EcoOcéan Institut	2011													PELMED-1993-Present-MM-MT-SB
MarineRenewables	PGL	BIOTOPE	2011													PGL-2011-2013-MM-MT-SB-MB-BH
PACOMM	SAMM1	Observatoire Pelagis	2011													SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF
FLT MED Net	FLT	EcoOcéan Institut	2012	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MEDIAS/INDEMARES	MEDIAS	IEO	2012													MEDIAS-2009-Present-SB
PELMED	PELMED12	CEFE	2012													PELMED-1993-Present-MM-MT-SB
MarineRenewables	PGL	BIOTOPE	2011													PGL-2011-2013-MM-MT-SB-MB-BH
MarineRenewables	PGL	BIOTOPE	2012													PGL-2011-2013-MM-MT-SB-MB-BH
PACOMM	SAMM1	Observatoire Pelagis	2012													SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF
FLT MED Net	FLT	EcoOcéan Institut	2013	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MEDIAS/INDEMARES	MEDIAS	IEO	2013													MEDIAS-2009-Present-SB
PELMED	PELMED13	CEFE	2013													PELMED-1993-Present-MM-MT-SB
MarineRenewables	PGL	BIOTOPE	2013													PGL-2011-2013-MM-MT-SB-MB-BH
MarineRenewables	PGL	BIOTOPE	2013													PGL-2011-2013-MM-MT-SB-MB-BH
FLT MED Net	FLT	EcoOcéan Institut	2014	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MEDIAS	MEDIAS	IEO	2014													MEDIAS-2009-Present-SB
PELMED	PELMED14	CEFE	2014													PELMED-1993-Present-MM-MT-SB
FLT MED Net	FLT	EcoOcéan Institut	2015	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MEDIAS	MEDIAS	IEO	2015													MEDIAS-2009-Present-SB
PELMED	PELMED15	CEFE	2015													PELMED-1993-Present-MM-MT-SB
FLT MED Net	FLT	EcoOcéan Institut	2016	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF

Program	Dataset	Institution	Year	Months												Reference in data sheets
				1	2	3	4	5	6	7	8	9	10	11	12	
MarineRenewables	EOLMED	BIOTOPE	2016													EOLMED-2016-2017-MM-MT-SB-MB-BH
MEDIAS	MEDIAS	IEO	2016													MEDIAS-2009-Present-SB
PELMED	PELMED16	CEFE	2016													PELMED-1993-Present-MM-MT-SB
FLT MED Net	FLT	EcoOcéan Institut	2017	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
MarineRenewables	EFGL	BIOTOPE	2017													EFGL-2017-2018-MM-MT-SB-MB-BH
MarineRenewables	EOLMED	BIOTOPE	2017													EOLMED-2016-2017-MM-MT-SB-MB-BH
MarineRenewables	EOLMED	BIOTOPE	2017													EOLMED-2016-2017-MM-MT-SB-MB-BH
MarineRenewables	EOLMED/EFGL	BIOTOPE	2017													EFGL-2017-2018-MM-MT-SB-MB-BH
MEDIAS	MEDIAS	IEO	2017													MEDIAS-2009-Present-SB
PELMED	PELMED17	Observatoire Pelagis	2017													PELMED-1993-Present-MM-MT-SB
FLT MED Net	FLT	EcoOcéan Institut	2018	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
Grand dauphin en Occitanie	TtOccitanie	EcoOcéan Institut, DREAL Occitanie	2019	-	-	-	-	-	-	-	-	-	-	-	-	TT-OCCITANIE-2019-2020-MM-SB
ASI	ASI	ACCOBAMS	2018													ASI-2018-BOAT-MM-MT-SB-EB-SF
ASI	ASI	ACCOBAMS	2018													ASI-2018-PLANE-MM-MT-SB-EB-SF
MarineRenewables	EFGL	BIOTOPE	2018													EFGL-2017-2018-MM-MT-SB-MB-BH
MarineRenewables	EOLMED/EFGL	BIOTOPE	2018													EOLMED-2016-2017-MM-MT-SB-MB-BH
MEDIAS	MEDIAS	IEO	2018													MEDIAS-2009-Present-SB
suivi MegaObs	MegaObs	PNMGL - EcoOcean Institut	2018													MEGAOBS-MM-MT-SB-EB-SF-2018-Present
PELMED	PELMED18	Observatoire Pelagis	2018													PELMED-1993-Present-MM-MT-SB
FLT MED Net	FLT	EcoOcéan Institut	2018	-	-	-	-	-	-	-	-	-	-	-	-	FLT-2011-Present-MM-MT-SB-SF
Grand dauphin en Occitanie	TtOccitanie	EcoOcéan Institut, DREAL Occitanie	2019	-	-	-	-	-	-	-	-	-	-	-	-	TT-OCCITANIE-2019-2020-MM-SB
MEDIAS	MEDIAS	IEO	2019													MEDIAS-2009-Present-SB
suivi MegaObs	MegaObs	PNMGL	2019													MEGAOBS-MM-MT-SB-EB-SF-2018-Present
PELMED	PELMED19	Observatoire Pelagis	2019													PELMED-1993-Present-MM-MT-SB
DCSMM	SAMM2	Observatoire Pelagis	2019													SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF

Program	Dataset	Institution	Year	Months												Reference in data sheets
				1	2	3	4	5	6	7	8	9	10	11	12	
FLT MED Net	FLT	EcoOcéan Institut	2019													FLT-2011-Present-MM-MT-SB-SF
suivi MegaObs	MegaObs	PNMGL	2020													MEGAOBS-MM-MT-SB-EB-SF-2018-Present
PELMED	PELMED20	Observatoire Pelagis	2020													PELMED-1993-Present-MM-MT-SB

III. Identified data acquisition campaigns within canyons in the North-Western Mediterranean Sea

Table 3A: List of data acquisition campaigns identified in the canyon area, North-Western Mediterranean Sea. Credits: OFB.

Sector	Campaign	Year of data collection	Data acquisition methods (non exhaustive)	Metrics/Results (non exhaustive)	References (ex: campaigns, publications)
Blanes cayon	RECS II Project	2003	commercial bottom trawl	species identification (benthic megafauna); abundance and biomass	Ramirez-Llodra et al., 2010
Blanes cayon	RECS II Project	2004	commercial bottom trawl	species identification (benthic megafauna); abundance and biomass	Ramirez-Llodra et al., 2010
Blanes cayon	PROMARES - OASIS DEL MAR	2011	Video images	marine litter characterization	Tubau et al., 2015
La Fonera canyon	CANYON	2007	Multibeam echosounder	bathymetry	Ribó et al., 2011
La Fonera canyon	HERMIONE	2009	ROV video images	species identification, litter characterization, substrates characterization	Lastras et al., 2016
La Fonera canyon	HERMIONE	2010	ROV video images	species identification, litter characterization, substrates characterization	Lastras et al., 2016
La Fonera canyon	PROMARES - OASIS DEL MAR	2011	Video images	marine litter characterization	Tubau et al., 2015
Cap de Creus canyon	CORAL 1	2003	ROV video images	species identification	Gili et al., 2010
Cap de Creus canyon	HERMES I_CORAL 2	2005	ROV video images, water and zooplankton sampling	species identification, litter characterization, substrates characterization	Orejas et al., 2009
Cap de Creus canyon	DEEPCORAL I_CORAL 4	2006	ROV video images, water and zooplankton sampling	species identification, litter characterization, substrates characterization	Orejas et al., 2009
Cap de Creus canyon	HERMES IV_CORAL 8	2007	Video images; multibeam bathymetry	species identification, litter characterization, substrates characterization, bathymetry	Orejas et al., 2009 Gori et al., 2013
Cap de Creus canyon	INDEMARES 0 et 1	2009	Video images; sediment and biological sampling	species identification, substrates and habitat characterization	Gili et al., 2010
Cap de Creus canyon	INDEMARES 2	2010	Video images; Echosounder; sampling (deep plankton); dredging	species identification, litter identification, habitat characterization, coral growth rate, granulometry	Gili et al., 2010
Cap de Creus canyon	PROMARES - OASIS DEL MAR	2011	Video images	marine litter characterization	Tubau et al., 2015
Lacaze-Duthiers offshore reefs / rocky outcrop	MEDSEACAN	2009	Video images and pictures; multibeam bathymetry; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Lacaze-Duthiers canyon	MOLA	2008	Video images	species identification	Goujard, 2021

Sector	Campaign	Year of data collection	Data acquisition methods (non exhaustive)	Metrics/Results (non exhaustive)	References (ex: campaigns, publications)
Lacaze-Duthiers canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Lacaze-Duthiers canyon	MARUM SECKENBERG	2011	Video images	species identification, litter characterization, substrates characterization	Fabri et al., 2014
Lacaze-Duthiers canyon	PROMARES - OASIS DEL MAR	2011	Video images	marine litter characterization	Tubau et al., 2015
Lacaze-Duthiers canyon	CALADU	2019	ROV video images; coral samplngs; mulitbeam echosounder	species identification; bathymetry; 3D modelling of benthic habitats	Fabri & Participants, 2019
Lacaze-Duthiers canyon	CALADU	2021	ADCP; ROV video images; coral samplings; multibeam echosounder; vertical echosounder; CTD	species identification; bathymetry; coral genetics	Fabri & Arnaud-Haond, 2021
Pruvost canyon	MEDSEACAN	2009	Video images and pictures	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Bourcart canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Sète offshore reef / rocky outcrop	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Ichtys offshore reef / rocky outcrop	MEDSEACAN	2009	Video images and pictures	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Sète canyon	MEDSEACAN	2009	Video images and pictures; multi-beam bathymetry; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Marti canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Montpellier canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Petit Rhône canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Grand Rhône canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry;	Fourt & Goujard, 2012

Sector	Campaign	Year of data collection	Data acquisition methods (non exhaustive)	Metrics/Results (non exhaustive)	References (ex: campaigns, publications)
				litter characterization	
Couronne canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Planier canyon	CYATOX	1995	Grab sampling; photography	litter identification; zoo-benthos	GALGANI François (1995) CYATOX cruise, RV Le Suroît, https://doi.org/10.17600/95020060
Planier canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Cassidaigne canyon	CYATOX	1995	Grab sampling; photography	litter identification; zoo-benthos	Galgani et al., 1996
Cassidaigne canyon	HERMES (MARUM)	2009	ROV video images; coral samplings	species identification (benthic megafauna)	Fabri et al., 2014
Cassidaigne canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Cassidaigne canyon	ESSROV	2010	Multibeam echosounder; vertical echosounder; ROV video images	species identification (benthic megafauna); substrate description / imagery; substrate characterization	SIMEONI Patrick (2010) ESSROV 2010 cruise, RV Pourquoi pas ?, https://doi.org/10.17600/10030090
Esquine offshore reef / rocky outcrop	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Blauquieres offshore reef / rocky outcrop	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Anonymous canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Sicié canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Toulon canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Porquerolles canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012

Sector	Campaign	Year of data collection	Data acquisition methods (non exhaustive)	Metrics/Results (non exhaustive)	References (ex: campaigns, publications)
Magaud offshore reef / rocky outcrop	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Stoechades canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Nioulargue offshore reef / rocky outcrop	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Nioulargue offshore reef / rocky outcrop	RAMOGE EXPLO2015	2015	Multibeam echosounder; ROV video images	species identification; bathymetry; litter characterization	M. Fourt et al., 2015
Reyss 1964 site	RAMOGE EXPLO2018	2018	Multibeam echosounder; fauna samplings; litter samplings; sediment cores	species identification; bathymetry; litter characterization	DANIEL Boris (2018) RAMOGE cruise, RV L'Atalante, https://doi.org/10.17600/18000739
Pampelonne canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Saint-Tropez canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Dramont canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Méjean shoal/seamount	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Méjean shoal/seamount	RAMOGE EXPLO2018	2018	Multibeam echosounder; fauna samplings; litter samplings; sediment cores	species identification; bathymetry; litter characterization	DANIEL Boris (2018) RAMOGE cruise, RV L'Atalante, https://doi.org/10.17600/18000739
Cannes canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Cannes canyon	RAMOGE EXPLO2018	2018	Multibeam echosounder; fauna samplings; litter samplings; sediment cores	species identification; bathymetry; litter characterization	DANIEL Boris (2018) RAMOGE cruise, RV L'Atalante, https://doi.org/10.17600/18000739
Juan canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012

Sector	Campaign	Year of data collection	Data acquisition methods (non exhaustive)	Metrics/Results (non exhaustive)	References (ex: campaigns, publications)
Var canyon	CYATOX	1995	Grab sampling; photography	litter identification; zoo-benthos	Galgani et al., 1996
Var canyon	ENVAR1	2005	Core sampling; multibeam echosounder; ADCP; vertical echosounder; sediment trap	species identifiation; turbidity; organic matter concentrations	VANGRIESHEIM Annick (2005) ENVAR1 cruise, RV L'Europe, https://doi.org/10.17600/5060140
Var canyon	ENVAR2	2005	Core sampling; multibeam echosounder; ADCP; vertical echosounder; sediment trap	species identifiation; turbidity; organic matter concentrations	BLANDIN Jérôme (2005) ENVAR2 cruise, RV Le Suroît, https://doi.org/10.17600/5020150
Var canyon	ENVAR3	2006	Core sampling; multibeam echosounder; ADCP; vertical echosounder; sediment trap	species identifiation; turbidity; organic matter concentrations	KHRIPOUNOFF Alexis (2006) ENVAR3 cruise, RV Le Suroît, https://doi.org/10.17600/6020040
Var canyon	ENVAR4	2006	Core sampling; multibeam echosounder; ADCP; vertical echosounder; sediment trap	species identifiation; turbidity; organic matter concentrations	KHRIPOUNOFF Alexis (2006) ENVAR4 cruise, RV Le Suroît, https://doi.org/10.17600/6020060
Var canyon	ENVAR5	2007	Core sampling; multibeam echosounder; ADCP; vertical echosounder; sediment trap	species identifiation; turbidity; organic matter concentrations	CRASSOUS Philippe (2007) ENVAR5 cruise, RV Le Suroît, https://doi.org/10.17600/7020040
Var canyon	MEDECO	2007	ROV video images; bottom photography; sediment trap; ADCP; multi-beam echosounding; chemical measures	species identification; diversity and biomass of faunal and microbial communities; biochemistry	SARRAZIN Jozée, PIERRE Catherine (2007) MEDECO cruise, RV Pourquoi pas ?, https://doi.org/10.17600/7030090
Var canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Paillon canyon	CYATOX	1995	Grab sampling; photography	litter identification; zoo-benthos	Galgani et al., 1996
Paillon canyon	MEDSEACAN	2009	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt & Goujard, 2012
Monaco canyon	RAMOGE EXPLO2015	2015	Multibeam echosounder; ROV video images	species identification; bathymetry; litter characterization	Fourt et al., 2015
Monaco canyon	RAMOGE EXPLO2018	2018	Multibeam echosounder; fauna samplings; litter samplings; sediment cores	species identification; bathymetry; litter characterization	DANIEL Boris (2018) RAMOGE cruise, RV L'Atalante, https://doi.org/10.17600/18000739
Spinola Spur seamount	RAMOGE EXPLO2018	2018	Multibeam echosounder; fauna samplings; litter samplings; sediment cores	species identification; bathymetry; litter characterization	DANIEL Boris (2018) RAMOGE cruise, RV L'Atalante, https://doi.org/10.17600/18000739
Janua seamount	RAMOGE EXPLO2018	2018	Multibeam echosounder; fauna samplings; litter samplings;	species identification; bathymetry; litter characterization	DANIEL Boris (2018) RAMOGE cruise, RV L'Atalante,

Sector	Campaign	Year of data collection	Data acquisition methods (non exhaustive)	Metrics/Results (non exhaustive)	References (ex: campaigns, publications)
			sediment cores		https://doi.org/10.17600/18000739
Ulisse seamount	RAMOGE EXPLO2018	2018	Multibeam echosounder; fauna samplings; litter samplings; sediment cores	species identification; bathymetry; litter characterization	DANIEL Boris (2018) RAMOGE cruise, RV L'Atalante, https://doi.org/10.17600/18000739
Madrepora mound area (NE Corsica)	LM99	1999	Samplings (dredge and grab); seismic profiles/echosounder	species identification; seismic profile	Remia & Taviani, 2005
Madrepora mound area (NE Corsica)	CORTI	2003	Samplings (dredge and grab); seismic profiles/echosounder	species identification; seismic profile	Remia & Taviani, 2005
Seamounts and canyons	CYLICE	1997	Photography; seismics	geomorphology; litter characterization; bathymetry	SOSSON Marc, GUENNOC Pol (1997) CYLICE cruise, RV Le Nadir, https://doi.org/10.17600/97080120; Fourt & Goujard, 2014
Northern Centuri canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Southern Centuri canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Saint-Florent canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Île-Rousse canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Calvi canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Galéria canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Porto canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Cargèse canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013

Sector	Campaign	Year of data collection	Data acquisition methods (non exhaustive)	Metrics/Results (non exhaustive)	References (ex: campaigns, publications)
Sagone canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Ajaccio canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Ajaccio promontory	CYLICE-ECO	2018	ROV video images; multibeam echoounder; vertical sounder; CTD	species identification; bathymetry	LE BRIS Nadine (2018) CYLICE-ECO 2018 cruise, RV L'Europe, https://doi.org/10.17600/18000590
Valinco canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Valinco canyon	CYLICE-ECO	2018	ROV video images; multibeam echoounder; vertical sounder; CTD	species identification; bathymetry	LE BRIS Nadine (2018) CYLICE-ECO 2018 cruise, RV L'Europe, https://doi.org/10.17600/18000590
des Moines canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Castelsardo canyon	CORSEACAN	2010	Video images and pictures; samplings	species identification (benthic megafauna); substrate description / imagery; bathymetry; litter characterization	Fourt et al., 2013
Bordighera canyon	RAMOGE EXPLO2015	2015	Multibeam echosounder; ROV video images	species identification; bathymetry; litter characterization	Fourt et al., 2015
Arma di Taggia canyon	RAMOGE EXPLO2015	2015	Multibeam echosounder; ROV video images	species identification; bathymetry; litter characterization	Fourt et al., 2015

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IV. Consulted data platforms

Table 4A: List of data platforms identified and consulted during the knowledge synthesis elaboration. Sources and types of referenced data are diverse, and this catalogue may not be exhaustive.

Platform / reference	Link to web page
ASI (ACCOBAMS Survey Initiative)	https://accobams.org/asi-data-presentation/
BirdLife International	http://datazone.birdlife.org/home
Cartomer	https://cartographie.afbiodiversite.fr/geosource/apps/search/?hl=fre&extent=-550000,5000000,1200000,7000000
eBird	https://ebird.org/home
EMODnet (European Marine Observation and Data Network)	https://www.emodnet.eu/en/portals
ESA's Ecological Archives	http://esapubs.org/archive/
FAO (Food and Agriculture Organization of the United Nations) GeoNetwork	http://www.fao.org/geonetwork/srv/en/main.home
GBIF (Global Biodiversity Information Facility)	https://www.gbif.org/
Geoportail	https://www.geoportail.gouv.fr/
GFCM (General Fisheries Commission for the Mediterranean)	http://www.fao.org/gfcm/data/en/
IEO (Instituto Español de Oceanografía)	http://datos.ieo.es/geonetwork/srv/fre/catalog.search#/home
Ifremer	http://data.ifremer.fr/pdmi/portalssearch/main
iNaturalist	https://www.inaturalist.org/
INPN (Inventaire National du Patrimoine Naturel)	https://inpn.mnhn.fr/accueil/recherche-de-donnees
INTERCET	http://www.intercet.it/
Marine Mammal Protected Areas Task Force	https://www.marinemammalhabitat.org/imma-eatlas/
Mediterranean Biodiversity Platform	https://data.medchm.net/en/
Meridionalis	https://www.faune-lr.org/
MITERD (Ministerio para la Transición Ecológica y el Reto Demográfico)	https://www.miteco.gob.es/ide/metadatos/
MSFD Spain	http://barretosm.md.ieo.es/arcgis/rest/services/MSFD
Nature France	https://naturefrance.fr/ressources-accessibles
Natusfera	https://natusfera.gbif.es/
NCEAS (National Center for Ecological Analysis and Synthesis)	https://www.nceas.ucsb.edu/globalmarine
OBIS (Ocean Biodiversity Information System)	https://obis.org/
OBIS-Seamap	http://seamap.env.duke.edu/
Observadores del mar	www.observadoresdelmar.es
Observatoire des Oiseaux Marins et Côtiers	https://oiseaux-marins.org/accueil
ODATIS	https://www.odatis-ocean.fr/en/data-and-services/data-access/direct-access-to-the-data-

Platform / reference	Link to web page
	catalogue#/search?from=1&to=30
ONB (Observatoire National de la Biodiversité)	http://indicateurs-biodiversite.naturefrance.fr/indicateurs/tous
OpenObs	https://openobs.mnhn.fr/
Ornithocat	www.ornitho.cat
Sea Turtle Database	www.seaturtledb.com
Sea Turtle Rescue Sites	https://www.google.com/maps/d/viewer?mid=13y5tmCo3feRD49zatUTqeitpfnI&ll=41.89232179317704%2C9.22578176210937&z=6
SeaDataNet : Pan-European structure for ocean and marine data management	https://cdi.seadatanet.org
SEXTANT Ifremer	https://sextant.ifremer.fr/Donnees/Catalogue
Surval / Quadrige	https://wwz.ifremer.fr/surval/Presentation/Quadrige
WDPA (World Database on Protected Areas)	https://www.protectedplanet.net/

V. Data to knowledge: reviewed information and references

Table 5A: Reviewed information used to synthesize the mobilization of knowledge in the Gulf of Lions area through data, methods and results.

Ecological component	Data type	Measured parameter (first step)	Methods (second step)	Resulting product/parameter	References / Examples
Cetaceans	Passive acoustics	Species identification	Detection function based on the acoustically derived perpendicular distances	Location of recorded individuals; abundance estimation (nb ind.)	Cauchy et al., 2020; Lewis et al., 2018
Cetaceans	Passive acoustics	Species identification and estimates of the number of detected individuals	Habitat modelling (GAM, GLM, …)	Habitat suitability	Praca et al., 2009
Cetaceans	Passive acoustics	Species identification	Description of spatial and temporal variability	Daily activity (e.g. "foraging schedule")	van der Schaar et al., 2017
Seabirds	drone + fine scale tracking	velocity and tortuosity of track	hidden-markov model incorporating physical parameters	fine-scale relationship between local environmental conditions and seabird behaviour	Lieber et al., 2021
Cetaceans, seabirds, sea turtles	Aerial or/and boat-based surveys	Encounter rate (nb sightings/km)	Description of spatial and temporal variability	Spatio-temporal presence/absence	Di-Méglio et al., 2015
Cetaceans, seabirds	Aerial or/and boat-based surveys	Species richness (nb species/km²)	Description of spatial and temporal variability	Phenology/Ecology of species	Rufray et al., 2015
Cetaceans, seabirds, sea turtles	Aerial or/and boat-based surveys	Relative abundance (nb ind./km²) Count of groups in each sampling unit (nb. group per sampling unit)	Habitat modelling (GAM, GLM, …)	Predicted abundance of groups (nb of groups/grid cell or km²); predicted abundance of individuals (nb ind./grid cell or km²)	**Relative abundance:** Di-Méglio et al., 2015 **Abundance estimates :** Laran et al., 2017 **GAMs :** Lambert et al., 2017 Cañadas et al., 2018

Ecological component	Data type	Measured parameter (first step)	Methods (second step)	Resulting product/parameter	References / Examples
Cetaceans, seabirds	Aerial or/and boat-based surveys	Occurrence of individuals: distribution of detected groups and group-size estimates	Correction: detectability Covariate analysis	Density estimates	Di-Méglio et al., 2015 Forcada et al., 2004
Cetaceans	Boat-based surveys	Density (nb ind./km²)	Linked to averaged body weight and ingestion or metabolic rate	Estimates of the daily rations of cetaceans	Laran et al., 2010
Cetaceans, seabirds	Opportunistic sightings	Presence/absence in grid cells	Comparison within the suitable habitat distribution	Area of occupancy (%)	Praca et al., 2009
Cetaceans, seabirds, sea turtles	Aerial or/and boat-based surveys	Predicted density (kriging)	Description of spatial and temporal variability	Predicted spatial distribution of species Local sightings density maps	Pettex et al., 2017
Cetaceans, seabirds, sea turtles	Aerial or/and boat-based surveys	Distribution of observations	Occupancy models	Predicted spatial distribution of species	Lauret et al., 2019
Cetaceans, seabirds	Aerial or boat-based surveys	Age-class	Description of spatial and temporal variability	Phenology/Ecology of species	Di-Méglio et al., 2015
Cetaceans	Boat-based surveys	Behaviour	Description of spatial and temporal variability	Habitat use, ecology of the species	Di-Méglio et al., 2015
Seabirds	Censuses of birds attending fishing vessels	Influence of fishing boat activity on seabird attendance (nb of birds)	discard experiment + energetic model	Estimates of the proportion of energy demands met by the discards	Arcos & Oro, 2002 Louzao et al., 2011
Cetaceans, seabirds, sea turtles	Telemetry	Movement ecology, Behaviour, activity	Description of spatial and temporal variability Hierarchical state-space models Kernel density analysis (and overlap) Straightness index Dive time	Ecology of species, home range (core and total), at-sea activity patterns, diving behaviour + GAMs to test influence of environmental variables on the choice of foraging area Comparison to SPAs location	Meier et al., 2015; Panigada et al., 2017; Péron & Grémillet, 2013
Seabirds	Telemetry	Movement ecology, Behaviour, activity	Description of spatial and temporal variability Hierarchical state-space models Kernel density analysis	Ecology of the species, home range, migratory behaviour (timing, stop-overs, …) and its evolution through life stages	Péron & Grémillet, 2013

Ecological component	Data type	Measured parameter (first step)	Methods (second step)	Resulting product/parameter	References / Examples
Seabirds	Telemetry	Movement ecology, Behaviour, activity	Comparison with environmental data	Habitat preference, learning/selection (tracking through life stages)	Péron & Grémillet, 2013
Cetaceans	stranding data	Distribution of strandings, characteristics of individuals	reverse drift model	Probable spatial and temporal origin of drift: proxy of potential death causes	Peltier et al., 2020
Cetaceans	biopsy data	Population genetic (mitochondrial DNA sequencing, microsatellite genotyping and validity)	clustering (multivariate, Bayesian) methods	Nuclear genetic differentiation and diversity, Mitochondrial DNA differentiation and diversity, Recent migration rates, Effective population sizes, Genetic differentiation and genetic diversity, Hierarchical structure	Louis et al., 2014
Cetaceans, seabirds	biological samples	Population genetic (mitochondrial DNA sequencing, microsatellite genotyping and validity)	various	Genetic structure of populations	Thanou et al., 2017
Cetaceans	Photo-Identification	Occurrence of identified individuals	Capture-recapture models	Demographic parameters of populations (abundance, …)	Labach et al., 2021 Di-Méglio et al., 2015
Cetaceans	Photo-Identification	Occurrence of identified individuals	Maximal displacement distances and convex hull of captures/recaptures	Use of the area, minimal movements of individuals	Di-Méglio et al., 2015
Cetaceans	photo-identification & acoustic data	Occurrence of identified individuals + movements (recapture)	Combination with acoustic data (body length estimates)	Ecology of sperm whales: north-south migration of males (Gulf of Lions/ Ligurian sea <-> Balearic Islands), feeding areas, probable mating area	Drouot-Dulau & Gannier, 2007
Cetaceans (,seabirds ?)	opportunistic data: scientific source or citizen science	Description of spatial distribution of observations	Model design: -> binary logistic regression, univariate explanatory logistic regression models to assess each of the eight spatio-temporal variables individually -> forward-backward stepwise regression (combination of explanatory variables)	Significant univariate models: include respectively latitude, longitude and season Significant multivariate model: latitude & continental shelf	Torreblanca et al., 2019

Ecological component	Data type	Measured parameter (first step)	Methods (second step)	Resulting product/parameter	References / Examples
Cetaceans, seabirds	opportunistic data: scientific source or citizen science	Trend surface analysis (TSA) : probability of each opportunistic sighting according its geographical position	Binary stepwise logistic regressions between the occurrence or otherwise of opportunistic sightings within IMMAs as the target variable (independent variables: lat, long)	The most likely opportunistic sightings are selected; determination of differences between the observed opportunistic sighting rate and expected rate within IMMAs weighted by the surface area of each IMMA	Gonzalvo et al., 2014
Cetaceans, seabirds	Aerial or/and boat-based surveys	Linear effort distribution (nb km/grid cell)	Gap analysis (evaluate the environmental coverage of surveys: effort x environmental covariates)	Environmental coverage of survey	Mannocci et al., 2018

VI. Reports of technical meetings 1 (June 2021)

As mentioned in the main document, technical meetings organized in the context of tasks 2.2.1 and 2.2.2 of the MSPMED project (within the Gulf of Lions case study) were merged into a sequence of four steps (1-June, 2-September, 3-October, 4-November 2021) conducted in parallel for five ecological components. Hereafter, the reports of the first session of technical meetings 1 (June 2021) dedicated to task 2.2.1 have been extracted.

Technical meeting 1 – Cetaceans and sea turtles

This first meeting (15th of June 2021) has been dedicated to (1) the identification of existing data and knowledge gaps regarding cetaceans and turtles encountered in the Gulf of Lions, and (2) the initiation of the work to be conducted on interactions between ecological stakes and offshore windfarms, following the programme below:

Not reported hereafter	**Introduction** Presentation of the MSP-MED project and objectives of meeting 1; introduction to/of experts (20’).
Reported hereafter	**Session 1 : Build a global view of existing knowledge in the Gulf of Lions** a. Presentation of preliminary work: existing datasets (20’). b. Knowledge gaps selection: from pre-identified knowledge gaps, a ranking exercise will help to prioritize those to address during the session (25’). c. Discussion: contribution of on-going research/projects to bridging knowledge gaps, design of complementary programs and methodological perspectives (45’).
Not reported hereafter	**Session 2 : Provide knowledge about interactions between Mediterranean ecosystems and windfarm development in Gulf of Lions** d. Presentation of the methodology; and presentation of technologies and activities related to floating windfarm projects in Mediterranean and potential pressures (30’). e. Open discussion on the relevance of pre-identified ecological receptors (50’). **Conclusion and future work (20’).**

Participants: Neil Allonce (OFB)*, Carla Álvarez Chicote (SUBMON), Camille Assali (OFB)*, José Carlos Báez (IEO(CSIC)), Manuel Bou (IEO(CSIC)), Txema Brotons (Asociación Tursiops), Cristina Cervera Núñez (IEO(CSIC))*, Mónica Campillos Llanos (IEO(CSIC))*, Léa David (EcoOcean Institute), Lucía di Iorio (CHORUS Institute), Alexandra Gigou (OFB), Marc Girondot (U. Paris Saclay), Sybill Henry (FEM)*, Hélène Labach (MIRACETI), Morgane Lejart (FEM)*, Helena Moreno (MITERD), Toni Raga (U. Valencia), José Antonio Vázquez (IEO(CSIC)).

*Organisers (MSPMED team)

Session 1: Build a global view of existing knowledge in the Gulf of Lions

a. Presentation of preliminary work: existing datasets

Participants have been presented the preliminary overview of datasets/campaigns/programs documenting cetaceans and sea turtles, partly or entirely covering the Gulf of Lions.

The number of at-sea surveys (from boat or plane) increased during the last decade, concomitantly with the increasing need for cetacean and sea turtle data (e.g. MSFD implementation).

b. Pinpoint data and knowledge gaps

Through a brainstorm exercise[52], participants contributed to three questions related to the at-sea distribution of cetaceans and sea turtles. Questions and synthetized results are presented in section c. below. Raw results are reported in

52 Used tool: http://digistorm.app

Table 6A-1.

Participants could answer by selecting four categories referring to knowledge level: (1) Incomplete/Poor, (2) Spatially incomplete / temporally incomplete, (3) Satisfying/Complete, (4) Other, and complement their choice by writing comments.

For the three questions, only the categories “(1) Incomplete/Poor” and “(2) Spatially incomplete/Temporally incomplete” received contributions.

a. Perspectives: bridge knowledge gaps

After having identified main knowledge gaps regarding the distribution of cetaceans and sea turtles in the Gulf of Lions, a discussion was conducted so as to characterize these gaps in detail (e.g. spatially, temporally, distinctly between different data types, technological or methodological limitations).

In the following paragraphs, results of the brainstorming session and subsequent discussion are synthetized in two main topics: (1) cetacean & sea turtle distribution, and functional areas in the Gulf of Lions, (2) predictability of the habitat use by these species.

At-sea distribution and functional areas

For both components (cetacean species and sea turtle species found in the Gulf of Lions), the knowledge levels associated with their at-sea distribution and functional areas (and especially through life stages) have confirmed either poor or incomplete knowledge.

This knowledge level referred either to a larger scale consideration (e.g. distribution area of those species) or to our specific Gulf of Lions case study. Globally, the monitoring effort that is larger in coastal areas and in summer suggests a poorest knowledge in offshore areas and during non-summer months. Moreover, experts highlighted both the need to obtain data from unsampled areas and the lack of fine scale temporal and spatial data. In the study area, more and more large-scale information is acquired, in addition with local studies, but a gap exists between these two scales, and this would require a combination of existing datasets or results.

Furthermore, knowledge levels have been qualified relatively to the considered species. In link with the spatial and temporal distribution of the standardized monitoring effort (aerial or boat-based surveys, commonly conducting line-transect or strip-transect protocols), the distribution of coastal cetacean species is more easily described than the distribution of deep-divers or more cryptic species (e.g. Cuvier’s beaked whale). In addition to a limited effort in offshore areas, the limited time span of boat-based and aerial surveys may not inform the diversity of behaviors and habitat uses, such as suggested by opportunistic observations of fin whales and common bottlenose dolphins in coastal waters during summer in the Natural Marine Park of the Gulf of Lions (MPA).

Despite the significant effort conducted in the Gulf of Lions area, photo-identification data and analysis have not yet achieved a satisfying knowledge about cetacean’s functional areas.

However, photo-identification and genetics of common bottlenose dolphin showed either resident or transient individuals in the study area[53]. In the northern part of the Catalan sea,

53 Final report of GDEGeM project, 2013-2015, https://www.gdegem.org/sites/gdegem.org/files/documentation/gis3m_gdegem_rapport_technique_final.pdf

experts mentioned a lot of common bottlenose dolphin re-sightings, which highlighted the important variation of group structure. Contrarily to the resident population of the Balearic Islands, common bottlenose dolphin of the Gulf of Lions may use a large area of the north-western basin of the Mediterranean Sea. The structure, residency or spatial plasticity of populations in the study area, as well as their movements at the transboundary scale, can have consequences on their consideration into planning processes, e.g. when planning the settlement of offshore windfarms.

If stranding events are well monitored, no baseline information exists about the at-sea distribution of sea turtles in the Gulf of Lions. Indeed, despite a significant effort at sea, very few observations have been acquired in the Gulf of Lions. On the contrary, Spanish experts mentioned an important number of boat-based observations in the Catalan Sea (census, species identification).

Data from tracked (GPS, Argos, etc.) individuals from French coasts or waters can be considered as biased (females or by-caught individuals only), and non-representative of the population(s). No data exists from male or through life stages, and very few data was acquired from juveniles, especially in the Gulf of Lions area. However, more and more nesting events occur in the study area and must be considered when addressing the distribution of sea turtle functional zones.

Specific focuses on some knowledge gaps emerged during the discussion and are reported in Table 6A-2.

Predictability of cetacean and sea turtle distributions

Experts stressed the incomplete knowledge about predictability of cetacean and sea turtle distributions, both at the Gulf of Lions scale than at a larger scale.

Despite the increasing need for habitat modelling, and especially in the context of offshore windfarm development, such analysis is limited by (1) a lack of homogeneous data, (2) an inappropriate quality of environmental data, (3) the environment dynamics.

Considering the first parameter, experts mentioned the usual analysis of a single observation dataset in habitat modelling studies. However, an increasing effort is currently made in order to combine different observation data sources to build habitat models from.

The second parameter refers to a lack of appropriate environmental data, including deep oceanography and dynamics, which sets the environmental conditions faced by deep-diving cetacean species. Moreover, complementary variables such as resource distribution and availability, as well as the distribution of human activities (influencing megafauna distribution) may be critical to consider when predicting the cetacean at-sea distribution. As an example, the behavior of Common bottlenose dolphin during non-trawling days (weekends) is quite unknown. Finally, experts mentioned the very limited use of ecosystem-based approaches to predict the distribution of megafauna species and interactions between them (until now, such analysis have been limited to spatial co-occurrence studies), despite appropriate data exists (ASI[54], SAMM[55] surveys, etc.).

[54] ACCOBAMS Survey Initiative, 2018, https://accobams.org/main-activites/accobams-survey-initiative-2/accobams-survey-initiative/

[55] Suivi Aérien de la Mégafaune Marine, https://www.observatoire-pelagis.cnrs.fr/pelagis-2/les-programmes/samm/

The last parameter suggests that predictive models have to deal with a changing environment (e.g. global warming) and thus be frequently updated. This is critical to be considered for sea turtles, which recent nesting events in the French Mediterranean coasts indicate dynamic distributions of functional areas.

Specific focuses on some knowledge gaps emerged during the discussion and are reported in Table 6A-2.

*Table 6A-1: Results of the brainstorming session (Session 1). "**Gulf of Lions (Barcelona to Marseille) case study: identify main knowledge gaps**".*

	Question 1: *Megafauna distribution in the study area has been described through several spatial scales (MPAs, Gulf of Lions, Mediterranean-wide surveys) and temporal scales (monthly, yearly, seasonally). How would you qualify the current knowledge level about cetacean and/or sea turtle distribution in the study area?* *Does this knowledge level depend on the considered species, temporal scale, and/or spatial scale?*	Question 2: *The location of functional areas (foraging areas, migratory paths, nurseries, …) is critical to be considered into a global view of ecological stakes in the Gulf of Lions. To your opinion, what is the current knowledge level of the distribution (within the Gulf of Lions) of functional areas for commonest cetacean and sea turtle species?* *Do we know about a potential spatial and temporal segregation of individuals through life stages?*	Question 3: *The variability of marine species distribution and habitat use may be related to environmental conditions, such as weather, oceanographic features, location of feeding resources, etc. Many efforts have been made to predict the presence and abundance of megafauna species in the Mediterranean Sea, from static (i.e. topography) and dynamic (i.e. sea surface temperature) environmental data. To your opinion, what is the current knowledge level about the influence of environmental conditions on cetaceans and/or sea turtles species distribution and abundance in the Gulf of Lions?* *More specifically, is the performance of predictive models insufficient, incomplete or satisfying?*
Insufficient / Poor	For marine turtles, the main problem is that the distribution changes a lot in recent time (#10 years). It will be wrong to make a static map.	For marine turtles, you must include nesting area. There are more and more nesting in the North of Mediterranean Sea in this region. This is still poorly documented but clearly it increases.	I believe that the unknown of climate change hangs over everything, but especially on this aspect.
	For marine turtles, we have a relatively good knowledge of distribution of stranding but nearly nothing in this region about at sea distribution.	For most of cetaceans we don't have precise information on functional areas especially for different life stages	The current knowledge level about the influence of environmental conditions on sea turtle distribution is rather good in general. But if you add: "in the Gulf of Lions", the answer is: no knowledge at all.
		There is a huge lack of data on the knowledge of functional areas for most cetaceans. I imagine that this observation is the same for marine turtles.	In general, it is poor both due to the uncertainty of the habitat models themselves (that is, the statistical tool used), the source data that is not sufficiently extensive and of good quality, and the changing dynamics of the ecosystem itself.
		No information exists for marine turtles about life stages. Probably the only way to solve this question is to do models linking oceanography in this region and the knowledge of distribution at sea gathered in other regions for these species.	For marine turtles, we have thousands of individuals that are followed using GPS or ARGOS telemetry data in the world. But none in this region.

Spatially incomplete / Temporally incomplete	At both spatial and temporal scales: both needs to be improved.	Without knowing the complete temporal status and without knowing the status of other adjacent areas, the knowledge is clearly insufficient	Predictive models need to be more regularly updated.
	For most of cetacean species fine spatial and temporal scale are insufficient especially in offshore areas and for some species like Cuvier's beaked whale.	There is no well-defined time sequence. Currently, due to the warming of the Mediterranean, many species are changing their distribution, for example sea turtles, with sporadic nest.	The deep oceanographic dynamics in the Mediterranean are largely unknown. This affects all deep diving especially.
	Some cetacean species such as bottlenose dolphin are better studied because there is more monitoring in coastal areas. The species that essentially frequent the slope and the deep sea are therefore less known (ziphius in particular).	Depending on the species (deep divers, migratory species, coastal species) there are more identified areas than for other.	The problem with existing predictive models is that they concern either a single species with a reduced number of environmental variables (bottlenose dolphin), or a single data set (although it is multi-species and with many environmental variables).
	Most species have distributions that exceed the target area. For this reason, there are large knowledge gaps, both spatial and temporal. There is an urgent need to obtain data from the temporally and spatially unsampled areas.	For cetaceans we have some global knowledge. For sea turtles we have an idea but as they spend more time under water we still do not know a lot. There are still some gaps for some areas (more offshore) and season (winter).	It may depend on the scales (spatial and temporal) you are interesting in. The models are a proxy and the % explained is sometimes low. But we are limited by the availability of data...probably with some data on preys it could be better. And finally, the environmental data are not the only variables playing a role.
	There is a lack of homogeneous data at the scale of the Gulf of Lions (and probably more widely). In the context of the development of offshore wind farms, the need for habitat models has emerged.	Focal and photo ID follow-ups are carried out for bottlenose dolphins at different periods of the year, allowing to collect data on behaviors, but they seem insufficient	The usual problem with the models is that they depend on the data entry, so in the case of some species we have a lack of data to fit the models that really predict relationships.
	I think we already have a good rough knowledge spatially and temporally for cetaceans and probably sea turtles, with new campaigns we will get data to fine-tuned, but I am not sure we will discover something very new. Anyway, more study help to fine tune our knowledge.		

Table 6A-2: Perspectives to bridge some knowledge gaps relative to cetaceans and sea turtle at-sea distribution or predicted distribution and abundance, detailed during session 1.

Focus on knowledge gaps	Perspectives
Data gaps to address cetacean and sea turtle distribution exist at different spatial and temporal scales, e.g. at the medium scale between local and Mediterranean-wide surveys.	- Data sharing has to be supported and facilitated (e.g. ACCOBAMS or INTERCET[56] initiatives), through a dedicated platform.
Functional areas are poorly known at the local scale.	- Data exists and has to be analysed appropriately so as to inform, in addition to the distribution of species, their behaviour/activity (foraging, breeding, etc.) and thus their sensitivity to the at-sea human activities in development; - Results must be shared massively so as to improve the general awareness about sensitive areas, especially in the context of offshore windfarm planning.
Sea turtle distribution, and especially through life stages, is unknown in the study area.	- Complementary data acquisition could be conducted (preferentially from aerial surveys, ferry lines and finally from boat) in the Gulf of Lions (continental shelf); - At-sea turtle observations in Spanish waters may be shared to provide information on sea turtle distribution on the study area; - Habitat models from other areas (linking oceanographic variables and sea turtle at-sea distribution) could be transposed/adapted to the study area.
The resident/transient status and connectivity of cetacean populations is insufficiently known in the study area.	- Photo-identification data from French and Spanish programs should be analyzed at the transboundary scale.
The changing environment deepens knowledge gaps about species distribution.	-Habitat models have to be frequently updated; -Dynamic models should be developed.
Predictive models are limited by the available data (quality, availability, homogeneity).	-Existing data must be combined (such methodologies are currently being developed); -Data and/or results have to be shared and compared; -Multi-approach monitoring surveys must be encouraged (e.g. ASI); -Data acquisitions and methodologies are currently being standardized globally (e.g., ECOSYSM-EOF[57], TURSMED 2[58]); -Classical methodologies are being compared and completed with new technologies (e.g. OWFSOMM[59], SEMMACAPE[60]) through intercalibration methods.

56 INTERCET, http://www.intercet.it/, supports the sharing and network management of geo-referenced data related to populations of cetaceans and sea turtles.
57 ECOSYSM-EOF, 2020-2022, https://www.france-energies-marines.org/en/projects/ecosysm-eof/
58 TURSMED 2, 2021-2023, https://www.gis3m.org/actu/decouvrez-notre-protocole-scientifique-cadre-tursmed2
59 OWFSOMM, 2020-2023, https://www.france-energies-marines.org/en/projects/owfsomm/
60 SEMMACAPE, 2019-2022, https://semmacape.irisa.fr/files/2020/03/plaquette_semmacape.pdf

Technical meeting 1 – Seabirds

This first meeting (16th of June 2021) has been dedicated to (1) the identification of existing data and knowledge gaps regarding seabirds encountered in the Gulf of Lions, and (2) the initiation of the work to be conducted on interactions between ecological stakes and offshore windfarms, following the programme below :

Not reported hereafter	**Introduction** Presentation of the MSP-MED project and objectives of meeting 1; introduction to/of experts (20’).
Reported herafter	**Session 1 : Build a global view of existing knowledge in the Gulf of Lions** a. Presentation of preliminary work: existing datasets (20’). b. Knowledge gaps selection: from pre-identified knowledge gaps, a ranking exercise will help to prioritize those to address during the session (25’). c. Discussion: contribution of on-going research/projects to bridging knowledge gaps, design of complementary programs and methodological perspectives (45’).
Not reported hereafter	**Session 2 : Provide knowledge about interactions between Mediterranean ecosystems and windfarm development in Gulf of Lions** d. Presentation of the methodology; and presentation of technologies and activities related to floating windfarm projects in Mediterranean and potential pressures (30’). e. Open discussion on the relevance of pre-identified ecological receptors (50’). **Conclusion and future work (20’).**

Participants: Felipe Aguado (IEO(CSIC)), Neil Alloncle (OFB)*, Camille Assali (OFB)*, Etienne Boncourt (CEFE-CNRS), Mónica Campillos Llanos (IEO(CSIC))*, Cristina Cervera Núñez (IEO(CSIC))*, Jocelyn Champagnon (Tour du Valat), Léa David (EcoOcean Institute), Alexandra Gigou (OFB), Karine Heerah (FEM), Sybill Henry (FEM)*, Julie Marmet (OFB), Maëlle Nexer (FEM)*, Raul Ramos (UB), Jose Manuel Reyes Gonzalez (UB).

*Organisers (MSPMED team)

Session 1: Build a global view of existing knowledge in the Gulf of Lions

a. Presentation of preliminary work: existing datasets

Participants have been presented the preliminary overview of datasets/campaigns/programs documenting seabirds, partly or entirely covering the Gulf of Lions. In the study area, 34 and 28 boat-based surveys have been censed in June and July respectively, while less than 10 were identified during each of the other months, from 1993 and 2020 (these results have to be considered as minima). On the contrary, aerial surveys have been conducted less frequently, with at least one survey per each month, up to 5 in January and February (first aerial survey considered - 2011). Globally, when merging boat-based and aerial survey yearly distribution, spring (especially April) and autumn (especially October) months have been less informed than summer and winter months[61].

In order to comment more specifically the spatial redundancy of datasets, complementary information has to be collected (transects and precise time span) so as to calculate and represent the cumulative linear effort in the study area.

b. Pinpoint data and knowledge gaps

Through a brainstorm exercise[62], participants contributed to five topics related to different potential knowledge gaps about seabirds in the Gulf of Lions. Participants could answer by selecting each of the five categories referring to (1) seabird at-sea distribution, (2) functional areas in the Gulf of Lions, (3) predictability of seabird distribution, (4) seabird abundance and trends, (5) other, and complement their choice by writing comments on the associated knowledge level or specific gaps. Contribution were collected and organized in a mind ap for a subsequent discussion with experts.

Topics and synthetized results are presented in section c. below. Raw results are reported in Table 6A-3.

c. Perspectives: bridge knowledge gaps

After having identified main knowledge gaps regarding the distribution of seabirds in the Gulf of Lions, a discussion was conducted so as to characterize these gaps in details (e.g. spatially, temporally, distinctly between different data types, technological or methodological limitations).

In the following paragraphs, results of the brainstorming session and subsequent discussion are synthetized in five main topics: (1) seabird distribution, (2) seabird functional areas in the Gulf of Lions, (3) predictability of their habitat use, (4) seabird abundance and trends, (5) seabird sensitivity to anthropogenic pressures. Due to time limitation, the last topic could not be discussed in detailed and will be studied further during next meetings.

At-sea distribution of seabirds

While many individuals have been, or are equipped[63,64] (GPS, GLS, ARGOS, …) and many boat-based or aerial surveys have been conducted in the study area, seabird at-sea distribution has been characterized as partially known. Indeed, experts mentioned (1) a progress to be made about the standardization of at-sea survey protocols to complete a global view of seabird distribution in the area, in addition to (2) the limited available data further offshore the continental shelf and during non-summer months.

Moreover, data is still lacking for small species (e.g. storm-petrel) or wintering ones. For the latter, data is rather obtained at low resolution (GLS) or from the coast (ring re-sightings), thus

[61] As visible in the table, p.2 of the "Supporting Information" document.
[62] Used tool : http://digistorm.app

[63] INTEMARES, 2018-2024, https://intemares.es/prensa/actualidad/estudiamos-movimientos-pardela-balear-para-reforzar-proteccion
[64] Data acquisition in the context of pilot and commercial windfarm development, A. Gigou, pers. com.

poorly inform on the individual and local-scale behaviours of wintering species in the Gulf of Lions and all along their migratory route.

Globally, 3-D distribution (i.e. including flight altitudes) is unknown for seabirds, except for Scopoli's shearwater (on-going research at the CEFE-CNRS). Moreover, their nocturnal behaviour at sea is unknown (except for tracked individuals).

Functional areas of seabirds in the Gulf of Lions

To experts, many gaps remain about functional areas of seabirds in the Gulf of Lions, except for some well-informed species such as the Scopoli's shearwater. However, current technology (as long as colonies' location is known) and existing data may be sufficient to bridge those knowledge gaps. Firstly, equipment at colonies allows to track either juveniles or breeding adults. Secondly, a lot of data has been acquired in recent years (gulls, shearwaters, terns) and could be analysed to estimate "densities of at-sea behaviours" (foraging areas, flight corridors, etc). Fine-scale tracking of seabirds is possible and shall be used in MSP processes. The main limitation remains in the cost of tracking devices.

Predictability of seabird at-sea distribution

The predictability of seabird distribution has been commented on several aspects: environmental factors, co-occurrence with other top-predators, attendance of maritime activities and infrastructure.

Firstly, experts mentioned the lack or unavailability of fine-scale environmental data that could be used to inform the relationship between environmental conditions and at-sea distribution of seabirds. Moreover, wind patterns (strength, distribution, etc.) have been qualified as a key factor to be studied. Indeed, as for migratory species, wind patterns can influence the space use by seabirds and especially their flight altitude, which is critical to be considered in the context of windfarm development. To date, flight altitude of seabirds found in the Gulf of Lions has been rather rarely addressed in research, except recently with the development of energetic models for the Scopoli's shearwater[65]. To address the relationship between wind patterns and seabird 3-D distribution, fine-scale (high-frequency) data is required and thus may represent an important limiting factor.

Secondly, experts underlined the influence of human maritime activities and infrastructures on seabird distribution. As an example, at-sea distribution of seabirds (e.g. gulls and shearwaters) is known to be influenced by trawling activities (attendance behaviour, e.g. in the western Gulf of Lions), and might be an interesting explanatory variable to be considered in predictive models. Moreover, several species are known to attend floating infrastructures (resting sites) and tuna farms (e.g. gulls, gannets, terns, shags, … feed either on waste, feeding resource of tuna, or surrounding fish).

[65] ORNIT-EOF project, 2019-2021, https://www.france-energies-marines.org/en/projects/ornit-eof/

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Thirdly, experts commented on the co-occurrence of top-predators in the study area. If seabird distribution is more commonly studied in relation with prey distribution, from fieldwork experience, seabirds are known to associate with surface-feeding tuna, but not with cetacean species that adopt other foraging strategies (e.g. the Common bottlenose dolphin consumes demersal resources).

Seabird abundance and trends

At-sea abundance and trends of seabirds in the Gulf of Lions area may be difficult to obtain as few baseline data exists. Moreover, abundance variations at colonies are insufficiently explained, and monitoring may not be sufficiently compared and combined between colonies so as to describe the variability of site use.

Demographic models are needed to evaluate the potential impact of windfarms on populations (e.g. collision, disturbance or habitat loss/modification). Such methodologies already exist, but the main limitation relies in getting both (1) data of spatial distribution of birds and (2) data informing the population demographics and trends, i.e. to combine information at the individual and population scales.

Similarly, an important information to be considered would be the origin of seabirds observed at sea, e.g. through connectivity models, so as to estimate if pressures would impact one or several colonies, what would have different demographic implications.

Sensitivity of seabird species

This very large topic could not be addressed in the remaining time; however, we report here some related comments. Sensitivity can be addressed through different criteria, and to different kinds of pressures (by-catch, collision, disturbance, etc.). The classification of species regarding their sensitivity to pressures is still to be conducted, and especially in the context of offshore windfarm development. In this precise case, very few is known about the avoidance behaviour of seabirds towards wind turbines at fine scale. Seabird sensitivity to these new obstacles could be linked to their manoeuvrability under the different weather conditions they encounter.

The sensibility to windfarm-related pressures will be studied and discussed further during next meetings.

Specific focuses on some knowledge gaps emerged during the discussion and are reported in Table 6A-4.

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*Table 6A-312: Results of the brainstorming session (Session 1): "**Gulf of Lions (Barcelona to Marseille) case study : identify main knowledge gaps**".*

Topic	Knowledge gaps and comments
1. Seabird distribution in the study area (spatial scale, temporal scale, group of species, 3D distribution)	Few data on empirical flight height (all species). Wintering distribution of tracked species - low resolution of spatial data coming from light-level geolocation devices. I think that there is an overall lack of data on small seabird species or a lack of knowledge of the species (aerial campaigns). Standardized methodology for seabird surveys at the open sea. Lack of knowledge on small species (hard for biologging studies) i.e. storm petrel. Wintering movements at individual level unknown for many species - for most of them only PVC ring resightings from the coast. Many gaps on the flight altitudes. Maybe there is lack of data outside the continental shelf (e.i - INDEMARES project use the information of MEDIAS campaigns where were located in the continental shelf. And in addition, data was from summer season. EcoOcéan Institut get seabirds data on its line transects made during GDEgeM (2013-2015, all seasons).
2. Functional areas (foraging areas, migratory paths, …)	Many gaps on the functional areas (in my opinion especially knowledge on shearwaters, in particular Scopoli's shearwater). Foraging areas can be identified using both GPS and geolocator data and algorithms, but still rarely used - these methods should be used for MSP.
3. Predictability of seabird distribution at sea (weather conditions, environmental variables, resource distribution, interactions with other predators, etc.)	Lack of fine scale environmental data (spatially and temporally). At least as for many models, only satellite data are used as other variables are difficult to get for an entire area. Fisher boats will certainly be an important variable to use for certain species !! Attraction or aggregation effect of seabirds around floating or standing structures at the open sea. Flying altitude is rarely addressed in seabird research, but it can be critical for windfarm. Existence of model on energetic landscapes of Scopoli shearwaters with project in progress, but to my knowledge not much on other species.
4. Abundance of seabird species and trends	Difficult for trends as we have few baseline data from the past.
5. Other	Classification of seabird species with regards to sensitivity to specific pressure (wind farm or whatever). For collision risk assessment with wind farms: lack of knowledge about what happens in the vicinity of wind turbines, at a very fine spatial scale (avoidance behaviour).

Table 6A-4: Perspectives to bridge some knowledge gaps relative to seabird at-sea distribution or predicted distribution and abundance, detailed during session 1.

Focus on knowledge gaps	Perspectives
At-sea distribution data is lacking for small seabird species such as the storm petrel.	-New light tracking technology is being developed and small species will be possibly equipped with geolocators/sensors soon.
Nocturnal behaviours at the community levels are unknown.	-Radar data can inform on coastal or at-sea behaviours of birds during day and night, given quite good weather conditions (no rain).
Functional areas are partially unknown.	-Analysis of existing data could bridge this gap. -Additional GPS-tracking could be acquired, but a balance between invasive and non-invasive data acquisitions has to be considered, as well as their complementarity.
Seabird (3-D) habitat use relatively to wind patterns is mostly unknown.	-Fine-scale (high-frequency) data on wind and seabird behaviors has to be acquired.
Seabird abundance at sea and trends is partially unknown.	-Census on colonies and at sea should be shared and analyzed at a larger scale (at least transboundary) to improve knowledge on estimated abundances.
Aerial surveys can be biased because observations are dependent on the circadian activity of seabirds: protocols are not appropriate to all species.	- Aerial surveys from drone could allow more temporal flexibility, but would be better appropriate for larger species and focal surveys (e.g. cetaceans). - Radar data can inform the circadian activity of seabirds in a defined area (within a radius of some kilometers).

VII. Reports of technical meetings 3 (October 2021)

As mentioned in the main document, technical meetings organized in the context of tasks 2.2.1 and 2.2.2 of the MSPMED project (within the Gulf of Lions case study) were merged into a sequence of four steps (1-June, 2-September, 3-October, 4-November 2021) conducted in parallel for five ecological components. Hereafter, the reports of the first session of technical meetings 3 (October 2021) dedicated to task 2.2.1 have been extracted.

Technical meeting 3 – Cetaceans and sea turtles

The third technical meeting (22nd of October 2021) was dedicated to the consideration of ecological parameters within public policies, in the context of the MSPMED transboundary case study "Planning the offshore Gulf of Lions" (sessions 1 and 2). The last part of the technical meeting (session 3) was focused on the presentation of the last step of the methodological framework conducted so far to characterize interactions between ecosystems and pressures linked to offshore floating windfarm development. The meeting was conducted following the program below:

Not reported herafter	**Introduction (15')** Introduction of experts and presentation of the objectives of technical meetings
Reported herafter	**Session 1: Focus on criteria informing public policies (30')** Selection of topics to be addressed during the meeting.
	Session 2: Focus on knowledge transfer to decision makers (40') Discussion about (a) the knowledge level associated to the selected topics, and (b) the consideration of these topics into public policies.
Not reported hereafter	**Session 3: Characterization of interactions with a ranking method (20')** Presentation of the last step of the methodological framework addressing the characterization of interactions between ecological receptors and pressures.
	Conclusion and objectives of technical meeting 4 (10')

Participants: Juan Antonio Camiñas (Asociación Herpetológica Española - AHE), Luis Cardona (Universidad de Barcelona), Léa David (EcoOcéan Institut), Alexandra Gigou (Office Français de la Biodiversité – OFB), Karine Heerah (France Énergies Marines -FEM), Ludivine Martinez (Cohabys – Université de La Rochelle), José Antonio Vázquez (Instituto Español de Oceanografía - IEO(CSIC)), Neil Alloncle * '(OFB), Camille Assali* (OFB), Mónica Campillos Llanos* (IEO(CSIC)), Cristina Cervera Núñez* (IEO(CSIC)), Elena Gutierrez Ruiz* (IEO(CSIC)), Sybill Henry* (FEM).

* Organisers (MSPMED team)

The global objective of sessions 1 and 2 was to discuss the consideration of ecological stakes within public policies and to share experience between France and Spain in order to help improving the coherence of Maritime Spatial Planning (MSP) at the transboundary scale.

From (i) background information collected in literature (evaluation reports, existing datasets, current projects, scientific articles, etc.), and (ii) the results of the first technical meeting of June 2021 (identification of knowledge gaps about cetacean and sea turtle distributions, their predictability, and functional areas), exchanges were conducted so as to answer two general questions:

- How could we better inform ecological stakes at the transboundary scale?
- How should we transfer appropriately this information to decision makers of the MSP process?

To address those questions, discussions were divided into two steps: the first session was focused on topics collectively selected from a list of criteria (see *Session 1: focus on criteria informing public policies*), and a second session was dedicated to highlighting limitations and perspectives to facilitate knowledge sharing, especially with competent authorities (see *Session 2: focus on knowledge transfer to decision makers*) and at a transboundary scale.

Session 1: focus on criteria informing public policies

In order to focus on key topics to be addressed in our transboundary exchanges, the experts were proposed a list of criteria, selected from current public policies such as the descriptor 1 "Biodiversity is maintained" of the Good Environmental Status targeted by the Marine Strategy Framework Directive (MSFD), as well as from criteria commonly used to inform Marine Protected Area (MPA) designation (see table 1).

Experts were firstly asked to vote for 5 out of 10 the topics to be addressed during the meeting, considering two decision rules:

- Is the criterion relevant for informing public policies (especially MSP) in the study area?
- Is the criterion relevant to be addressed at the transboundary scale?

Secondly, experts were asked to associate a level of knowledge (high/sufficient, medium/incomplete, low/insufficient) to these topics, either relative to the baseline data (e.g. abundance) or to the evaluation method for the criterion (e.g. threshold).

The results of this voting session are reported in Table 7A-1 below.

Table 7A-1: Results of the voting session aimed at selecting key topics to be addressed in session 2, from MSFD D1 criteria and MPA designation (e.g. Specially Protected Areas of Mediterranean Importance), and associated knowledge levels. Selected topics (highest voting scores) appear in purple.

Process	Criteria		Number of votes	Votes to associate a knowledge level		
				High	Medium	Low
MPA designation	Uniqueness	The area contains unique or rare ecosystems, or rare or endemic species.	3	2	2	0
	Representativeness	The area has highly representative ecological processes, or community or habitat types or other natural characteristics.	4	0	3	0
	Diversity	The area has a high diversity of species, communities, habitats or ecosystems.	3	1	2	0
	Naturalness	The area has a high degree of naturalness as a result of the lack or low level of human-induced disturbance and degradation.	0	0	0	0
	Critical habitats	The area hosts habitats where any impact represents a high potential risk for endangered, threatened or endemic species.[66]	5	2	0	1
MSFD – Good Environmental Status evaluation	D1C1	The mortality rate per species from incidental by-catch is below levels which threaten the species, such that its long- term viability is ensured.	3	0	0	3
	D1C2	The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.	4	0	3	0
	D1C3	The population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity, and survival rates) of the species are indicative of a healthy population which is not adversely affected due to anthropogenic pressures.	3	0	1	1
	D1C4	The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions.	2	0	1	0
	D1C5	The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species.	3	1	0	1

The three selected topics obtained 5 or 4 votes (rated by 7 experts), and were respectively associated to a high or low level of knowledge ("*The area hosts habitats where any impact represents a high potential risk for endangered, threatened or endemic species*"), and a medium knowledge level (criteria "*The area has highly representative ecological processes, or community or habitat types or other natural characteristics*." and "*The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured*."). The poorest knowledge score was obtained for the criterion "*The mortality*

[66] Adapted from the SPAMI criteria « Presence of habitats that are critical to endangered, threatened or endemic species." in order to integrate the "risk" approach in subsequent discussion.

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rate per species from incidental by-catch is below levels which threaten the species, such that its long- term viability is ensured." (3 votes).

Session 2: focus on knowledge transfer to decision makers

Session 2 was dedicated to (i) experience sharing about the current limitations related to selected topics, (ii) perspectives to overcome those difficulties, and (iii) information transfer to decision makers of MSP.

Topic 1: The area hosts habitats where any impact represents a high potential risk for endangered, threatened or endemic species.

Experts were asked to comment about necessary data, method or strategy to inform this criterion.

Parameters such as relative abundance, functional areas, resident/transient status of individuals as well as their spatio-temporal distribution were cited as important input to be considered.

Firstly, experts suggested that **habitat models** shall be developed for each species in the area. However, data is limiting this analytical effort, especially for deep-diving species in cetaceans and for sea turtles. For the latter, satellite tracking was suggested as the best way to obtain relevant information (when combined with environmental data[67]) for habitat modelling.

Secondly, **spatial and temporal scales** appeared as key parameters to be defined for this criterion. Both distribution and abundance of species have to be informed at the marine sub-region level (e.g. MSFD reporting units), before assessing the importance of a smaller target area (in our case: the Gulf of Lions) and its **representativity** for species. Habitat models may allow to extrapolate from individual tracks to population, but need to be interpreted cautiously. Indeed, as mentioned during the first technical meeting held in June, individual tracks may not be representative of a population, e.g. in the case of telemetry data of sea turtles from by-catch events, or nesting females in the Gulf of Lions area.

Large-scale survey data (e.g. ASI[68] 2018) does not allow to describe species distribution at the local scale (i.e. at the scale of the Gulf of Lions). If southern Balearic waters are known to be critical for sea turtles, the Gulf of Lions area must not be neglected with regards to the number of by-caught individuals, tracked individuals, recent nesting events[69], etc. However, at the Gulf of Lions' scale, precise information on spatio-temporal distribution of sea turtles is still lacking; while recent data from Ifremer/CESTMed may provide valuable information. For cetaceans and sea turtles, **connectivity** between functional areas is still to be understood. For cetacean species displaying migratory patterns, an important gap remains in the **seasonal variability** of their distribution, as large-scale surveys are often conducted during summer months.

Thirdly, experts highlighted perspectives to improve the global knowledge at the transboundary scale: from data collection to the evaluation processes, cooperation and coordination has to be

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[67] Copernicus services have been mentioned as an example: https://www.copernicus.eu/en

[68] ACCOBAMS Survey Initiative: https://accobams.org/wp-content/uploads/2021/04/ASI-Med-Report.pdf

[69] Experts mentioned that the number of nesting events is increasing in the whole western Mediterranean, but that eggs may either be unviable or produce only males (low temperature).

strengthen (e.g. sharing questions, building projects together, standardizing and coordinating monitoring surveys, using standardized analysis and combining existing data and methods).

Finally, these exchanges underlined the importance of considering cetacean and sea turtle species within any maritime planning process in the area. Information exchanges at the **transboundary scale** shall also contribute to the **investigation of cumulative risks and impacts** in space and time.

Topic 2: The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.

Parameters to be assessed in order to inform this criterion are (i) population abundance and (ii) impacts of anthropogenic pressures on abundance.

Experts emphasized the need to **conduct long-term surveys** in order to inform trends in populations abundance but also trends in pressures and their impacts. As an example, aerial surveys seem to be the best method to assess sea turtle density, although confidence intervals are usually rather large. Complementarily, telemetry data is also necessary to estimate the time individuals spend at the sea surface, corresponding to individuals' "availability" – linked to detection probability- at the surface during aerial or boat-based surveys.

Moreover, experts stressed again the need to assess the **seasonal and interannual variability** of distributions and thus local-scale abundance. This could be addressed with additional and shared data acquisitions[70] (e.g. during non-summer months, at fine spatial scale). A lot of datasets already exist[71] in the Gulf of Lions area and can inform population abundance; however, the major limitation of their analysis remains the diverse scales of data acquisitions. According to experts' opinion, if sharing is interesting, conducting surveys and studies together may be more productive.

With regards to anthropogenic pressures and MSP, **existing designations** should be appropriately considered. In that sense, experts mentioned the Fishing Restricted Area (FRA) of the General Fisheries Commission of the Mediterranean (GFCM) adopted in the eastern Gulf of Lions. With the aim of minimizing conflicts between stakeholders and pressures on ecosystems, including cetacean and sea turtle species, the planning of additional human activities such as offshore windfarms shall be avoided in the existing FRA.

Topic 3: The area has highly representative ecological processes, or community or habitat types or other natural characteristics.

The Gulf of Lions is already recognized as an important area for the Common bottlenose dolphin – *Tursiops truncatus* (Shelf of the Gulf of Lions Important Marine Mammal Area[72], and N2000 site[73]).

[70] The marine mammal group of IEO (Spain) and researchers from La Rochelle University (France) collaborate to share data collection methods and coordinate MSFD monitoring programs.
[71] Experts mentioned data from Proyecto Mediterráneo, SUBMON association, MEDIAS campaigns, for the Spanish side.
[72] Shelf of the Gulf of Lions IMMA : https://www.marinemammalhabitat.org/portfolio-item/shelf-gulf-of-lion/
[73] FR9102018 - Grands dauphins du golfe du Lion : https://inpn.mnhn.fr/site/natura2000/FR9102018

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As an additional information, results from the GDEGeM project[74] were provided to experts. These results show the density of Common bottlenose dolphin from four different groups (social units). Social units were defined through photo-ID analysis[75] (recaptures of individuals often found in association), and distribute themselves differently within the Gulf of Lions area. Some individuals move over the whole area ("transient" individuals) while others usually stay in specific areas ("resident" individuals). This information seems difficult to integrate into maritime planning process. Indeed, human at-sea activities may impact differently distinct social groups (depending on the co-occurrence of cetaceans and activities), but at the Gulf of Lions' scale, which encompasses the home ranges of Common bottlenose dolphin social groups, any pressure could have an effect on all groups.

Moreover, in the specific context of offshore windfarm development in the Gulf of Lions area, the effect on species is still mostly unknown. As an example, the Common bottlenose dolphin could be disturbed by the increasing maritime traffic and the activities conducted during the construction phase, while it may also be attracted by fish aggregation during the functioning phase. Extrapolation from other offshore windfarm projects is not easy in this Mediterranean case as -(i) technologies (fixed vs floating windfarms), (ii) species in the cetacean community, and (iii) species' reactions to pressures- are different.

How to share this information with MSP competent authorities?

As a concluding question, experts were asked to provide recommendations/ideas about the best way(s) to transfer this knowledge and associated limitations to competent authorities.

Several recommendations emerged:

- **Make results easily available.** Make abundance and distribution maps of the sensitive species available through the official GIS servers, such as https://sig.mapama.gob.es/geoportal/ in Spain and https://www.geoportail.gouv.fr/carte in France.
- **Conduct collaborative, transboundary, and synthetic work**, based on experts' knowledge (robust science), provide synthetic information to decision makers (e.g. IMMA[76], IMTA[77], CCH[78]), conduct workshop gathering scientists and decision makers from different member states (e.g. PSSA[79]).
- **Ensure stakeholders engagement.** See recommendations in UNESCO-IOC/European Commission. 2021. MSPglobal International Guide on Marine/Maritime Spatial Planning. Paris, UNESCO. (IOC Manuals and Guides no 89).

[74] GDEGeM project reports: https://www.gdegem.org/rapports
[75] Data is searchable in: http://intercet.it/
[76] Important Marine Mammal Areas: https://www.marinemammalhabitat.org/
[77] Important Marine Turtle Areas: https://www.iucn-mtsg.org/imtas
[78] Critical Cetacean Habitats: https://accobams.org/conservations-action/protected-areas/
[79] Particularly Sensitive Sea Areas: https://www.imo.org/en/OurWork/Environment/Pages/PSSAs.aspx

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Technical meeting 3 – Seabirds

The third technical meeting (21st of October 2021) was dedicated to the consideration of ecological parameters within public policies, in the context of the MSPMED transboundary case study "Planning the offshore Gulf of Lions" (sessions 1 and 2). The last part of the technical meeting (session 3) was focused on the presentation of the last step of the methodological framework conducted so far to characterize interactions between ecosystems and pressures linked to offshore floating windfarm development. The meeting was conducted following the program below:

Participants: Felipe Aguado (Instituto Español de Oceanografía - IEO(CSIC)), Etienne Boncourt (Centre d'Ecologie Fonctionnelle et Evolutive - CEFE-CNRS), Léa David (EcoOcéan Institut), Sophie de Grissac (France Energies Marines - FEM), Jacob González-Solis Bou (Universidad de Barcelona), Raul Ramos García (Universidad de Barcelona), Emeline Pettex (Université de la Rochelle), Marcel Gil Velasco (Cory's), Neil Alloncle* (OFB), Camille Assali* (OFB),), Mónica Campillos Llanos* (IEO(CSIC)), Cristina Cervera Núñez* (IEO(CSIC)), Elena Gutierrez Ruiz* (IEO(CSIC)), Sybill Henry* (FEM).

*Organizers (MSPMED team)

The global objective of sessions 1 and 2 was to discuss the consideration of ecological stakes

Not reported herafter	**Introduction (15')** Introduction of experts and presentation of the objectives of technical meetings
Reported herafter	**Session 1: Focus on criteria informing public policies (30')** Selection of topics to be addressed during the meeting.
	Session 2: Focus on knowledge transfer to decision makers (40') Discussion about (a) the knowledge level associated to the selected topics, and (b) the consideration of these topics into public policies.
Not reported hereafter	**Session 3: Characterization of interactions with a ranking method (20')** Presentation of the last step of the methodological framework addressing the characterization of interactions between ecological receptors and pressures.
	Conclusion and objectives of technical meeting 4 (10')

within public policies and to share experience between France and Spain in order to help to improve the coherence of Maritime Spatial Planning (MSP) at the transboundary scale.

Based on (i) the background information collected in literature (evaluation reports, existing datasets, current projects, scientific articles, etc.), and (ii) the results of the first technical meeting held in June 2021 (identification of knowledge gaps about seabird at-sea distribution, its predictability, functional areas and abundance assessments), exchanges were conducted to answer two general questions:

- How could we better inform ecological stakes at the transboundary scale?

- How should we transfer appropriately this information to decision makers of the MSP process?

To address those questions, discussions were divided into two steps: the first session was focused on topics collectively selected from a list of criteria (see *Session 1: focus on criteria informing public policies*), and the second session was dedicated to highlighting limitations and perspectives to facilitate knowledge sharing, especially with competent authorities (see *Session 2: focus on knowledge transfer to decision makers*) and at a transboundary scale.

Session 1: focus on criteria informing public policies

In order to focus on key topics to be addressed in our transboundary exchanges, the experts were proposed a list of criteria, selected from current public policies such as the descriptor 1 “Biodiversity is maintained” of the Good Environmental Status targeted by the Marine Strategy Framework Directive (MSFD), as well as from criteria commonly used to inform Marine Protected Area (MPA) designation (see table 1).

Experts were firstly asked to vote for 5 out of 10 the topics to be addressed during the meeting, considering two decision rules:

- Is the criterion relevant for informing public policies (especially MSP) in the study area?
- Is the criterion relevant to be addressed at the transboundary scale?

Secondly, experts were asked to associate a level of knowledge (high/sufficient, medium/incomplete, low/insufficient) to these topics, either relative to the baseline data (e.g. abundance) or to the evaluation method for the criterion (e.g. threshold).

The results of this voting session are reported in Table 7A-2 below.

Table 7A-2: Results of the voting session aimed at selecting key topics to be addressed in session 2, from MSFD D1 criteria and MPA designation (e.g. Specially Protected Areas of Mediterranean Importance), and associated knowledge levels. Selected topics (highest voting scores) appear in purple.

Process	Criteria		Number of votes	Votes to associate a knowledge level		
				High	Medium	Low
MPA designation	Uniqueness	The area contains unique or rare ecosystems, or rare or endemic species.	5	4	1	0
	Representativeness	The area has highly representative ecological processes, or community or habitat types or other natural characteristics.	3	1	1	0
	Diversity	The area has a high diversity of species, communities, habitats or ecosystems.	3	2	0	0
	Naturalness	The area has a high degree of naturalness as a result of the lack or low level of human-induced disturbance and degradation.	1	0	0	0

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	Critical habitats	Presence of habitats that are critical to endangered, threatened or endemic species.	7	4	0	0
MSFD – Good Environmental Status evaluation	D1C1	The mortality rate per species from incidental by-catch is below levels which threaten the species, such that its long- term viability is ensured.	1	1	0	1
	D1C2	The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.	3	0	2	0
	D1C3	The population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity, and survival rates) of the species are indicative of a healthy population which is not adversely affected due to anthropogenic pressures.	1	1	0	1
	D1C4	The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions.	2	1	2	0
	D1C5	The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species.	4	1	1	1

The three selected topics obtained 7, 5 and 4 votes (rated by 8 experts), and were respectively associated to a high level of knowledge (“Presence of habitats that are critical to endangered, threatened or endemic species”), a high/medium knowledge (“The area contains unique or rare ecosystems, or rare or endemic species”), and disparate knowledge level (“The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species”).

Session 2: focus on knowledge transfer to decision makers

Session 2 was then dedicated to (i) experience sharing about the current limitations related to selected topics, (ii) perspectives to overcome those difficulties, and (iii) information transfer to decision makers of the MSP.

a. <u>Topic 1: The area hosts habitats that are critical to endangered, threatened or endemic species.</u>

According to experts’ opinion, the assessment of this criterion relates to **abundance and demographics** of seabird species in the north-western Mediterranean Sea.

From both France and Spanish experience, abundance and demographic assessments are not limited by the methodology (either regarding data collection or the subsequent evaluation process). Data is acquired through a standardized protocol at the Macaronesia scale, and this standardized effort could be enlarged to Balearic Islands, Mediterranean French waters and western Italian waters at least.

However, such evaluation is still **limited by data** itself. Experts mention that assessments are limited either by demographic parameters estimates (e.g. Audouin's gull - *Ichthyaetus audouinii*, Common tern - *Sterna hirundo*) or by population estimates (e.g. Scopoli's shearwater - *Calonectris diomedea*, Balearic shearwater - *Puffinus mauretanicus*). In addition, species distribution is not completely known in the area since colonies are undescribed, even for species receiving special attention such as the Balearic shearwater. For those cases, additional monitoring effort shall be conducted.

For unknown reasons, colonies sites and habitat use can **vary over space** from one year to another (e.g. Audouin's gull, Sandwich tern - *Thalasseus sandvicensis*) at the transboundary scale. While this information is transmitted by ornithologists/scientists networks, **an official data sharing network is needed** at least at the north-western Mediterranean scale (e.g. data from census of colonies).

Within the MSFD process, evaluation relies on the selection of representative species for each kind of habitat (e.g. continental shelf/productive areas, pelagic habitats, seamounts, etc.). In Spain, pilot colonies are monitored and results are extrapolated to the whole population. The Good Environmental Status assessment thus relies on the best associations of indicator species and pilot colonies. However, as mentioned during the first technical meeting held in June, evaluation thresholds are not definable without **baseline values**, which are still difficult to assess in both Spain and France.

b. Topic 2: The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species.

As the experts pointed out, this topic corresponds to a **secondary** MSFD criterion. Habitat extent and condition are not the most relevant descriptors to assess the Good Environmental States for seabirds, as their at-sea distribution and breeding success are rather linked to the feeding resource (prey distribution and availability). In that sense, demographics and abundance of breeding adults are more relevant (primary criteria) for describing seabird population states. For example, adult survival rate is especially important for tubenoses, whereas productivity is a key parameter for charadriiformes populations. However, it is still difficult to assess if some species breed in the study area (e.g. Storm petrel - *Hydrobates pelagicus*).

Moreover, this topic questions the current level of knowledge about habitat use through life stages in seabirds. For example, juveniles are almost exclusively monitored from at-sea surveys, and functional needs of seabirds through life stages may not be known for each species. Experts thus mention that **behavioural data** (e.g. activity, flight direction, etc.) should be collected simultaneously with identification and countings. This is actually done in the Gulf of Lion's continental shelf area[80] in boat-based surveys. Moreover, experts mention seabird species **associated with at-sea human activities**, such as storm petrels concentrating around fish farms and foraging in their vicinity, or shearwaters attending fishing vessels. The different

[80] Boat-based surveys conducted by EcoOcéan Institut.

activities can turn the habitat either suitable or unsuitable for foraging individuals, and potentially benefit specific life stages (e.g. juvenile northern gannets on fish farms).

However, life stages and behavioural data still have to be analysed at the Gulf of Lion's scale. Firstly, behavioral data could be analyzed so as to **understand rough patterns**, i.e. circadian activity and among life stages, in order to better inform seabird habitat use. Secondly, when the relationship between at-sea activities and seabird distribution is known, at-sea activities could be used as **predictors in habitat modelling**, and weighted dependently of other predictors (environmental factors). Experts highlight that literature already exists about seabird distribution modelling in relation to fish farms and fishing vessels distribution.

Finally, experts underline that a lot of information still needs to be collected through **analysis which combine telemetry data and at-sea surveys**, and could be used as an input for habitat models.

c. Topic 3: The area contains unique or rare ecosystems, or rare or endemic species

This "Uniqueness" criterion is abundantly informed by literature. Among seabird species, experts cited the Balearic shearwater *(Puffinus mauretanicus)*, the Mediterranean shag *(Phalacrocorax aristotelis)* and the storm petrel *(Hydrobates pelagicus)* to be considered in that topic, in addition to several other ecological components such as Posidonia meadows.

d. [Additional] Topic 4: The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions

This topic refers to the assessment of an "optimal use of habitat" by seabirds. According to experts, this criterion is closely related to others, while others are easier to assess (see above). As mentioned before (topic 1), important distributional variations can occur over time. Consequently, this criterion is not useful e.g. for terns and gulls because of the variability of colonies locations which does not seem to affect the species breeding success. Finally, this criterion would be even more difficult to address because of still undiscovered seabird colonies within the study area and at a broader scale (Balearic Islands).

e. How to share this information with MSP competent authorities?

As a concluding question, experts were asked to provide recommendations/ideas about the best way(s) to transfer this knowledge and associated limitations to competent authorities.

Several recommendations emerged:

- **Open data**. A lot of ecological data exists and, even when data is public, the access is still very difficult. A specific online database could be built to collect all data producers' contributions.
- **Standardize data acquisition protocols.** As previously mentioned by experts, data still miss homogeneity and effort shall be carried out to improve protocol standardization

(frequency, sample size, collected information) at an extended spatial scale/within public policies.

- **Standardize data analysis methods and discussion**. Producing relevant analysis requires a significant effort, which is insufficiently considered in evaluation/expertise processes. Analysis should be standardized and discussion of data/methods limitations should be closely associated with results. Confidence/uncertainty descriptors should be emphasized.
- **Increase exploratory analysis**. As many different and complementary data types exist, experts underline the need of additional analysis effort and exploratory work to combine data sources[81].
- **Communicate synthetic information.** Effort has to be continued in order to communicate scientific information through concept diagrams, synthetic documents and appropriate artwork. In the specific context of MSFD evaluation, a simple tool aimed at comparing the obtained results and the thresholds established to define the GES would be very informative/understandable. More generally, information is easier to be communicated through official frameworks and initiatives (e.g. similarly to Cetaceans Critical Habitats – ACCOBAMS).

[81] See for example: https://seo.org/wp-content/uploads/2012/06/lg_140_ibamarina_primer_inventario_oto%C3%B1o2009.pdf

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VIII. Synthesis of identified information in regards with submarine canyons in the Gulf of Lions

Produced in the context of the MSPMED project, within the case study "France and Spain; Planning the offshore Gulf of Lions in respect with ecosystems" – task 2.2.1, this note reports several references that could be mobilized so as to get an overview of the functionalities of submarine canyons in the Gulf of Lions. This effort shall be considered as non-exhaustive, and rather gathering key elements to consider within MSP processes at local (Marine Protected Areas) to regional (Western Mediterranean) scales.

The work conducted within the task 2.2.1 of the MSPMED project specifically targeted the data, methods and results informing cetaceans, sea turtles and seabirds in the Gulf of Lions. This synthesis effort allowed to identify sources informing the functioning of canyon ecosystems, e.g.:

- The characterization of the ecosystem of the Cape of Creus canyon within the LIFE+ INDEMARES project[82,] offering a detailed description of geomorphological and ecological specificities of this canyon[83];
- The review by Würtz M.[84] for IUCN, built on workshops results and ecological/environmental data analysis to offer a global view of canyon ecosystems functioning, as well as management potentials and issues.
- The review by Fernandez-Arcaya et al. (2017), describing the ecological status of canyons, current and future issues for canyon conservation, and research effort required to inform management measures.

In addition, following paragraphs reference several data sources obtained in canyon systems of the Gulf of Lions.

Benthic habitats characterization

Oceanographic campaigns contributing to the identification of benthic species and habitats in canyon and their vicinity are listed in annex III. Identified data acquisition campaigns within canyons in the North-Western Mediterranean Sea). This list also gathers references of scientific publications making used of the produced data.

Apart from these campaigns, several sources offer a review of existing datasets:

[82] https://www.indemares.es/

[83] Gili, J., Madurell, T., Requena, S., Orejas, C., Gori, A., Purroy, A., Dominguez, C., Lo Iacono, C., Isla, E., Lozoya, J., Carboneras, C., & Grinyo, J. (2010). Caracterización física y ecológica del área marina del Cap de Creus. Informer final area LIFE+ INDEMARES (LIFE07/NAT/E/000732). Instituto de Ciencias del Mar/CSIC (Barcelona). Coordinacion: Fundación Biodiversidad, Madrid.

[84] Würtz M. (ed.) (2012). Mediterranean Submarine Canyons: Ecology and Governance. Gland, Switzerland and Málaga, Spain: IUCN. 216 pages

- The seabed substrate database from a compilation of sediment samples taken during oceanographic campaigns carried out in the Gulf of Lion by Ifremer, CEFREM, IRSN, CEREGE, FOB, MIO, LECOB, The Conseil Général de l'Hérault and Rhône-Méditerranée-Corse Water Agency (Augris Claude et al., 2013).
- The review and collection of the available datasets on indicators and human pressures/impacts on Mediterranean deep-sea ecosystems within the IDEM project (Ciuffardi et al., 2018).

Pelagic habitats and resources

Several halieutic surveys encompass (at least partially) the canyons area, bordering the Gulf of Lions continental shelf:

- PELMED[85] – Halieutic surveys conducted annually in June or July and aiming at assessing the abundance of small pelagic fishes in the Gulf of Lions area;
- MEDIAS[86]- Halieutic surveys conducted annually in June or July and aiming at assessing the abundance of small pelagic fishes across the continental shelf bordering Spanish Mediterranean coasts;
- Biannual aerial surveys (April-May and September-October) dedicated to the observation of bluefin tuna (*Thunnus thynnus*) in order to inform its distribution and abundance in the offshore Gulf of Lions[87]

Megafauna associated with canyons area

While a significant amount of visual data has been collected over the Gulf of Lions continental shelf (see data sheets in annexe IX of the deliverable 2.4 - MSPMED project), offshore areas have been acknowledged as poorly informed in regards with megafauna species, such as cetaceans, sea turtles, seabirds, elasmobranchs, sunfishes. However, the spatial extent of following datasets may be compatible with a characterization of megafauna species habitat use in the canyons area:

- Aerial and boat-based surveys conducted in 2000-2022 along coast of Catalonia and Balearic Islands (see PROYECTO-MEDITERRANEAO-2001-2002-MM-plane and PROYECTO MEDITERRANEO 2000-2002-MM-boat).
- SAMM surveys conducted within the MSFD framework in the French Western Mediterranean reporting unit (see SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF).
- Aerial and boat-based surveys conducted in 2018 within the ACCOBAMS survey initiative (see ASI-2018-PLANE-MM-MT-SB-EB-SF and ASI-2018-BOAT-MM-MT-SB-EB-SF).

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[85] https://campagnes.flotteoceanographique.fr/series/19/
[86] See MEDIAS 2019 : https://csr.seadatanet.org/report/20195589
[87] https://wwz.ifremer.fr/peche/Archives/Survols-du-thon-rouge

- Boat-based surveys conducted in 2010 in the Cape of Creus canyon area within the LIFE+ INDEMARES project (INDEMARES-2012-MM.
- Boat-based surveys conducted within SUBMON projects and targeting cetacean species (see GRAMPUS-2014-MM, DDT-2017-2020-MM, AHAB-2020-MM).
- Boat-based surveys conducted during MEDSEACAN campaigns in 2008-2009 and specifically located in canyon areas (see MEDSEACAN-2008-2010-MM-SB).
- Boat-based survey conducted in 2018 within the Nature Marine Park of the Gulf of Lions (see MEGAOBS-MM-MT-SB-EB-SF-2018-Present).
- Aerial surveys conducted from 2016 to 2018 in the context of pilot offshore windfarm development in the Gulf of Lions (see EFGL-2017-2018-MM-MT-SB-MB-BH, EOLMED-2016-2017-MM-MT-SB-MB-BH, and PGL-2011-2013-MM-MT-SB-MB-BH).

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IX. Data sheets: identified aerial and boat-based surveys in the case study area

Large-scale visual surveys (Mediterranean Sea, Levantino-Balearic region)

Marine mammals Reference: PROYECTO-MEDITERRANEAO- 2001-2002-MM-plane

Characteristics

Data type	*Temporal and spatial scales*
Marine mammals observations from plane.	2001-2002 (summer and winter). The Proyecto Mediterráneo extended all along Spanish Mediterranean coasts; data referenced here corresponds to the northern sector (Catalonia and Balearic Islands).

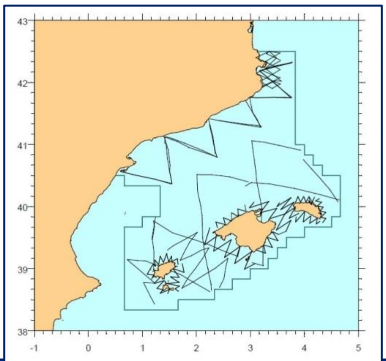


Figure 8: Aerial transects in effort conducted in 2001-2002. Transects off Catalonia, Balearic coasts and Cape Creus were surveyed twice, once in summer and once in winter. Figure extracted from the Proyecto Mediterráneo report (see citation below). Credits: Raga and Pantoja, 2004.

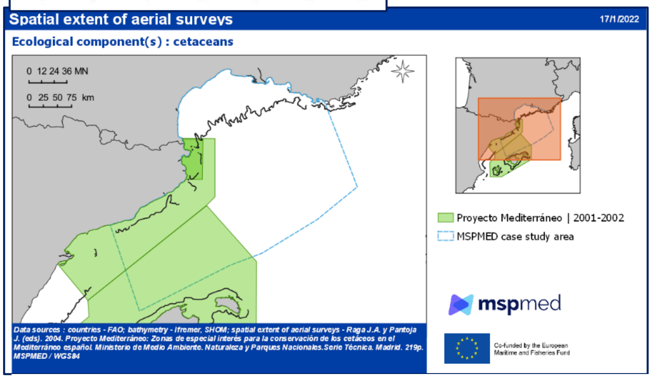


Figure 7: Spatial extent of the dataset within the MSPMED study case area. Credits: OFB.

Protocol

Line-transect distance sampling from plane; altitude: 500 ft; speed: 80-90 kt; number of observers: 2.

Short description

The Proyecto Mediterráneo was aimed at identifying areas of special interest for cetacean conservation in the Spanish Mediterranean Sea. Acquired data supported the designation of the SPAMI "*Mediterranean Cetacean Migration Corridor*" (see this link) .

Examples of data use

Reference	Raga J.A. y Pantoja J. (eds). 2004. Proyecto Mediterráneo: Zonas de especial interés para la conservación de los cetáceos en el Mediterráneo español. Ministerio de Medio Ambiente. Naturaleza y Parques Nacionales. Serie Técnica. Madrid. 219 p. Figure extracted from chapter *2. Sector Norte (Cataluña e Islas Baleares)* by Gazo, M., Forcada, J.; Aguilar, A.; Fernández-Contreras, M. M.; Borrell, A.; Gonzalvo, J.; Tornero, V.

Complementary information on data use

Data has been used in FORCADA, Jaume, GAZO, Manel, AGUILAR, Alex, et al. Bottlenose dolphin abundance in the NW Mediterranean: addressing heterogeneity in distribution. Marine Ecology Progress Series, 2004, vol. 275, p. 275-287.

Marine mammals

Reference: PROYECTO-MEDITERRANEAO-2000-2002-MM-boat

Characteristics

Data type	*Temporal and spatial scales*
Marine mammals observations from boats.	2000-2002. The Proyecto Mediterráneo extended all along Spanish Mediterranean coasts; data referenced here corresponds to the northern sector (Catalonia and Balearic Islands).

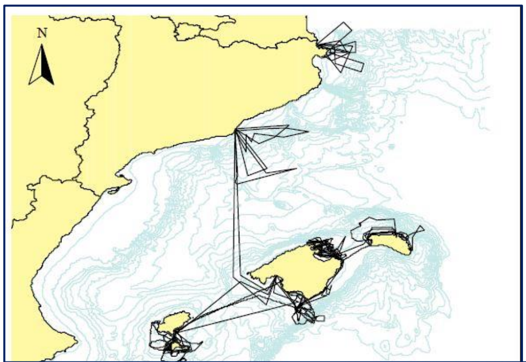


Figure 9: Boat-based transects in effort conducted in between 2000 and 2002 in the context of Proyecto Mediterráneo. Figure extracted from the Proyecto Mediterráneo report (see citation below). Credits: Raga and Pantoja, 2004.

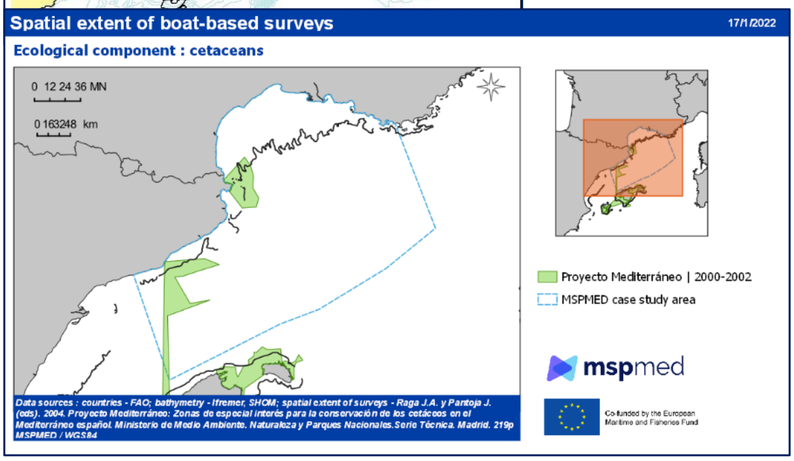


Figure 10: Spatial extent of the dataset within the MSPMED study case area. Credits: OFB.

Protocol

Not known.

Short description

The Proyecto Mediterráneo was aimed at identifying areas os special interest for cetacean conservation in the Spanish Mediterranean Sea. Acquired data supported the designation of the SPAMI "*Mediterranean Cetacean Migration Corridor*" (see this link) .

Examples of data use

Reference	Raga J.A. y Pantoja J. (eds). 2004. Proyecto Mediterráneo: Zonas de especial interés para la conservación de los cetáceos en el Mediterráneo español. Ministerio de Medio Ambiente. Naturaleza y Parques Nacionales. Serie Técnica. Madrid. 219 p. Figure extracted from chapter *2. Sector Norte (Cataluña e Islas Baleares)* by Gazo, M., Forcada, J.; Aguilar, A.; Fernández-Contreras, M. M.; Borrell, A.; Gonzalvo, J.; Tornero, V.

Complementary information on data use

Boat-based surveys conducted so as to obtain sightings and biopsies of cetaceans. Data is part of the GRUMM database.

Marine mammals, marine turtles, seabirds, elasmobranchs, sunfishes

Reference: SAMM-2011-2012-2018-2019-MM-MT-SB-EB-SF

Characteristics	*Data type*	*Temporal and spatial scales*
	Megafauna observations by plane.	2011-2012 (winter and summer), and 2018-2019 (winter). Coverage of French Mediterranean waters, including the whole Gulf of Lions (continental shelf and slope) as well as contiguous bathyal plain.

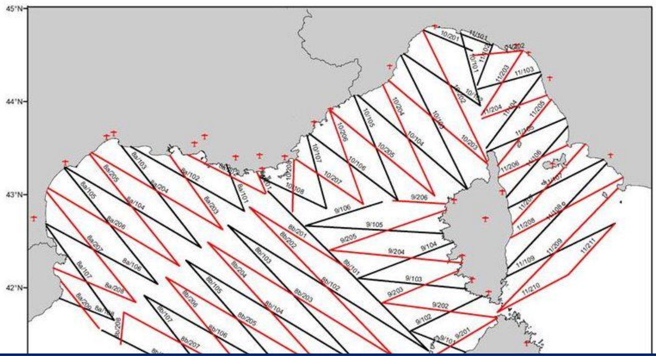


Figure 11: Planned sampling effort in SAMM II. From: https://www.observatoire-pelagis.cnrs.fr/samm-ii-2/ ; consulted the 10/01/2022.

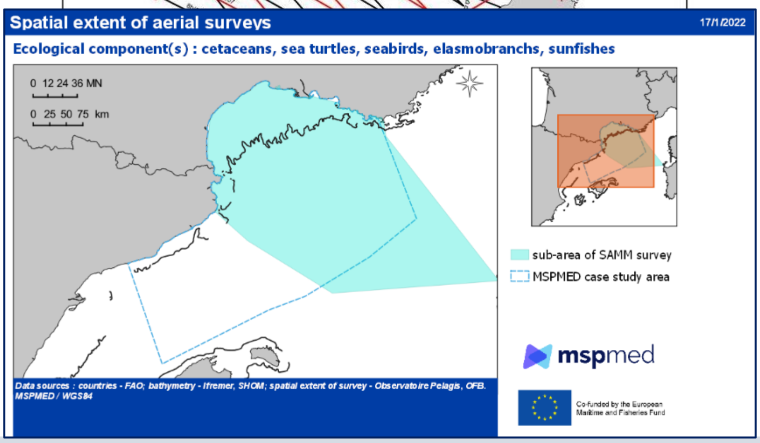


Figure 12: Spatial extent of the dataset within the MSPMED study case area. Credits: OFB.

Protocol

Observations by plane along transects (altitude: 600 ft; speed: 90 kt): seabirds - strip-transects of 200m width, marine mammals, elasmobranchs, sea turtles and sunfishes: line-transects distance sampling.

Short description

Suivi Aérien de la Mégafaune Marine (SAMM I and II): aerial surveys of marine megafauna (in 2011-2012, as part of the PACOMM program; both are used to inform MSFD descriptors).

Examples of data use

References

https://sextant.ifremer.fr/record/a436c152-b4ba-41ee-9890-e32204cd5c65/

SAMM I : PETTEX, E., LAMBERT, C., LARAN, S., et al. Suivi aérien de la mégafaune marine en France métropolitaine. SAMM Rapport final, 2014.

SAMM II : LARAN S., NIVIERE M., GENU M., DOREMUS G., SERRE S., SPITZ J., VAN CANNEYT O. et AUTHIER M. 2021. Distribution et abondance de la mégafaune marine lors des campagnes SAMM cycle I et II en Méditerranée. Rapport final. Observatoire Pelagis (UMS 3462, La Rochelle Université / CNRS) & OFB. 76 pp.

Complementary information on data use

Data has been used in e.g.: **SAMM I:** LARAN, Sophie, PETTEX, Emeline, AUTHIER, Matthieu, et al. Seasonal distribution and abundance of cetaceans within French waters-Part I: The North-Western Mediterranean, including the Pelagos sanctuary. Deep Sea Research Part II: Topical Studies in Oceanography, 2017, vol. 141, p. 20-30.

Characteristics

Data type	*Temporal and spatial scales*
Megafauna observations from plane and boat.	2018 (summer). Spatial Units over the Mediterranean Sea.

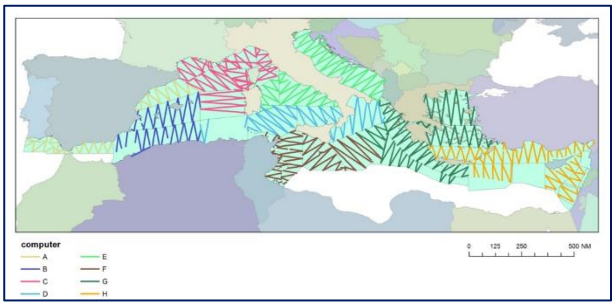


Figure 13: transects covered by plane during ASI 2018. From: https://accobams.org/main-activites/accobams-survey-initiative-2/asi-preliminary-results/ ; consulted the 10/01/2022.

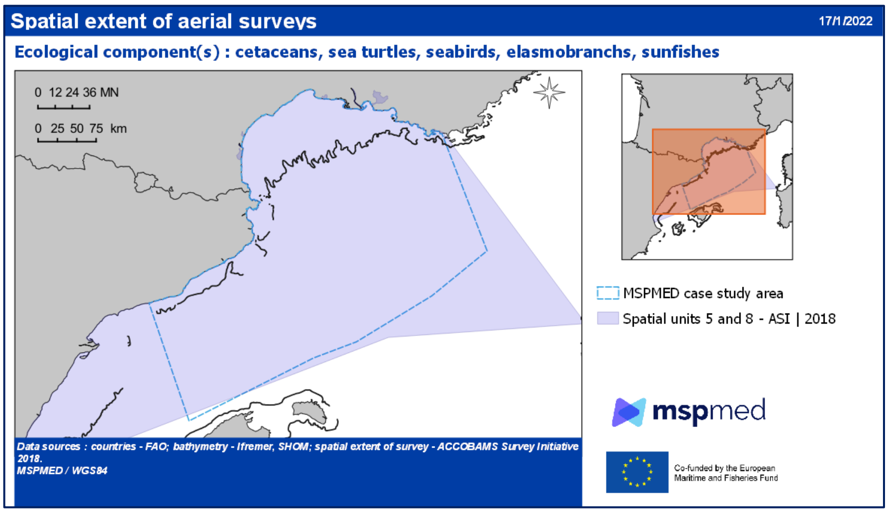


Figure 14: Spatial extent of the dataset within the MSPMED study case area. Credits: OFB.

Protocol

Observations by plane along zigzag transects in different Mediterranean sub-regions (altitude: 600 ft, speed: 100 kt; number of observers: 2).

Short description

ACCOBAMS Survey Initiative (ASI): large-scale campaign across the Mediterranean Sea.

Examples of data use

Reference	ACCOBAMS, 2021. Estimates of abundance and distribution of cetaceans, marine mega-fauna and marine litter in the Mediterranean Sea from 2018-2019 surveys. By Panigada S., Boisseau O., Canadas A., Lambert C., Laran S., McLanaghan R., Moscrop A. Ed. ACCOBAMS - ACCOBAMS Survey Initiative Project, Monaco, 177 pp. https://accobams.org/wp-content/uploads/2021/04/ASI-Med-Report.pdf

Complementary information on data use

Available upon request (https://accobams.org/asi-data-presentation/).

Marine mammals, marine turtles, seabirds, elasmobranchs, sunfishes

Reference: ASI-2018-BOAT-MM-MT-SB-EB-SF

Characteristics

Data type	*Temporal and spatial scales*
At-sea counting from boat (species identity, group size, direction of travel, behaviour), range and bearing to the centre of each group, and passive acoustics (identification and logging of vocalisations).	2018. Spatial Units over the Mediterranean Sea.

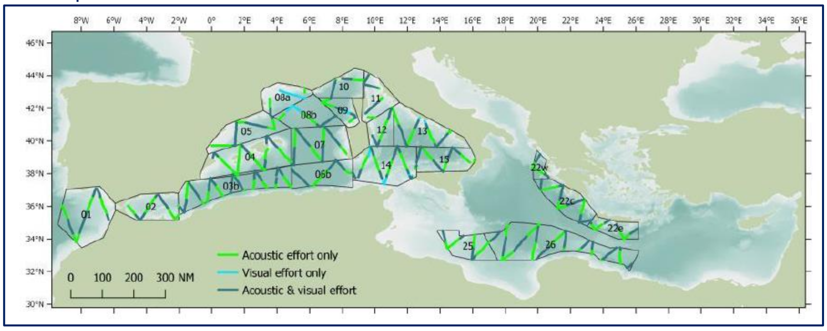


Figure 15: Survey transects completed by the Song of the Whale team between 18th May and 29th September 2018 (ASI). From https://accobams.org/main-activites/accobams-survey-initiative-2/asi-preliminary-results/ ; consulted the 10/01/2022.

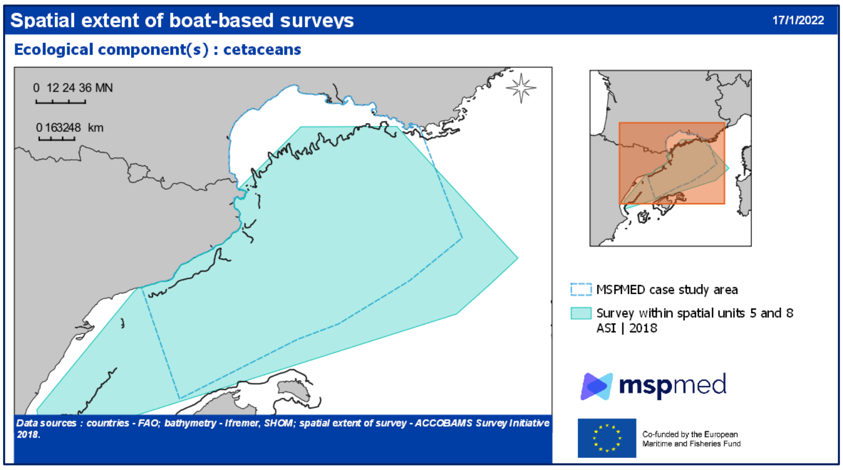


Figure 16: Spatial extent of the dataset within the MSPMED study case area. Credits: OFB.

Protocol

Observations by boat (line transect distance sampling; 2 observers scanning 270° to 20° and 340° to 90° relative to the ship's bow) along zigzag transects in different Mediterranean sub-regions. Passive acoustics: towed arrays of hydrophones (cable of 400 m), 24h a day, speed of 5 to 8 kt.

Short description

ACCOBAMS Survey Initiative (ASI): large-scale campaign across the Mediterranean Sea.

Examples of data use

Reference: ACCOBAMS, 2021. Estimates of abundance and distribution of cetaceans, marine mega-fauna and marine litter in the Mediterranean Sea from 2018-2019 surveys. By Panigada S., Boisseau O., Canadas A., Lambert C., Laran S., McLanaghan R., Moscrop A. Ed. ACCOBAMS - ACCOBAMS Survey Initiative Project, Monaco, 177 pp. https://accobams.org/wp-content/uploads/2021/04/ASI-Med-Report.pdf

Complementary information on data use

Available upon request (https://accobams.org/asi-data-presentation/).

Meso-scale visual surveys within punctual programs or projects

Seabirds

Reference: CSIC-CREUS-2009-SB

Characteristics

Data type	*Temporal and spatial scales.*
Observations from boat in the context of the CSIC-CREUS survey (Life+ INDEMARES 07/NAT/E/000732)	2009. Spanish Mediterranean continental shelf from Barcelona to Cape of Creus, and Creus canyon area.

Figure 17: Spatial extent of seabird census along transects (in red) and during stationary effort (in blue), realised during the CSIC-CREUS campaigns in September 2009. Credits: CSIC.

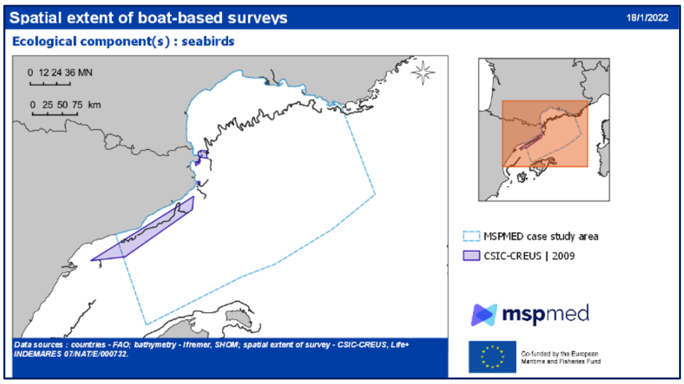


Figure 18: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.

Protocol

300m-width at-sea standardised transects to provide seabird observations (species, age, behaviour), with correction (snap-shot); units of 10 min effort. Additional data from stationary censuses of 10min (hourly when the boat was not in transit).

Short description

Seabird observations were obtained during the CSIC-CREUS campaign, conducted in 2009 within the INDEMARES project, with the participation of SEO-Birdlife observers.

Examples of data use

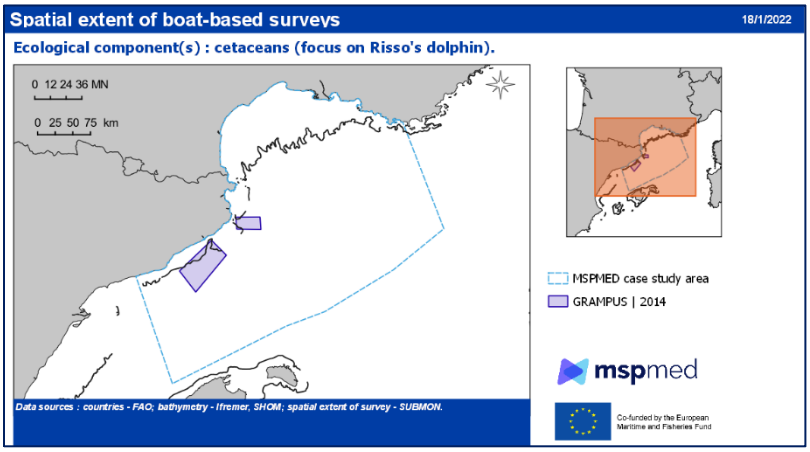
Reference	Seabird data and results are detailed here: https://www.indemares.es/areas-marinas/sistema-de-canones-submarinos-occidentales-del-golfo-de-leon

Complementary information on data use

Accessibility to data is unknown.

Marine mammals – Risso's dolphin (*Grampus griseus)*

Reference: GRAMPUS-2014-MM

Characteristics	*Data type*	*Temporal and spatial scale*
	At-sea observations of Risso's dolphin (*Grampus griseus*); photo-identification.	2014. Areas: Maresme canyon and Palamós canyon.  *Figure 19: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.*
	Protocol	
	Line-transect distance sampling from boat; approach (photo-ID).	
Short description	Grampus project of SUBMON supported the monitoring of Risso's dolphin population (*Grampus griseus*) in the Western Mediterranean in order to inform on the presence, abundance and seasonality of the species in the study area and to improve its conservation (management).	
Examples of data use	*References*	https://www.submon.org/project/grampus-project/
	Complementary information on data use	
	Data owners: SUBMON.	

Marine Mammals

Reference: INDEMARES-2012-MM

Characteristics

Data type	*Temporal and spatial scale*
At-sea observations of cetaceans; photo-identification; passive acoustics	2010 (summer season). Among other areas studied within the INDEMARES project, the covered area lies in front of Cape Creus (Creus canyon).

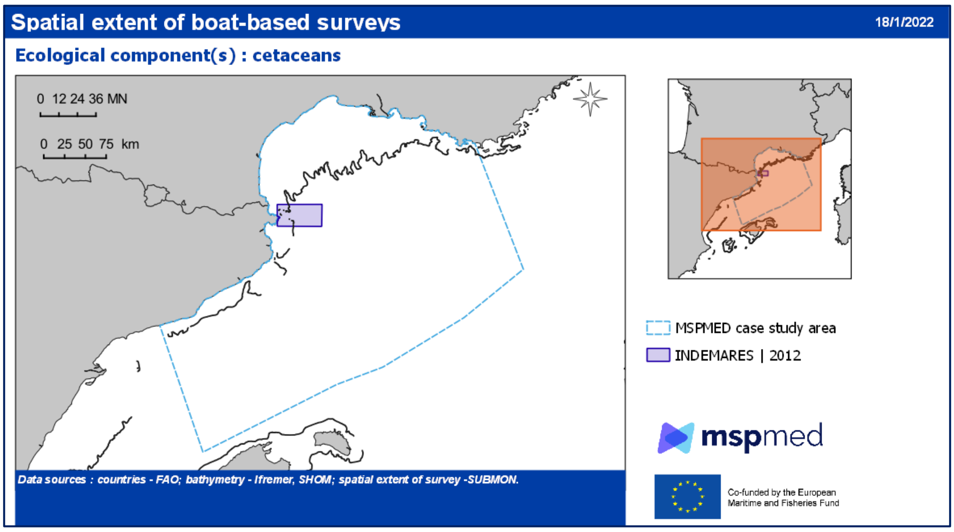


Figure 20: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.

Protocol

Line-transect distance sampling from boat (altitude: 5 ft; speed: 5 kt).
Approach (photo-ID).
Acoustic transect from boat (speed: 6 knots).

Short description

Life + INDEMARES (https://www.indemares.es/en**)**: identification of ecologically valuable areas (data acquisition on deep-sea habitats, pelagic species and seabirds) in the context of N2000 areas designation.

Examples of data use

Reference	Chicote, C.A, Parga, ML, Castellote, M, Monnà, A y M. Gazo. 2010. Actuaciones complementarias al Life+ INDEMARES de inventario de tortugas marinas y cetáceos en las tres áreas marinas propuestas para la Red Natura 2000 en el mediterráneo Nor-occidental”. Informe técnico - Fundación Biodiversidad

Complementary information on data use

Report available at: https://www.indemares.es/sites/default/files/inventario_cetaceos_y_tortugas_2010_-_submon.pdf

Marine mammals – Common bottlenose dolphin (*Tursiops truncatus*)

Reference: GDEGeM-2013-2015-MM

Characteristics

Data type

At-sea observations of megafauna, with a focus on common bottlenose dolphin (*Tursiops truncatus*); photo-identification

Temporal and spatial scale

2013-2015. Continental shelf of the Gulf of Lions (French waters).

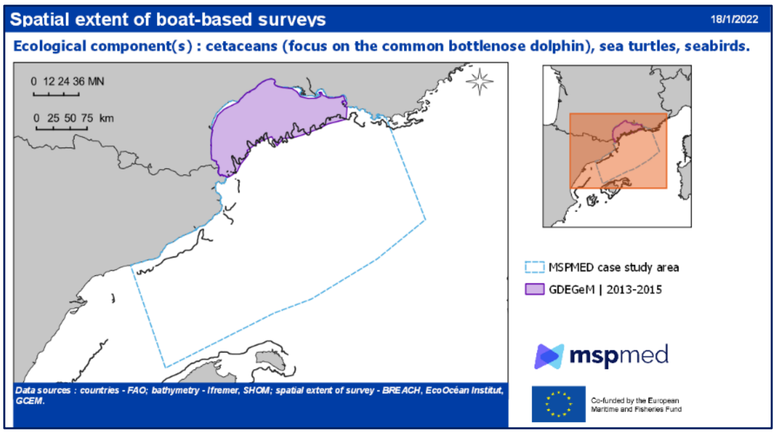


Figure 21: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.

Protocol

Line-transect distance sampling from boat; approach (photo-ID)

Short description

GDEGeM: *Grand dauphin Étude et Gestion en Méditerranée*: collaborative project (researchers & environmental managers) dedicated to the estimation of abundance and spatio-temporal distribution of the common bottlenose dolphin in the Gulf of Lions.

Examples of data use

References	
	Di-Méglio N., Roul M., David L., Gimenez O., Azzinari C., Jourdan J., Barbier M. et Labach H. 2015. Abondance et répartition spatio-temporelle et fonctionnelle du Grand dauphin dans le Golfe du Lion. Projet GDEGeM Grand dauphin Etude et Gestion en Méditerranée 2013-2015. Rapport GIS3M, fait par EcoOcéan Institut, BREACH et le GECEM. 79 p.+ 9p annexes. Final report (Fr): https://www.gdegem.org/sites/gdegem.org/files/documentation/gis3m_gdegem_rapport_technique_final.pdf

Complementary information on data use

Other publications (Fr): https://www.gdegem.org/rapports

Marine mammals – Common bottlenose dolphin (*Tursiops truncatus*)

Reference: DDT-2017-2020-MM

Characteristics	*Data type*	*Temporal and spatial scale*
	At-sea observations common bottlenose dolphin (*Tursiops truncatus*); photo-identification	2017-2020. Creus canyon area.

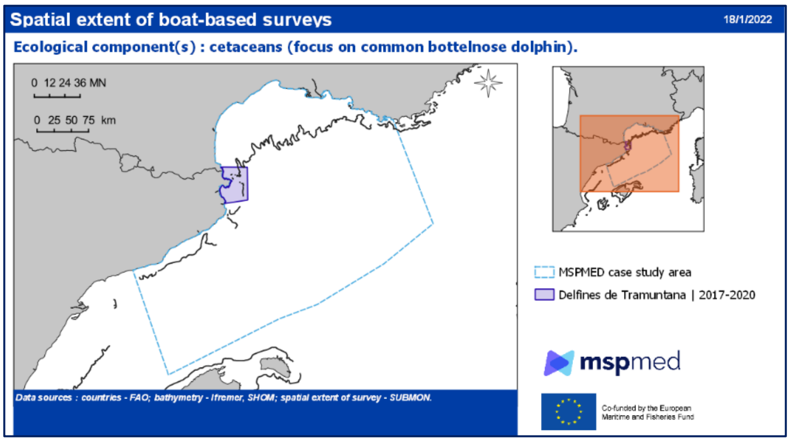


Figure 22: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.

Protocol

Line-transect distance sampling from boat; approach (photo-ID)

Short description

Delfines de Tramuntana project of SUBMON supports the conservation of marine ecosystems of the Creus canyon area and the common bottlenose dolphin population; in collaboration with the fisheries and tourism sectors.

Examples of data use

References	https://www.submon.org/project/delfines-de-tramuntana/ https://www.programapleamar.es/proyectos/deltra-delfines-de-tramuntana-implicando-al-sector-pesquero-en-la-conservacion-del-delfin

Complementary information on data use

Data owners: SUBMON.

Co-funded by the European Maritime and Fisheries Fund

Marine mammals – Common bottlenose dolphin (*Tursiops truncatus*)

Reference: AHAB-2020-MM

Characteristics

Data type	*Temporal and spatial scale*
At-sea observations from boat, passive acoustics, photo-identification.	2020. Two blocks in south-western Gulf of Lions: Creus canyon area to the Palamós canyon.

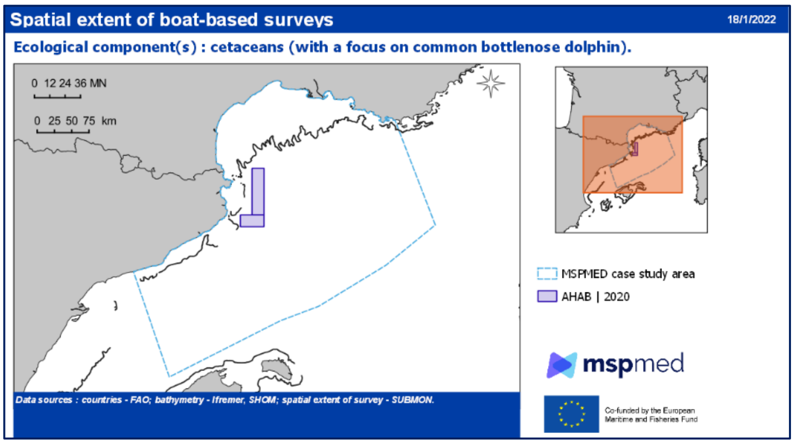


Figure 23: Spatial extent of datasets within the MSPMED case study area. Credits: OFB.

Protocol

Observations: line-transect distance sampling from boat.

Passive acoustics: two-channel hydrophone that was dragged about 150 meters behind the boat.

Short description

The AHAB project was conducted in order to determine the potential of the habitat for deep-diving cetacean species. The first objective was to estimate the abundance of these animals and see how they are using the habitat. The second objective was to evaluate relationships with other places within the Cetacean Migration Corridor or in contiguous areas, and to detect movements or crossing points in the study area.

Examples of data use

References	https://www.submon.org/project/ahab-project/

Complementary information on data use

Data producers: SUBMON, with the support of the Fundación Biodiversidad of the Ministry of Ecological Transition and Demographic Challenge.

Marine Mammals, Seabirds Reference: TT-OCCITANIE-2019-2020-MM-SB

Characteristics

Data type	*Temporal and spatial scales*
At-sea observations from boat; photo-identification of the common bottlenose dolphin (*Tursiops truncatus*).	2018-2019 (all seasons). North-eastern Gulf of Lions – Camargue area.

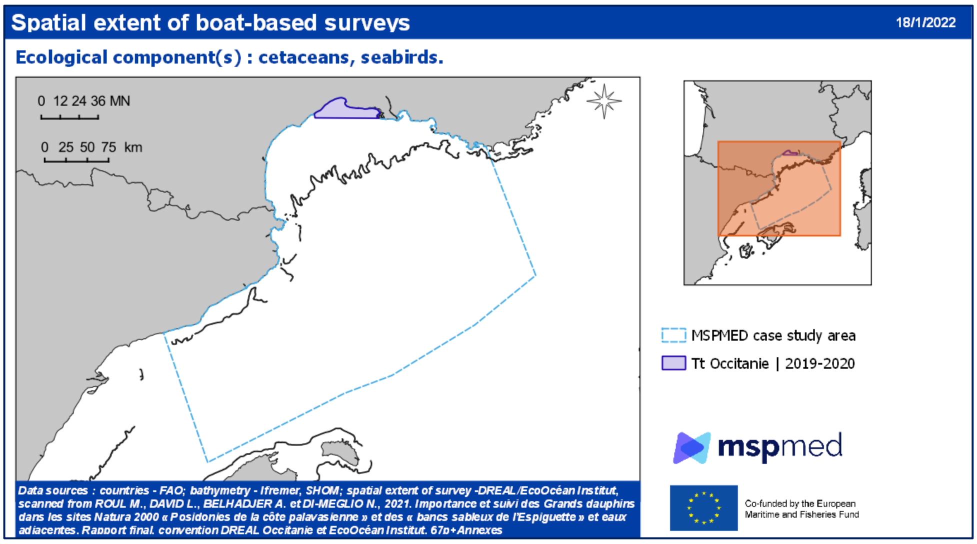


Figure 24: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.

Protocol

Line-transect distance sampling (species identification, countings, behaviour, age-class, for seabirds: flight direction); 3 observers.

Short description

Importance and monitoring of the common bottlenose dolphins in Natura 2000 sites named "Posidonies de la côte palavasienne" and "Bancs sableux de l'Espiguette" and in the adjacent waters. This study aims to improve the knowledge of common bottlenose dolphin's population, to assess the anthropogenic pressures and to determine the areas of cooccurrence between the species and human activities, within the two Natura 2000 sites called "*Posidonies de la côte palavasienne*" and "*Bancs sableux de l'Espiguette*" and the adjacent waters

Examples of data use

References: ROUL M., DAVID L., BELHADJER A. et DI-MEGLIO N., 2021. Importance et suivi des Grands dauphins dans les sites Natura 2000 « Posidonies de la côte palavasienne » et des « bancs sableux de l'Espiguette » et eaux adjacentes. Rapport final, convention DREAL Occitanie et EcoOcéan Institut. 67p+Annexes

Complementary information on data use

Funded by DREAL Occitanie. EcoOcéan Institut collected the data: https://ecoocean-institut.org/recherche/

Marine Mammals Reference: BREACH-2007-2010-MM

Characteristics	*Data type*	*Temporal and spatial scales*
	At-sea observations from boat.	2007-2010. South-western Gulf of Lions (within the perimeter of the Marine Nature Park of the Gulf of Lions).
	Protocol	
	Line-transect distance sampling (species identification, countings, behaviour).	
Short description	Data collected during the "Mission d'étude - Côte Vermeille", used to inform the designation of the Nature Marine Park of the Gulf of Lions (Marine Protected Area).	
Examples of data use	*References*	/
	Complementary information on data use	
	/	

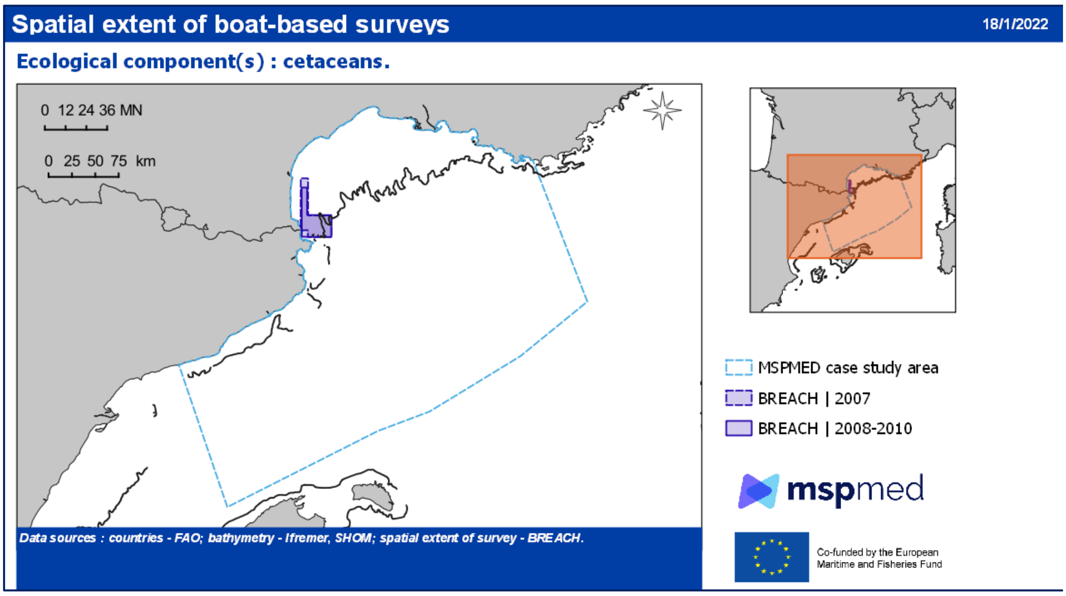


Figure 25: Spatial extent of datasets within the MSPMED case study area. Credits: OFB.

Marine Mammals, Seabirds

Reference: MEDSEACAN-2008-2010-MM-SB

Characteristics	*Data type*	*Temporal and spatial scale*
	At-sea observations of cetaceans and seabirds.	2008-2009. Data acquisition was conducted in canyons' head within or close to the Gulf of Lions (Lacaze-Duthiers, Stoechades, Cassidaigne, Nice and Toulon canyons).

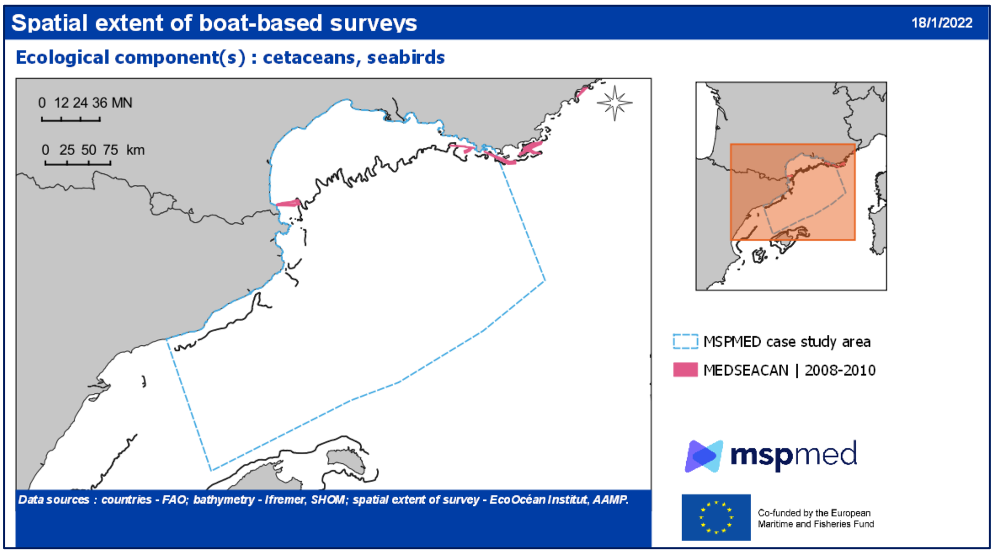


Figure 26: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.

	Protocol	
	Line-transect distance sampling from boat (in transit); stationary census instead (e.g. during ROV dives).	
Short description	MEDSEACAN project allowed to explore canyons' heads in the French Mediterranean waters in order to establish a reference state relatively to habitats, protected and commercial species, ecosystems and anthropogenic pressures. Among different campaigns all along the Gulf of Lions' slope, and further in Var area, EcoOcéan Institut collected data about cetaceans and seabirds.	
Examples of data use	*Reference*	DAVID, Léa et DI-MÉGLIO, Nathalie. Role and importance of submarine canyons for cetaceans and seabirds in the north-western Mediterranean Sea. *Mediterranean Submarine Canyons*, 2012, p. 113.
	Complementary information on data use	
	The reference is part of a broader knowledge synthesis: WÜRTZ, Maurizio. Mediterranean submarine canyons: Ecology and governance. IUCN, 2012. Available at: https://www.iucn.org/fr/content/mediterranean-submarine-canyons-ecology-and-governance	

Marine Mammals, Marine Turtles, Seabirds, Elasmobranch, Sun fishes

Reference: MEGAOBS-MM-MT-SB-EB-SF-2018-Present

Characteristics

Data type	*Temporal and spatial scales*
At-sea observations from boat; photo-identification.	2018-Present. Gulf of Lions Natural Marine Park (PNMGL)

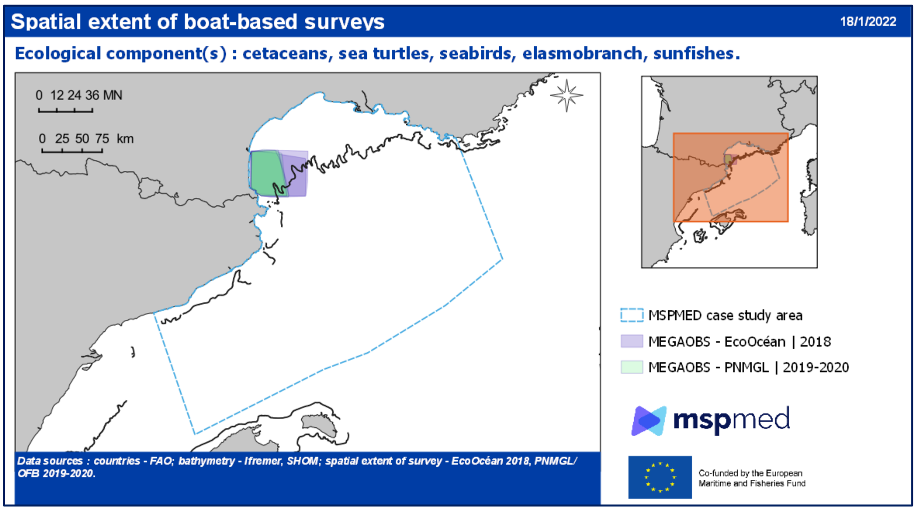


Figure 27: Spatial extent of datasets within the MSPMED case study area. Credits: OFB.

Protocol

Line-transect distance sampling (2 to 3 observers): counts, species identification (2018: behaviour, age-class).

Short description

The MEGAOBS monitoring program is conducted twice every year (in spring and in autumn) and targets the monitoring of megafauna (along with floating litter and at-sea activities) within the Gulf of Lions Natural Marine Park.

Examples of data use

References	/

Complementary information on data use

Data is uploaded in the ObsEnMer database (https://www.obsenmer.org/) and is available upon request to the Gulf of Lions Marine Park (PNMGL)/ French Office for Biodiversity (OFB).

2018: data acquired by EcoOcéan Institut.

2019-Present: data acquired by PNMGL/OFB.

Marine Mammals, marine turtles, seabirds, sunfishes

Reference: FLT-2011-Present-MM-MT-SB-SF

Characteristics

Data type	*Temporal and spatial scales*
At-sea observations from boat; photo-identification.	2011-Present (all seasons). North-western Mediterranean Sea.

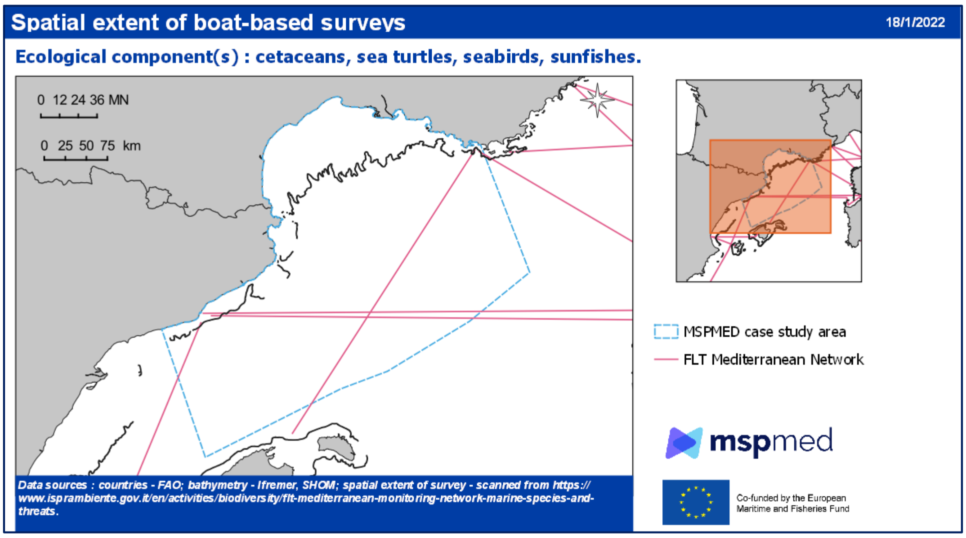


Figure 28: Ferry-line transects of FLT MED Net within the MSPMED case study area. Credits: OFB.

Protocol

Line-transect distance sampling (species identification, countings, behaviour, age-class, for seabirds: flight direction); 3 observers.

Short description

The Fixed Line Transect Mediterranean monitoring Network (FLT MED Net) is a network of research bodies using ferries as platform of observation to perform systematic surveys along several trans-boundary transects in the Mediterranean Sea. The network is coordinated by ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) and is run in collaboration with research bodies from Italy, France, Spain, Tunisia and Greece. More than 20 scientific partners are involved in the data collection, protocol definition, and data analysis. Aim of the Network is the long-term monitoring of key marine species and the main threats to detect early signs of changes in species abundance, distribution and habitat use, and link these to the main environmental and anthropogenic drivers.

Examples of data use

References

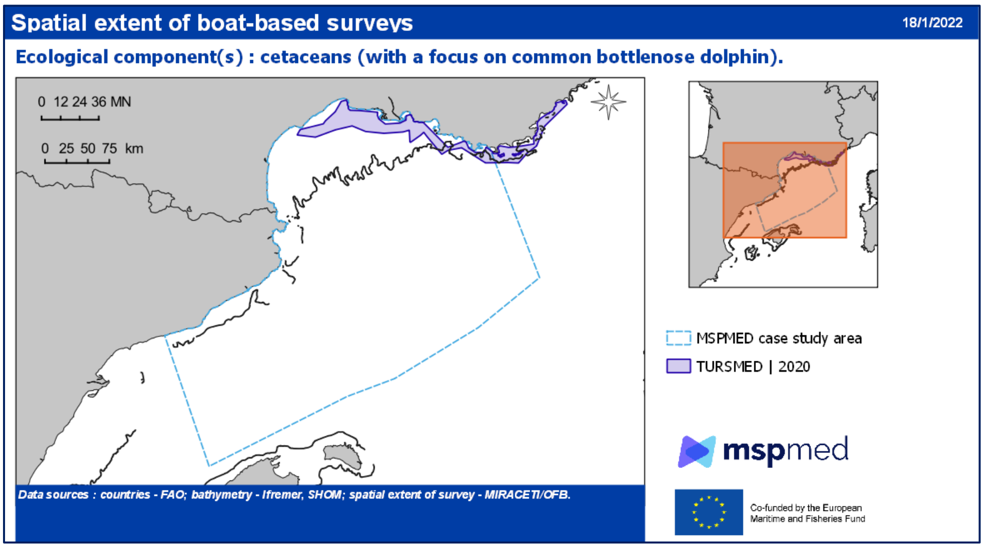
ARCANGELI, A., AISSI, M., ATZORI, F., et al. Fixed line transects Mediterranean monitoring network (flt med net), an international collaboration for long term monitoring of macro-mega fauna and main threats fixed line transect Mediterranean monitoring network. Biol. Mar. Mediterr, 2019, vol. 26, no 1, p. 400-401.

Complementary information on data use

EcoOcéan Institut is involved in the surveys, see: https://ecoocean-institut.org/recherche/

The potentials of using these data to inform the MSFD evaluation of the Good Environmental Status of sea turtles and seabirds are under study.

Marine Mammals Reference: TURSMED-2020-2023-MM

Characteristics	*Data type*	*Temporal and spatial scales*
	At-sea observations from boat; photo-identification.	2020-2023. Gulf of Lions – Marine Protected Areas.  *Figure 29: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.*
	Protocol	
	Line-transect distance sampling (species identification, countings, behaviour, age-class); photo-identification.	
Short description	TURSMED and TURSMED 2 projects (MIRACETI and OFB) support cetacean management within the French network of Marine Protected Areas in the Gulf of Lions, by contributing to the evaluation, characterization and achievement of the Good Environmental Status (MSFD) of cetaceans (and particularly the common bottlenose dolphin *Tursiops truncatus*).	
Examples of data use	*References*	https://www.ofb.gouv.fr/actualites/tursmed-2-mieux-connaitre-le-grand-dauphin-en-mediterranee-pour-mieux-le-proteger
	Complementary information on data use	
	/	

Co-funded by the European
Maritime and Fisheries Fund

Characteristics	*Data type*	*Temporal and spatial scales*
	At-sea observations.	*Data cited below: 2008-2014.* Focus on the Gulf of Lions Natural Marine Park (PNMGL), N2000 FR9112035 site "Cap Béar – Cap Cerbère" (included in PNMGL) and N2000 FR9112034 site "Côte languedocienne"

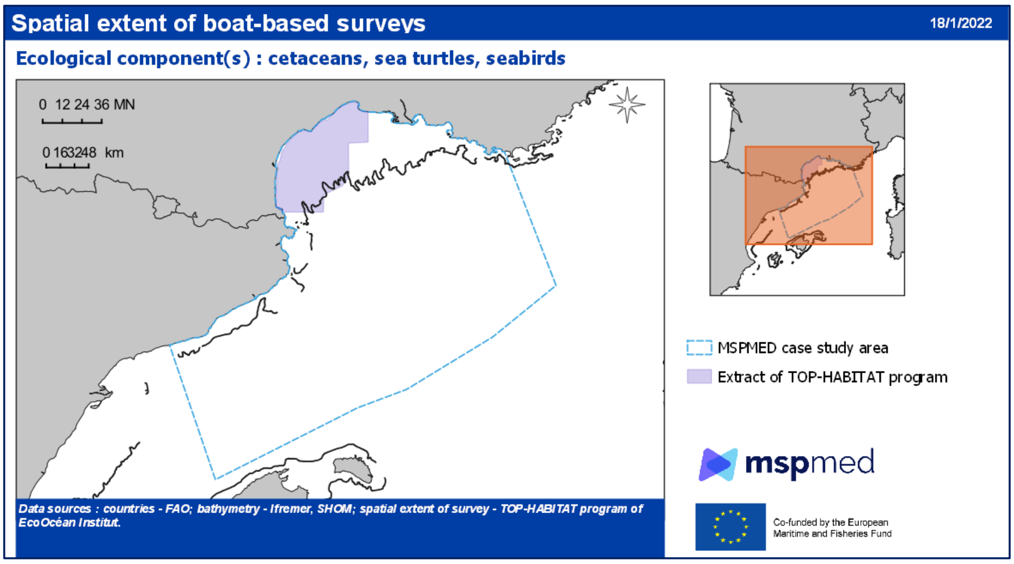


Figure 30: Spatial extent of one extract of the TOP-HABITAT dataset (see reference above), within the study area. TOP-HABITAT spatial extent covers the location of all data produced by EcoOcéan Institut (e.g. Gulf of Lions, Var, Corsica). Credits: OFB.

Protocol

Observations from boat (1km width strip-transect, 3 observers): countings, species identification, behaviour, age-class, flight direction.

Short description

TOP-HABITAT is a program conducted in order to gather and analyse available data about megafauna in the Gulf of Lions. If data mentioned below was acquired between 2008 and 2014 (EcoOcéan Institut, Cybelle Planète, SCS and AAMP), TOP-HABITAT refers to the collection of all data about cetaceans, sea turtles and seabirds by EcoOcéan Institut from 1992 to present.

Examples of data use

References	Rufray X., Garbé R., David L. & Di-Méglio N., 2014. *Etat des lieux des connaissances du patrimoine ornithologique du Golfe du Lion*. Agence des Aires Marines Protégées. 325 p. Data producers: https://ecoocean-institut.org/recherche/

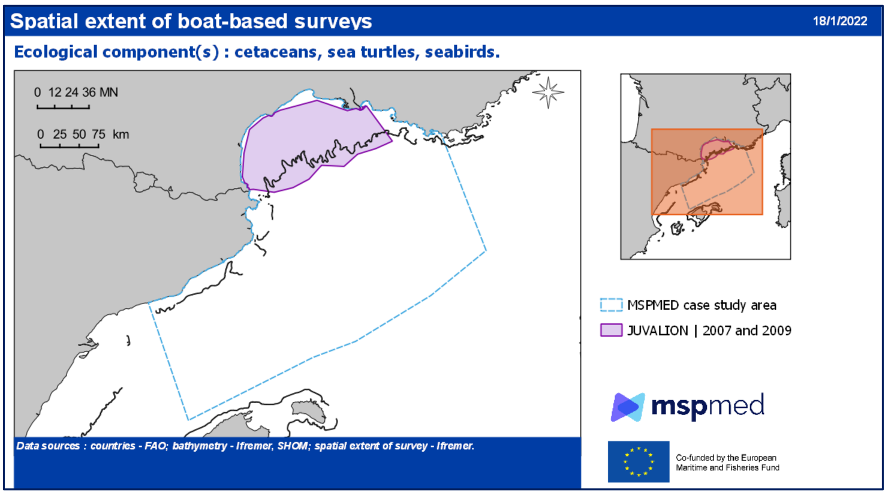
Complementary information on data use

See references in: https://ecoocean-institut.org/qui-sommes-nous/ressources/

Meso-scale visual monitoring in the context of halieutic surveys

Marine mammals, marine turtles, seabirds

Reference: JUVALION-2007-2009-MM-MT-SB

Characteristics	*Data type*	*Temporal and spatial scales.*
	Observations from boat in the context of the halieutic survey JUVALION.	2007 and 2009. Coverage of the Gulf of Lions continental shelf.  *Figure 31: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.*
	Protocol	
	Line-transect distance sampling – counts and species identification.	
Short description	JUVALION: Halieutic survey dedicated to designing a protocol in order to evaluate anchovy juveniles in the Gulf of Lions (active acoustics).	
Examples of data use	*References*	Beaubrun P., Roos D., Astruc G. et al. (2013). Etat de l'art des connaissances sur les distributions spatiales des oiseaux marins et des petits poissons pélagiques dans le golfe du Lion. Rapport de contrat DREAL-IFREMER n° 11/3211726/F. https://campagnes.flotteoceanographique.fr/campagnes/7060200/fr/ https://campagnes.flotteoceanographique.fr/campagnes/9060010/fr/
	Complementary information on data use	
	/	

Co-funded by the European Maritime and Fisheries Fund

Marine mammals, marine turtles, seabirds

Reference: PELMED-1993-Present-MM-MT-SB

Characteristics

Data type	*Temporal and spatial scales.*
Observations from boat in the context of the halieutic survey PELMED.	1993-Present (summer period). Coverage of the Gulf of Lions continental shelf.

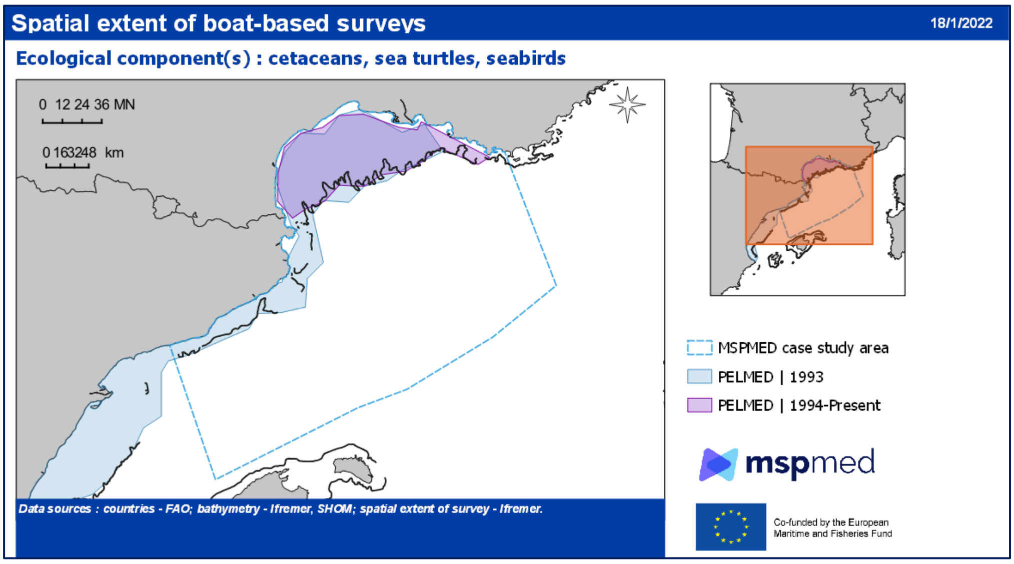


Figure 32: Spatial extent of the datasets within the MSPMED case study area. Credits: OFB.

Protocol

Annual observations by boat along transects (distance sampling). An additional data acquisition is collected during fishing manoeuvres (hauling of the net): censuses (snapshot counts) of attending seabirds (species, number, age-class).

Short description

PELagic fishes of the MEDiterranean sea (PELMED): annual halieutic campaign aimed at improving knowledge about small pelagic fishes' stocks of the Gulf of Lions. https://campagnes.flotteoceanographique.fr/series/19/fr/

Examples of data use

References

Beaubrun P., Roos D., Astruc G. et al. (2013). Etat de l'art des connaissances sur les distributions spatiales des oiseaux marins et des petits poissons pélagiques dans le golfe du Lion. Rapport de contrat DREAL-IFREMER n° 11/3211726/F. https://archimer.ifremer.fr/doc/00455/56628/

Rufray X., Garbé R., David L. & Di-Méglio N., 2014. *Etat des lieux des connaissances du patrimoine ornithologique du Golfe du Lion*. Agence des Aires Marines Protégées. 325 p.

Complementary information on data use

Accessibility of data from 1993 to 2003 is not known. Data from 2004-2009 is referenced (https://seamap-dev.env.duke.edu/dataset/1405) and may be available upon request.

Availability of data from 2011 may be evaluated with EcoOcéan Institut.

Availability of data from 2012 to 2016 may be evaluated with the CEFE.

Availability of data from 2017 to present may be evaluated with the Observatoire Pelagis.

Seabirds

Reference: MEDITS-1994-Present-SB

Characteristics

Data type	*Temporal and spatial scales*
Observations from boat in the context of the halieutic survey MEDITS.	1994-Present (spring period). Spanish Mediterranean marine sub-regions (continental shelf).

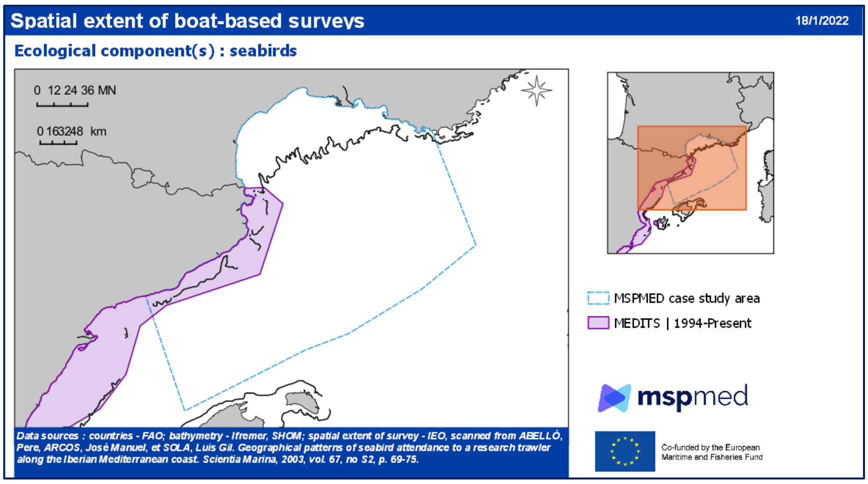


Figure 33: Spatial extent of the dataset within the MSPMED case study area. MEDITS campaigns may also be conducted within the Balearic Islands area. Credits: OFB.

Protocol

MEDITS halieutic campaigns are conducted annually; bottom-trawlling stations are homogeneously located so as to cover the continental shelf and slope between 10 and 800 m depth. Seabird data is collected during fishing manoeuvres (hauling of the net): censuses (snapshot counts) of attending seabirds (species, number, age-class).

Short description

MEDITS refers to annual trawl surveys dedicated to demersal halieutic species evaluation. Seabird data that was acquired concomitantly is included in **MSFD Seabird monitoring program: AV-3** = at-sea census.

Examples of data use

References

- ABELLÓ, Pere, ARCOS, José Manuel, et SOLA, Luis Gil. Geographical patterns of seabird attendance to a research trawler along the Iberian Mediterranean coast. Scientia Marina, 2003, vol. 67, no S2, p. 69-75.
- LOUZAO, M., BÉCARES, J., RODRÍGUEZ, B., et al. Combining vessel-based surveys and tracking data to identify key marine areas for seabirds. Marine Ecology Progress Series, 2009, vol. 391, p. 183-197. https://www.int-res.com/articles/theme/m391p183.pdf

PROGRAMAS DE SEGUIMIENTO SEGUNDO CICLO (2018-2024)

Estrategia de seguimiento de aves marinas y programas de seguimiento asociados

- Seabird data planned to be referenced at: http://infomar.cedex.es/datos

Complementary information on data use

Accessibility of data is not known. Only references to years 1994 to 2002 and 2007 have been found online (see references above and https://seamap.env.duke.edu/dataset/334).

Seabirds

Reference: MEDIAS-2009-Present-SB

Characteristics

Data type	*Temporal and spatial scales.*
Observations from boat in the context of the halieutic survey MEDIAS.	2009-Present (summer period). Spanish Mediterranean marine sub-regions, e.g. levantino-balear (continental shelf).

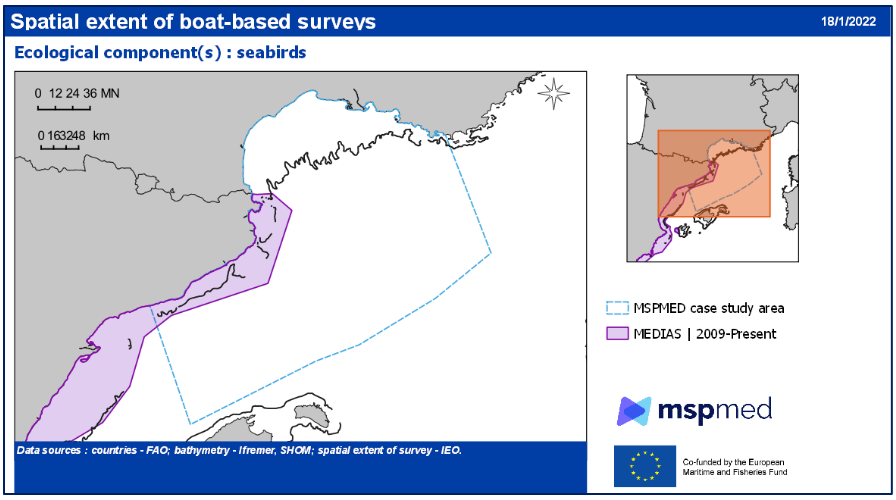


Figure 34: Spatial extent of the datasets within the MSPMED case study area. MEDIAS campaigns may also be conducted within the Balearic Islands area. Credits: OFB.

Protocol

MEDIAS campaigns are conducted annually. 300m-width at-sea standardised transects to provide seabird observations (species, age, behaviour), with correction (snap-shot); units of 5-10 min effort. Meteorological conditions, interactions and human activities are noted as well.

Distance-sampling may be also used in future data acquisition.

Short description

MEDIAS campaigns are annual halieutic surveys dedicated to acoustic evaluation of small pelagic stocks. Seabird data that was/is acquired concomitantly is included in **MSFD Seabird monitoring program: AV-3** = at-sea census.

Examples of data use

Reference

Seabird data and results are detailed here: https://www.indemares.es/areas-marinas/sistema-de-canones-submarinos-occidentales-del-golfo-de-leon

PROGRAMAS DE SEGUIMIENTO SEGUNDO CICLO (2018-2024)

Estrategia de seguimiento de aves marinas y programas de seguimiento asociados

- Seabird data planned to be referenced at: http://infomar.cedex.es/datos

Complementary information on data use

Accessibility to data is unknown. Data is referenced in: https://csr.seadatanet.org

Seabirds

Reference: ECOMED-2003-2008-SB

Characteristics	*Data type*	*Temporal and spatial scale.*
	At-sea and observations	2003-2008 (autumn-winter period). Spanish Mediterranean marine sub-regions, e.g. levantino-balear. No precise information has been found to locate datasets.
	Protocol	
	300m-width at-sea standardised transects to provide seabird observations (species, age, behaviour), with correction (snap-shot); units of 5-10 min effort. Meteorological conditions, interactions and human activities are noted as well.	
Short description	**ECOMED** refers to annual oceanographic campaigns dedicated to acoustic evaluation of small pelagic stocks. Seabird data that was acquired concomitantly is included in **MSFD Seabird monitoring program: AV-3** = at-sea census.	
Examples of data use	*Reference*	http://infomar.cedex.es/datos PROGRAMAS DE SEGUIMIENTO SEGUNDO CICLO (2018-2024) Estrategia de seguimiento de aves marinas y programas de seguimiento asociados https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/0_Documento%20grupo%20mamiferos%20marinos%20def_tcm30-130952.pdf
	Complementary information on data use	
	Availability and accessibility of data is unknown.	

Meso-scale surveys conducted before pilot offshore windfarms settlement

Marine mammals, marine turtles, seabirds, migratory birds, benthic habitats

Reference: EFGL-2017-2018-MM-MT-SB-MB-BH

Characteristics

Data type	*Temporal and spatial scales*
Megafauna: at-sea observations from plane and from boat; Benthic habitats: dredge sampling; video recording.	2017-2018. Western of the Gulf of Lions (continental shelf), with focus on the pilot windfarm location.

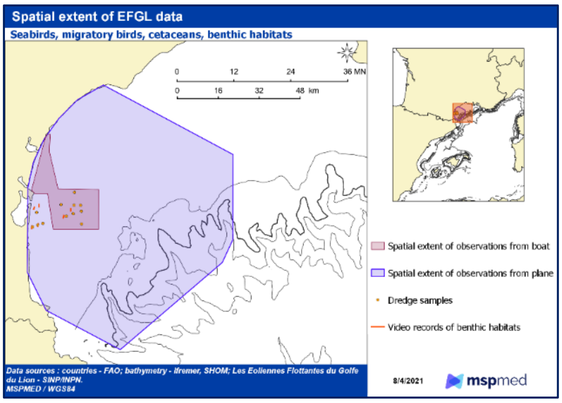


Figure 35: Spatial extent of data acquisitions in the western Gulf of Lions. Credits: OFB.

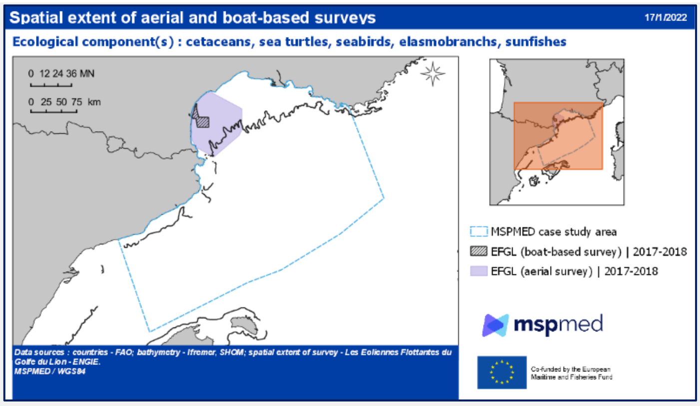


Figure 36: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.

Protocol

Transects from (1) boat and (2) plane to monitor local megafauna (1) in the vicinity of the future location of the pilot windfarm and (2) within a larger adjacent area, respectively.

Boat: line-transect, speed: 10 kn, number of observers: 2.

Plane: line-transect distance sampling, altitude 330 ft, speed 70 kn.

Data obtained from boat-based and aerial surveys are complementary, in time, to data collected in the context of another pilot windfarm development in the same large area (EOLMED-2016-2017-MM-MT-SB-MB-BH).

Additional video and dredge sampling data have been acquired in future windfarm location as well as along the potential location of sea-cables.

Short description

Les Eoliennes Flottantes du Golfe du Lion (EFGL) project: Data collected to inform the initial state of the ecosystem, in the context of a pilot windfarm development. Data owner: ENGIE.

Examples of data use

Reference	https://inpn.mnhn.fr/espece/jeudonnees/20627

Complementary information on data use

Public data. At least, data will be used (1) to compare the state of ecosystem components before installation, during installation, functioning and dismantlement of the windfarm, (2) consequently, to help understanding the interactions between offshore floating windfarms and Mediterranean ecosystems, (3) as a baseline knowledge to be used in potential future commercial windfarm settlement.

Seabirds, migratory birds, marine turtles, marine mammals, benthic habitats

Reference: EOLMED-2016-2017-MM-MT-SB-MB-BH

Characteristics

Data type	*Temporal and spatial scales*
Megafauna: at-sea observations from plane and from boat; Benthic habitats: dredge sampling.	2016-2017. North-western Gulf of Lions (continental shelf), and focus on the pilot windfarm location.

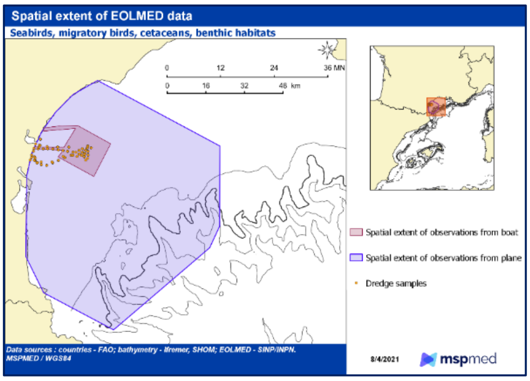


Figure 37: Spatial extent of data acquisitions in the western Gulf of Lions. Credits: OFB.

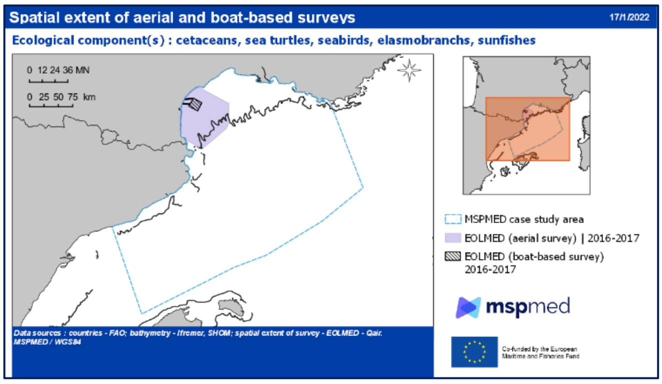


Figure 38: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.

Protocol

Transects from (1) boat and (2) plane to monitor local megafauna (1) in the vicinity of the location of the pilot windfarm and (2) within a larger adjacent area, respectively.

Boat: line-transect, speed: 10 kn, number of observers: 2.

Plane: line-transect distance sampling, altitude: 330 ft, speed: 70 kn.

Data obtained from boat-based and aerial surveys are complementary, in time, to data collected in the context of another pilot windfarm development in the same large area (see EFGL-2017-2018-MM-MT-SB-MB-BH).

Dredge sampling data has been acquired in future windfarm location as well as along the potential location of sea-cables.

Short description

Eolmed project: Data collected to inform the initial state of the ecosystem, in the context of a pilot windfarm development. Data owner: Qair.

Examples of data use

Reference	https://inpn.mnhn.fr/espece/jeudonnees/20432

Complementary information on data use

Public data. At least, data will be used (1) to compare the state of ecosystem components before installation, during installation, functioning and dismantlement of the windfarm, (2) consequently, to help understanding the interactions between offshore floating windfarms and Mediterranean ecosystems, (3) as a baseline knowledge to be used in potential future commercial windfarm settlement.

Characteristics

Data type

Megafauna: at-sea observations from plane and from boat;

Benthic habitats: dredge sampling.

Temporal and spatial scales

2011-2013. North-eastern Gulf of Lions (continental shelf), and focus on the pilot windfarm location.

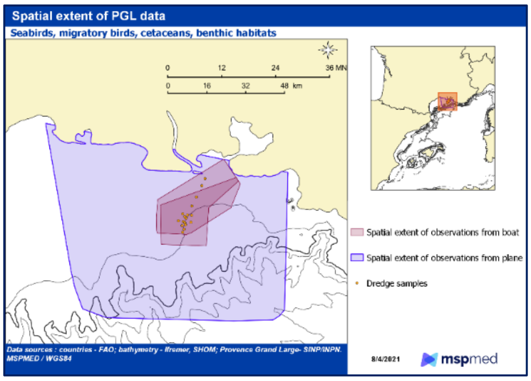


Figure 39: Spatial extent of data acquisitions in the western Gulf of Lions. Credits: OFB.

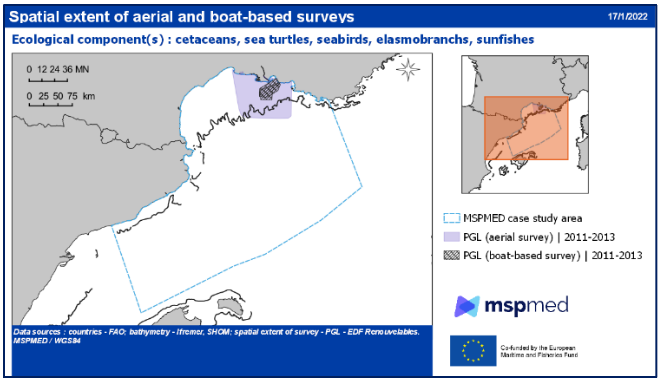


Figure 40: Spatial extent of the dataset within the MSPMED case study area. Credits: OFB.

Protocol

Transects from (1) boat and (2) plane to monitor local megafauna (1) in the vicinity of the location of the pilot windfarm and (2) within a larger adjacent area, respectively.

Boat: line-transect.

Plane: line-transect distance sampling, altitude: 330 ft, speed: 70 kn, number of observers: 2.

Dredge sampling data has been acquired in future windfarm location as well as along the potential location of sea-cables.

Short description

Provence Grand Large (PGL) project: Data collected to inform the initial state of the ecosystem, in the context of a pilot windfarm development. Data owner: EDF Renouvelables;

Examples of data use

Reference	https://inpn.mnhn.fr/espece/jeudonnees/12548

Complementary information on data use

Public data. At least, data will be used (1) to compare the state of ecosystem components before installation, during installation, functioning and dismantlement of the windfarm, (2) consequently, to help understanding the interactions between offshore floating windfarms and Mediterranean ecosystems, (3) as a baseline knowledge to be used in potential future commercial windfarm settlement.

Msp-Med
Towards the operational implementation
of MSP in our common Mediterranean Sea

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