Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area, concluded under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS)

Accord sur la Conservation des Cétacés de la Mer Noire, de la Méditerranée et de la zone Atlantique adjacente, conclu sous l'égide de la Convention sur la Conservation des Espèces Migratrices appartenant à la Faune Sauvage (CMS)

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PREPARATORY STUDY FOR AN INFORMATION MANAGEMENT SYSTEM FOR CETACEAN SURVEY DATA IN THE ACCOBAMS AGREEMENT AREA

Accord sur la Conservation des Cétacés de la Mer Noire, de la Méditerranée et de la zone Atlantique adjacente

ACCOBAMS

Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area

PREPARATORY STUDY FOR AN INFORMATION MANAGEMENT SYSTEM FOR CETACEAN SURVEY DATA IN THE ACCOBAMS AGREEMENT AREA

Final Report

February 2019

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EXECUTIVE SUMMARY

The ACCOBAMS Survey Initiative (ASI) will produce an overview of cetacean presence, distribution and abundance in the whole Mediterranean Sea in Summer 2018. Most of data will be collected through aerial observation and complementary surveys will be carried out by boat. Given the geographical extent of the ASI and the importance of this project in producing robust knowledge on cetacean ecology, a great interest in questions about the management of cetacean survey data has arisen. Therefore, a preparatory study on data management appeared necessary to attempt to extract the greatest value for (but not limited to) the conservation of cetaceans.

This document analyses and draws possible management scenarios to support the ACCOBAMS Secretariat to implement a proper framework for an information management system for cetacean survey data in the Agreement area.

Methodological approach

The first part of the study aims at drawing a state of the art on data and information management frameworks. For this part, we listed relevant initiatives and studied the different features as accessible via their websites, in particular: the terms and conditions of use, technologies, available functionalities and services, information on funding schemes. A benchmark analysis was carried out to compare strength and weaknesses of the different systems analysed. On this basis, proposals for possible suitable systems for ACCOBAMS were done, not limited to the ASI, and we attempted to identify, as far as possible at this stage, the main drivers for meaningful decisions.

State-of-the art existing frameworks and benchmark analysis

As a first step, we studied several management systems for marine data, with a focus on marine biodiversity and particularly on cetaceans. Three main categories of roles were identified:

- Data producers, including research groups from public or private entities conducting programs and research which include a data collection phase;
- Data aggregators, i.e. platforms available via web with the aim of centralising data from multiple disciplines and giving wide and low-constraint access to data and information
- Data users. With “data use” we mean the final goal of data collection, processing and analysis. In this regard, researchers may use data to produce knowledge and papers. On the other hand, country’s environmental agencies may use data to support expert advice and decision making on conservation measures, on the management of human activities, etc. We focussed on the latter type of data users.

The data and information management systems of aggregators and users were thoroughly studied, as a possible role of ACCOBAMS may be identified between these two categories. Example of initiatives we analysed are : the European Marine Observatory and Data Network (EmodNet) and the Ocean Biogeographic Information System (OBIS) as data aggregators; the website of IUCN Red List of Threatened Species, the data portal of the International Council for the Exploration of the Sea (ICES), the data and information management system of the Oslo-Paris Convention on the protection of the Marine Environment of the North East Atlantic (OSPAR), the data portal on natural resource management of the Italian Ministry of Economic Development (MISE), the data portal of the International Whaling Commission (IWC), the French National Inventory of Natural Heritage (INPN), and more, as examples of data users.

Fundamental aspects of all such categories are the following elements: the terms and conditions for use or re-use of data, the techniques and technologies employed for the building and maintenance their databases, the accessibility accorded to users, the existence of processing tools, and of course the funding scheme.

Terms and Conditions

Several possibilities exist concerning terms and conditions of use. An interesting point is the large use of standard Creative Common licensing schemes (CC) for raw data, datasets, databases, maps, graphs and reports, as well as other content found in different web platforms. CC licenses clearly indicate the suite of standard conditions that are requsted from the author for re-use of data without directly asking permission: no conditions (no rights reserved by the author); attribution (citing the author); Share Alike (redistributing at the same conditions); Non Derivative (data cannot be modified); Non Commercial (use for commercial purposes not allowed). Combinations of all such conditions are possible and make up the licence selected by an author. On the other side, some platforms developed specific terms of use regulating the redistribution of data and information, which usually include further conditions than the standard CC conditions described in this paragraph.

Technologies

About technologies, this topic is not the focus of our work because, on the one hand, it mainly deal with informatics and a wide range of common technologies, including open source and free of charge, is already available; on the other hand, these will very likely evolve in the next future and any recommendation made here may quickly become obsolete.

Data accessibility

However, it is worth noting what kind of access is given to data from analysed web platforms, which can be classed in four main ways: manual download (e.g. from a catalogue on a web page), through mapping services that help filtering and searching the wanted data, through web services that enable connecting to databases from other interfaces (e.g. programming languages, or GIS software), by providing tools developed in *R*.

Data processing tools

In two cases, we found platforms providing also data processing tools: the data portal of the ICES, and the European Biodiversity Portal of the Biodiversity Observation Network (EU-funded project). In such platforms, processing tools are provided under different forms: standardised algorithms, user-friendly web applications, and/or code and software.

Funding schemes

Finally, an overview on funding schemes is given as available from publicly available information. The most important point is likely the almost ubiquitous participation of the European Union to funding and/or co-funding of platforms we analysed in this work.

Benchmark analysis

From a comparative analysis, we found that data and information management should, at least: indicate clear terms and conditions; and provide adequate access to data with respect to well defined long-term goals. On this basis, scenarios were drawn for setting up a system for the ASI project, and for future perspectives.

Proposals for the ASI

Considering the different roles described above, ACCOBAMS appears to belong to the category of data users. From this perspective, the main drivers (beyond the obvious importance of funding) to consider for setting up a suitable system appear to be the following: the terms and conditions, and accessibility to data. ThereHencem concerning the ASI, workable proposals may be built around the two following schemes:

Option 1. A system allowing manual download of data from a web page, meaning no particular technological demand and low to very low funding required. Concerning terms and conditions,

the simplest choice could be assigning a standard CC licence to the different datasets produced during the ASI.

Option 2. A system allowing different ways to access data (including via mapping and webservice). Common web technologies are required for this option, with limited funds needed. Concerning terms and conditions, again assigning CC licenses appear to be a simple and effective way.

The final choice on the most suitable option can be made after defining the long-term goals, i.e. after answering a number of questions presented in section 4.2. and in section 6.4 (Annex 4)

Priority recommended actions for an ASI data and information management system

For either options described above, there are common priority questions to be addressed:

- Understanding what kind of data may be accessed (if any): products (reports, pictures, graphs), analysed data (model results such as raw gridded values), raw data (occurrence and/or effort data)
- Deciding how much time should elapse from the collection phase till the moment data are made available
- Deciding what rights are granted for re-use, and to what users (see 6.2 - Annex 2 and 6.4 – Annex 4).
- Elaborating a standard citation formula for all ASI data and products that will be accessible (in case attribution is set as a mandatory condition for re-use of ASI data and products).

Perspectives concerning data and possible roles of ACCOBAMS in the future

The possible scenarios in the long run can be drawn after laying down some landmarks. First, the final goal of ACCOBAMS is to preserve a favourable conservation status of cetaceans. To do so, periodical assessments of cetacean status and of threats should be done and the availability of high quality data on cetacean population parameters, as well as data on by-catch, ship strikes, underwater noise, chemical pollution, marine litter, etc., would certainly help such assessments. In this regard, though ACCOBAMS is not a research institute or a management service, in the past years the Secretariat supported, and sometimes coordinated, projects and/or initiatives aimed at gathering data on cetaceans and threats, for example: the collaborative effort to estimate and map Cuvier's beaked whale distribution and abundance (Cañadas et al., 2012), the overview of the Noise Hotspots in the Agreement Area (Maglio et al., 2016), the Mediterranean Database of Cetacean Strandings (MEDACES), and more.

The second landmark can be the fact that some data aggregator platforms cover part or the whole Agreement area. In particular, the European Marine Observation and Data Network (EmodNet) and the Ocean Biogeographic Information System (OBIS, with is geographical node, MedOBIS). The first aggregates data from different disciplines (including biology, oceanography and human activities) in the European Union area. The second only include biodiversity occurrence data, at the global scale (thus explicitly including non-EU areas of the Mediterranean and Black Sea).

The third landmark is that in the Mediterranean and Black Sea regions there are no historical initiatives like the data repository of the International Council for the Exploration of the Sea (ICES), or the OSPAR Data and Information Management System (ODIMS). These are regional databases fed with marine data and information coming from data collection programmes promoted (and usually implemented jointly) by different kinds of institutions from different countries. However, the UNEP/MAP has planned to develop such a system with respect to the implementation of the EcAp process in the Mediterranean. Nevertheless, this initiative is still at its planning phase and does not cover the Black Sea.

With these premises, we could draw the following possible scenarios:

- In the short run, it may be of interest to capitalize the efforts done by ACCOBAMS in coordinating projects that resulted in the production of data and databases. Establishing a simple catalogue of existing ACCOBAMS data and products could certinly serve future initiatives and assessments.
- In the longer run, ACCOBAMS may position itself as an actor of the establishment of a regional data hub for data on cetaceans and threats. This could mean different sub-scenarios, according to different degrees of involvement, for example: promoting the creation of the data hub, or leading such a project, or intermediate scenarios.

Actions recommended to better understand suitable perspectives

To figure out the shape of a suitable Data and Information Management System, the ACCOBAMS Secretariat should try to predict their future needs on the following aspects:

- How frequent for the Secretariat is the need to access row data on cetaceans?
- And/or other marine environmental parameters?
- Does it belong to ACCOBAMS to carry out assessments on cetaceans and threats?
- How frequent are the incoming requests for data?
- Shall ACCOBAMS supply data to third parties?
- And tools for periodical reporting (e.g. national reports from Focal Points)?

Answering these and further questions will certainly help finding the future role of ACCOBAMS in the production and management of data.

GLOSSARY AND ACRONYMS

API Application Programming Interface. In short, an API is an URL string (such as those used in the search bar of any internet navigator like Mozilla, Explorer, etc.) that can be read by another programming environment (e.g. MATLAB, PHP, JAVA, PYTHON, etc.) to retrieve data from a web server. APIs are therefore the interface for automated data exchange between different websites, or between websites and local servers and vice-versa.

Web service In practical words, a web service is a URL like those used in the search bar of any internet navigator (Firefox, Chrome, Explorer, etc.). Web services can be regarded as special URLs which point to data contained in a distant server connected to internet (i.e. a web server). Different kinds of web services exist. In this document, it is important to understand that web services (i.e. such special URLs) allow accessing data contained in web servers. Users of any programming and/or processing language (C++, Python, PHP, MATLAB, R, etc.) can use web services to connect to distant databases. This possibility is very interesting when databases evolve, for example in size, diversity and quality of data. This is the case of data aggregator platforms such as OBIS and GBIF. Accessing data through web services provided by such platforms enable getting the most updated data, thus preventing to work with outdated or lower quality data.

AMMC Australian Marine Mammal Centre

CMEMS Copernicus Marine Environmental Monitoring Service

EmodNet European Marine Observatory and Data Network

GBIF Global Biodiversity Information Facility

ICES International Council for the Exploration of the Sea

INPN Inventaire National du Patrimoine Naturel

IWC International Whaling Commission

MISE Ministero dello Sviluppo Economico

OBIS Ocean Biogeographic Information System

OSPAR Oslo-Paris Convention on the Protection of the Marine Environment of the North-east Atlantic

1 INTRODUCTION - CONTEXT

1.1 ACCOBAMS SURVEY INITIATIVE

The ACCOBAMS Survey Initiative (ASI) project aims to establish an integrated, collaborative and coordinated monitoring system for the status of cetacean populations at the whole ACCOBAMS area level, with the final aim to strengthen the conservation effort and governance for cetacean species. Implemented by the ACCOBAMS Secretariat, in coordination and with the support of riparian countries and local scientists, the ASI will lead as a first step to assess cetacean abundance and distribution at the Mediterranean level during a synoptic survey to be carried out in the summer 2018. As a direct effect, the ASI has raised the interest on the management of cetacean survey data in the Mediterranean area, and several questions appear today: how data are collected today? What are the existing and forthcoming methodologies and tools for data and information management? How to better coordinate survey efforts at a regional scale to improve management and conservation?

To tackle such a vast topic, we start from outlining the characteristics of cetacean survey data, as those produced during the ASI, and then describe the problematics and objectives of this document.

1.2 CETACEAN SURVEY DATA

The assessment of ecological parameters such as distribution, habitat and abundance, needs the gathering of field data on cetaceans. Several biological and ecological parameters can be collected during a field survey and different types of analyses can be applied according to the goals of a study. For the ASI, the foreseen analysis requires to collect parameters of sightings and of the observation effort during the survey. Sighting parameters collected during field surveys like the ASI are usually the following:

- Geographical coordinates (latitude and longitude)
- Date/Hour
- The species (or higher taxon if the species identification was not possible)
- The size of the cetacean group
- The distance from the observing platform (an aircraft for the ASI case)

Further sighting parameters are also collected, allowing for more precise analyses:

- Presence and number of calves
- Behaviour
- Swimming direction
- Reaction to the passage of the observing platform
- The cue (i.e. the signal that enabled the sighting: a splash, the blowing of whales, etc.)

Also survey effort parameters are collected, such as:

- GPS data for the track lines surveyed
- Start and end times of transects
- Sighting conditions (sea state, transparency of water, light reflection on the surface, and cloud coverage)

The result of a field survey is usually a set of matrices of data, with at least one matrix for sightings, one for survey effort and one for survey positions (GPS points). Such matrices can be represented in txt format as shown in Figure 1.

SIGHTING_NO		PASSAGE	TRANSECT_NO	FLIGHT_NO	TM	OBSERVER		DEC_ANGLE		SPECIES	POD_SIZE
3852	1	N2/03	A27/11_00359	27/11/2011	09:48:13	AM	1	GOEGRI	2	A	
3851	1	N2/03	A27/11_00359	27/11/2011	09:48:13	VB	1	GOEGRI	1	A	
37	1	N2/03	A27/11_00359	27/11/2011	09:48:27	VB	1	MACDEC	1		
4116	1	N2/19	A27/11_00365	27/11/2011	12:14:18	AM	32	STEDEL	3	A	180
4117	1	N2/19	A27/11_00365	27/11/2011	12:14:46	VB	45	STECOE	3	U	
4292	1	C2/08	A30/11_00368	30/11/2011	10:28:33	AB	1	LARRID	1	A	
5074	1	P2/16	A01/12_00385	01/12/2011	09:00:21	GD	52	TURTRU	2	6	360
5075	1	CB	A01/12_00000	01/12/2011	09:03:19	ND	49	TURTRU	20	U	360

Figure 1. Example of sighting matrix from aerial surveys (source: SAMM surveys in the French European waters)

Such data are subsequently processed and analysed through statistical methods with appropriate software to produce estimates of ecological parameters such as distribution and abundance over the area of interest.

1.3 PROBLEMATICS AND OBJECTIVES OF THIS STUDY

In the European context, a great number of field surveys have been conducted in the past 30 years. The amount of data collected represents a great value that is yet to be exploited to some degree. This is even more clear considering that methodologies for analysis have rapidly and constantly evolved and that many other data, such as environmental variables and data on human activities amongst others, are necessary to model and predict biological and ecological parameters of populations, and to assess the conservation status of species. Eventually, such results can be integrated in global/holistic assessments of the status of the oceans and seas. The way to handle such a growing complexity is a matter of the Data Science.

Data Science is a growing discipline applied to marine conservation. It addresses the development of methods and tools capable to store, process and use the increasing amount of marine data collected around the world's oceans and sea. The growing interest in such discipline is based on two common observations:

- First, an effective understanding of complex processes (as the ecological processes are) requires the analysis of considerable volumes of a various range of marine data, which usually have heterogeneous sources and formats
- Secondly, it is increasingly understood that data represent a value which is not limited to the project they were collected for, but can be exploited for further uses, including in different domains and with different objectives.

However, managing marine data taking into account such observations may lead to face several issues such as interoperability, accessibility, as well as conditions for redistribution and what rights are granted to users.

The ASI will produce data with an acknowledged value for the Mediterranean area. Therefore, a careful study on how to manage them now and in the future appeared necessary to try to extract the greatest value for (but not limited to) the conservation of cetaceans. The main objective of this document is to draw possible management scenarios to support the ACCOBAMS Secretariat to implement an appropriate framework for an information management system for cetacean survey data in the Agreement area. The document is organised in 4 chapters addressing the following topics:

1. A state of the art on existing data and/or information management systems and tools
2. A benchmark analysis for drawing preliminary management scenarios with relevance for ACCOBAMS
3. Proposals for an ASI data management system
4. Perspectives for the development of a Cetacean Data Management System for the ACCOBAMS Agreement area.

2 STATE-OF -THE- ART ON INFORMATION MANAGEMENT SYSTEMS

As a first step, we address here the different kinds of roles involved in the lifecycle of marine data, with a particular focus on cetacean survey data, and describe the different processes employed to deal with data from such different perspectives. Three main roles can be identified: data producers, data aggregators, and data users, as defined in table 1 hereafter.

Table 1. Description of main roles concerning marine data

Role	**Description**	**Example**
Producers	People who carried out fieldwork, deployed sensors, etc.	Research groups from universities, laboratories, NGOs
Aggregators	Thematic data aggregator/integrators	OBIS on biology, CMEMS[1] on oceanography, SeaDataNet on chemistry
	Holistic ocean data aggregators; they integrate data sources covering different topics (biology, chemistry, oceanography, human activities, etc.)	e.g. EmodNet
Users	All types of bodies exploiting data and/or using information produced by exploiting such data for assessments, environmental policy, regulation, etc.	Regulatory bodies, advisory groups, decision makers, etc. (e.g. OSPAR[2])

2.1 DATA PRODUCERS

Data producers are referred here to people that use to go at sea to collect data. Producers can be from the public and private domain:

- Universities
- Research institutes
- NGOs
- Private companies

Focussing on cetacean surveys like SAMM[3] and SCANS[4], the process employed for data gathering and storing follows the simple steps described hereafter:

- Entering data on sightings and survey effort on dedicated data collection software (e.g. VOR or SAMMOA for aerial surveys).
- Reporting data in a database built in MS Access
- Storing the MS Access file in a computer or local server

[1] The Copernicus Marine Environment Monitoring Service (CMEMS) provides regular and systematic reference information on the physical state, variability and dynamics of the ocean and marine ecosystems for the global ocean and the European regional seas.

[2] The Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention')

[3] Suivi Aérien de la Mégafaune Marine, DEB/AAMP/Observatoire PELAGIS - http://www.observatoire-pelagis.cnrs.fr/observatoire/Suivi-en-mer/suivi-aerien/

[4] Small Cetacean Abundance in the North Sea and Adjacent waters (SCANS) survey - https://synergy.st-andrews.ac.uk/scans3/background/

This is a simple organisation, representing a common working organisation for scientist groups working on cetaceans (where for *scientist groups* we mean all kinds of data producers as described in the above paragraph). At this stage, data are directly accessible only to the research group who was in the field. Compared to the list of steps above, in the 3rd edition of the SCANS survey (2016), the back-up of survey data on a cloud was also done (Google Drive in that specific case). Data saved in the cloud included row data in VOR format (which are actually a txt format such as in Figure 1, Cf chapter 1), and the MS Access file.

The back-up on a cloud represents a step forward toward a faster sharing of data with other people involved with some role in the project. However, the access to data remain usually locked until the end of the project, i.e. after the processing, analysis, and reporting phases have been concluded.

Recently, scientist groups started developing tools for better organising their data. The same scientist group may indeed carry out research using aerial surveys, boat-surveys, telemetry, acoustic recorders, stranding networks, etc., and technologies are currently available to built comprehensive databases to structure such heterogeneous data. Obviously, this appears as an effective way to exploit data, thus increasing the potential for stimulating research. However, for the case of data producers, such tools are currently not meant to give direct sharing rights outside the scientist group.

With regards to funding, resources for field work like in the SCANS project are usually ensured through a mix of structural funds and project-based fund raising. In the case of SCANSIII, only funds made available by national governments were employed, without the financial support of the European Union. These funds are usually not meant to ensure a long-term management of data produced during fieldwork.

2.2 DATA AGGREGATORS

We focus here on projects and initiatives aiming at gathering data and at structuring them with the explicit goal of giving the widest access to data. We consider aggregators different kinds platforms:

- Those gathering data on a single discipline, such as the Ocean Biogeographic Information System (OBIS), where we can find data on marine biodiversity. Likewise, the Copernicus Marine Environment Monitoring Service (CMEMS) gathers oceanographic data, and the SeaDataNet platform is especially conceived for data on marine chemistry.
- Platforms aggregating data from different disciplines. In waters around Europe, the best example is probably the EmodNet project which aggregates data from single-discipline platforms (OBIS, CMEMS, SeaDataNet, and others).

In this section, **we focus on the OBIS platform for marine biological data**. OBIS emanates from the Census of Marine Life (2000-2010) and was adopted as a project under IOC-UNESCO's International Oceanographic Data and Information (IODE) programme in 2009. This section aims at outlining the general functioning of the OBIS system and to describe the principle features of the available services, in particular: the technology, the standards, the accessibility of data, the availability of processing and analysis tools, the data policy, and finally the funding and sustainability.

OBIS is a global open access data platform on marine biodiversity whose database is built on PostgreSQL. PostgreSQL is an object-relational database management system (ORDBMS), particularly adapted for managing spatial objects (also called geographical features), such as grids or polygons, although this kind of data does not represent the largest type of data in OBIS. Instead, the OBIS platform primarily hosts species occurrence data (i.e. point data).

OBIS hosts species occurrence data using the Darwin Core standard (DwC). Darwin Core is a body of standards for biodiversity informatics. It provides stable terms and vocabularies for sharing biodiversity data. Darwin Core is maintained by the TDWG (Biodiversity Information Standards, formerly The International Working Group on Taxonomic Databases). This standard specifies the

parameters (referred to as "terms" in the standard) to consider when contributing data to OBIS. In other words, DwC terms[5] correspond to the column names of a dataset. Currently, OBIS require eight DwC terms to be informed for contributing data:

- occurrenceID
- eventDate
- decimalLongitude
- decimalLatitude
- scientificName
- scientificNameID
- occurrenceStatus
- basisOfRecord

Today, 500 institutions from 56 countries have provided data to OBIS. Collectively, this represent over 45 million observations of nearly 120 000 marine species. OBIS provides different ways to access data:

- Viewing species occurrence data (point and gridded data) through an interactive map service
- Viewing common biological and ecological statistics and indicators (such as Shannon and Simpson indices) on a global scale
- Data can be downloaded manually
- An R package client is provided in GitHub, allowing accessing data from R scripts
- Using Web services, i.e. it is possible to query the OBIS database using Web coding and scripts
- Accessing the database itself in the host server. For this option, the user need to ask the OBIS data manager for a password.

Data in OBIS can be easily downloaded, retrieved or fetched through various means, and is interoperable with other systems and tools using the same standards and tools for data management and sharing.

Today, the system does not provide processing and analysis tools on the website, but an R package is provided, and guidance is given on how to process and view data and results on R and QGIS.

With regards to re-use, OBIS published guidelines for the sharing and use of data. The OBIS data policy is based on the principles of timely, free and unrestricted access to biodiversity data for the benefit of science and society, as defined in the **IOC data exchange policy, IOC guidelines on transfer of marine technology, IODE objectives, and OBIS vision and mission**[6]. Data are largely published under the different standard Creative Commons (CC) licenses. Rarely, data have specific terms and conditions. Each dataset has a specific licence (usually from the CC family) assigned by the dataset owner (see annex 1 for a deeper insight in data licenses and terms of use).

As a project under IOC-UNESCO's International Oceanographic Data and Information, OBIS resources are covered by UNESCO's regular programme, through extra-budgetary projects, by donations from the private sector and governments as well as in-kind contributions to core activities. UNESCO provides

[5] A list of all possible Darwin Core terms can be found on http://rs.tdwg.org/dwc/terms/index.htm#Occurrence

[6] https://iode.org/index.php?option=com_content&view=article&id=51&Itemid=95
http://unesdoc.unesco.org/images/0013/001391/139193m.pdf
https://www.iode.org/index.php?option=com_content&view=article&id=385&Itemid=34
http://iobis.org/about/

the salary of one position (OBIS project manager), while the OBIS data manager is currently covered by project funding. Finally, OBIS currently welcomes invitations to join project/grant proposals, as well as partnerships for new projects, tools or products.

In this section we have selected a system considered as effective and thus a good example of the management of big marine biodiversity data. Especially, we listed and described the different features that form the system. However, this should not be considered as a norm and many differences may exist with systems having similar goals. Should we extend the analysis to a wider domain (for example including other marine data), we may find many differences concerning some features, particularly on the data policy. For example, the CMEMS platform on oceanographic satellite data (the principle European platform for the distribution of such data), provides a single document with Terms of Use (ToU) which are specific to the platform, not to the dataset. The ToU are therefore valid for all the datasets that are found on the platform. These and other differences are better explored and summarised in the chapter 3.

2.3 DATA USERS

Among the many types of users, it is worth distinguishing, on the one hand, users such as Academics, NGOs, and downstream application developers for commercial uses, and on the other hand national or international regulators, MPA managers, policy makers. Here, with "data use" we don't mean how data are processed or analysed, but rather what is the final goal of such processing and analyses. In this regard, researchers may use data to produce papers and hence knowledge. On the other hand, country's environmental agencies may use data to support expert advice and decision making on conservation measures, on the management of human activities, etc. In this section we focus on the latter type of users, as it appears closer to a potential role of ACCOBAMS.

With these premises, we selected to describe four types of users along with some examples for each type: the IUCN Red List of Threatened Species™ representing an intergovernmental body (hereafter referred to as just the **IUCN Red List**), OSPAR Data and Information System (**ODIMS**) as regional regulatory bodies; the French national inventory of natural heritage (**INPN)** representing a national environmental agency, the Italian Ministry of Economic Development (**MISE**) as a national regulatory body, and a **NATURA2000 protected area** (located in northern France) as a local environmental management body.

We can highlight that the data found in such systems appear as higher-valued data than those found in OBIS (or Copernicus, or other aggregator platform), i.e. they carry a higher potential to inform and support decision making and management. In such systems, the available data are generally copyrighted, like documents, reports, papers and maps or charts, and some constraints may exist for re-use. Lower-valued data such as geographical objects or row occurrence data, may also be available and re-usable, but the goal is different that for OBIS or similar platforms. As a matter of fact, the primary goal is not to stimulate research or innovation, but rather to provide support to decision making and/or allow a large diffusion of results and conclusions of projects having potential societal implications. Thus, row occurrence data found in such systems may be not meaningful for re-use in any type of analysis. For example, some occurrence data from the INPN do not provide geographical coordinates.

Further, we can point out a lower technology level and a less structured accessibility to data, with absence of specific toolboxes and, except the IUCN Red List and OSPAR, web-services (see glossary). However, for all systems analysed, the download is available manually at least. Furthermore, no data processing or analysis functionalities were found. Finally, it is noteworthy that, while data producers (e.g. universities) appear to be well connected to aggregators (like OBIS), and vice-versa (Cf. section 2.2), systems belonging to data users (like the INPN) seem to be generally disconnected from aggregators.

Concerning the data policy, we found that the INPN generally relies on dispositions from the Aarhus Convention[7], which deals with general principles on access to information, while the MISE provides data and information with a Licence Creative Commons Attribution 4.0 International (CC-BY). On the other hand, the IUCN Red List and the ODIMS platform provide specific Terms of Use. Finally, no specific terms are found on data policy for the NATURA2000 site.

About funding and sustainability, management bodies and national instances are supported by structural funds; the ODIMS platform was funded by the OSPAR Contracting Parties [8]; while the IUCN Red List relies on different sources, including international and national instances, private companies and foundations.

2.4 FOCUS ON MARINE MAMMAL DATA USERS

Two relevant initiatives are described here: the web portal of the International Whaling Commission (IWC) and the data portal of the Australian Marine Mammal Centre (AMMC). The IWC is an international body established in 1946 with the aim of regulating whaling activities worldwide, while the AMMC is a centre of the Department of the Environment and Energy of the Australian Government. The AMMC responsibilities are to provide scientific research and advice to support conservation policies for marine mammals. For these reasons, such two bodies are considered as data users for the scope of this document.

2.4.1 IWC WEB PORTAL

The web portal (https://portal.iwc.int/) can be accessed from the page dedicated to ship strikes in the main IWC website (https://iwc.int/ship-strikes). However, ins the data portal a large variety of data on cetaceans are found, not limited to vessel strikes and including data on sightings, telemetry, tissue and biological sampling, direct catches, by-catch, strandings and more. Data are reported by countries.

Concerning data accessibility, the system requests to create an account, which gives some rights to explore the data portal and download data. However, the whole database is not accessible and data available for download carry little information. For example, concerning ship strikes, it is possible to search for events occurring in a given year for a macro-region such as the Bay of Biscay, the English Channel, or the North Atlantic. Indications on more focussed areas are given (e.g. “Kent” for events reported by UK, or “Canary Islands” for events reported by Spain) but these data only allow for simple summary reporting of events by marine region. This is the case also for data on fishery by-catch, strandings, and other kind of data found in the IWC portal.

Further, sighting data available to a generic registered user of the platform are not the usual lists of sighting points along with corresponding sighting parameters (latitude, longitude, group size, etc., as found in OBIS for example), but rather a list of sighting databases reported by countries. Only this list of databases can be downloaded, while the singe databases are not available (Figure 2).

id	Data Year	Year Submitte	Large Area	Species	Country	Local Area	Local Taxono	Survey Type	Contacts	References	No. of Sightin	Comments
PR/R/4824	2015	2015	Atlantic Ocea	Common minke whale	UNITED KING	Outer southern	Moray Firth	Systematic Su	PR/C/565 | Ke	PR/B/70 | Bea	5	Minke whales were
PR/R/4827	2015	2016	Atlantic Ocea	harbour porpoise	UNITED KING	Outer southern	Moray Firth	Systematic Su	PR/C/565 | Ke	PR/B/578 | Ro	109	Harbour porpoise n
PR/R/4828	2015	2016	Atlantic Ocea	common dolphin	UNITED KING	Outer southern	Moray Firth	Systematic Su	PR/C/565 | Ke	PR/B/593 | An	2	Common dolphins v

Figure 2. Sighting data available for download from the IWC data portal. Only summary metadata corresponding to single databases can be downloaded. For example, the second row show that the database PR/R/4827 (field “id”) includes 109 sighting of harbour porpoise (field “No. of Sightings”) in 2015, but no access is given to the list data of sightings and corresponding parameters (latitude, longitude, group size, etc.).

[7] https://www.unece.org/env/pp/treatytext.html
[8] https://odims.ospar.org/about/

With regards to data policy, no specific information is found in the IWC data portal. It is therefore not clear what are the rights granted to generic user. However, data described in this section are found from a page named “View public reports”, and therefore we understand that such reports, and summary data contained therein, may be redistributed publicly.

No information is given on technologies used for the architecture of the database.

In conclusion, summary data can be accessed by generic users, likely with the goal of informing and raising awareness on the work of the IWC, but databases useful for scientific research or studies are hidden. No direct access is possible through APIs, nor mapping services are proposed to the user. The system pretty clearly appears as serving as a tool for internal functioning of the IWC and therefore for the achievement of its objectives.

2.4.2 Australian Marine Mammal Centre Data Portal

The AMMC manages the National Marine Mammal Database available at https://data.marinemammals.gov.au/nmmdb. This data portal appears as highly use-friendly with emphasis put on interaction by the user. From the portal it is possible to:

- See clear summary data of the database from the homepage (total No of records, by reporting State, share between sightings and strandings, total number of records by species, etc.)
- Search and filter the database by species, by event type (sighting, stranding, by-catch, ship strike, etc.)

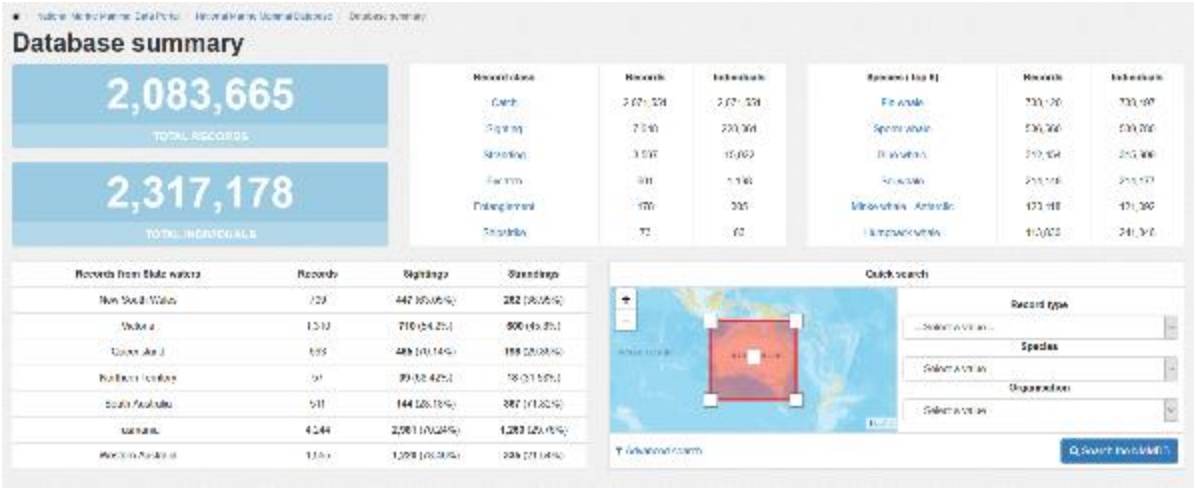


Figure 3. Homepage of the Australian National Marine Mammal Database.

The data portal offers interacting and user-friendly mapping services where selections of data can be done easily. However, no analysed data (such as maps) are available for display, and the download function is disabled for all kind of data (at least for generic users). User willing to download data are redirected to database managers through email contact.

Concerning data policy, no specific information is found in the AMMC data portal. It is therefore not clear what are the rights granted to generic users, but as all download functions are disabled, we understand that all rights are reserved *de facto*.

No information is given on technologies used for the architecture of the database.

In conclusion, summary data are shown to generic users with simple parameter describing the database(s) contained in the AMMC data portal. However, no download is directly available, no direct

access is possible through APIs, and mapping services only provide an overview of data. As for the IWC portal, it appears that the principle objective of this system is to serve as a tool for internal functioning of the AMMC.

2.5 A FURTHER STEP : PLATFORMS ALSO PROVIDING TOOLS FOR ANALYSIS

Two platforms are described here: the EU funded project Biodiversity Observatory Network, whose main product is the European Biodiversity Portal (EU BON)[9]; and the ICES data portal. These two platforms are of importance for the scope of this document as they integrate tools and information for data processing and analysis. Both platform provide indeed the user with keys for addressing different kinds of analyses in a standardised way: software, code, web applications, and more. Features of special interest are pointed out hereafter:

- The EU BON platform is a portal integrating the database of the Global Biodiversity Information Facility (GBIF[10]). The GBIF data portal is a constantly growing, database of occurrence data of worldwide biodiversity (terrestrial and marine species). GBIF promotes a widely opened data accessibility approach and adopt the Darwin Core standard for data terminology and formats. The connection with such a global and standardised database with processing tools and other facilities for analysis represents a great potential for those tools to become a standard, too. EU BON project is funded through the European Union's Seventh Programme for research, technological development and demonstration, and it formally ended in 2017.
- The ICES data portal is established under the ICES, which is an international body governed through a Convention signed by Contracting Parties from both sides of the North Atlantic area (including the North Sea and the Baltc Sea in Europe). It might be considered also as a data aggregator whereby data are gathered directly from research groups in the framework of studies that may be promoted, supported, or coordinated directly by ICES. Among all the initiatives analysed in this document, the ICES is the body that probably covers most roles: it promotes and coordinates research, aggregates data in a data portal, produces knowledge and uses it for scientific publishing and/or for advisory purposes, provides wide access to raw and analysed data, provides widely opened analytics, has a defined data policy and terms of use.

[9] http://biodiversity.eubon.eu/
[10] www.gbif.org

3 MAIN FEATURES OF ANALYSED SYSTEMS

In the precedent chapter we described the diversity of data systems. Here we try to summaries key information and common components, giving quantitative indicators whenever possible. We finally present a comparative analysis.

3.1 TECHNOLOGIES

A varied range of technologies exist today and is rapidly evolving. Possible combinations between technologies results in a great number of workable ways to implement a suitable architecture for data management. Therefore, no discussion is provided concerning the best technology as this may be highly debatable and rapid evolutions of technologies may make obsolete any recommendation outlined here.

However, we can note here that many open source and/or free of charge technologies exist having comparable, or event better performance than paying technologies; hence financial constraints will likely be the main driver for the definition the technologies suitable for the objectives of ACCOBAMS.

Nevertheless, we provide in Table 2 a summary of main technologies generally used today in biodiversity Data Science, with the unique purpose of giving an overview of currently existing possibilities.

Table 2. Summary of available technologies (not exhaustive). As an example, we highlighted in blue some technologies identified when reviewing OBIS ;

Geographic Information Files	Spatial Databases	API Maps	Web GIS framework / tools	Map Servers	Web Servers	Programming languages
Shapefile (SHP)	PostGIS	**OpenLayers**	ESRI geoportal 1	**GeoServer**	Apache 2,2	Python
Geographic Markup Lenguage (GML)	Oracle Spatial	Google maps	ESRI geoportal 2	MapServer	Apache 2,4	**PHP**
Comma Separated Value (CSV)	ESRI arcSDE	OpenStreetMaps	Mapbender	ArcGIS for server	Apache Tomcat	**JavaScript**
Extensible Markup Lenguage (XML)	MySQL	ArcGIS API for JavaScript	GeoNode			.NET
Keyhole Markup Language (KML)	**PosgreSQL**	Leaflet	OpenGeo Suite			**R**
GeoTIFF			Django (GeoDjango)			

3.2 DATA LICENCES

During the review of data repositories (Cf chapter 2), we could highlight the use of the following licence types: Creative Commons licences (CC[11]), and specific terms of use. CC licences were created by Creative Commons, a U.S. non-profit corporation founded in 2001, with the aim of promoting the distribution of creative work without incurring in usual issues related to copyrighted work. A CC license is used when an author wants to give people the right to share, use, and build upon a work that they have created. CC provides an author flexibility (for example, they might choose to allow only non-commercial uses of their own work).

Although the creative nature of data and datasets is source of debate, many datasets are given a CC licence, as a standardised way of granting rights to data users.

Table 3 summarises the main characteristics of licenses found during the review process.

Table 3. Description of licence types.

Licence type	**Description**
CC BY	Attribution. All CC BY licenses require that others who use the work in any way (even commercially) must give credit the way request by the owner, but not in a way that suggests the owner endorse them or their use. If users want to use the work without giving credit to the owner or for endorsement purposes, they must get the permission first.
CC BY-NC	Attribution+Non Commercial. All the above but the owner let others copy, distribute, display, perform, and (unless the owner chose No Derivatives) modify and use the work for any purpose other than commercially unless they get the permission from the owner.
CC BY-NC-SA	Attrbution+Non Commercial+Share Alike. All the above plus the following: the owner let others copy, distribute, display, perform, and modify the work, as long as they distribute any modified work on the same terms. If they want to distribute modified works under other terms, they must get the permission first.
CC BY-ND	Attribution+Non Derivative. Data owners let others copy, distribute, display and perform only original copies of the work, even commercially, If they want to modify the data, they must get permission first.
Specific Terms of Use	Some examples: - CMEMS. Attribution is requested, all kinds of uses allowed, explicitly including commercial uses - EmodNet (Human Activities Hub). Unrestricted re-use - IUCN Red List of Threatened Species™. Attribution requested. Commercial use explicit denied with more restrictive definition than the CC Non-Commercial definition. All other uses allowed - SeaDataNet and ICES (Interntional Council for the Exploration of the Sea). Attribution requested. Commercial use might require prior written permission from the data source - REBENT database (IFREMER). Unrestricted re-use

[11] https://creativecommons.org/licenses/?lang=en

Subsequently, we analysed a sample of datasets that are found in OBIS, to understand the proportions among the different licenses. If we focus on OBIS, we will find more than 1000 dataset therein, each corresponding to a specific license (among the options outlined in table 2). We therefore explored a random sample (372 datasets found in OBIS), and we obtained the following results: 68.3 % of datasets correspond to the CC BY license, 17.7% to CC BY-NC; 6.5% to CC BY-NC-SA; 3.8% of datasets in OBIS are totally restricted, i.e. not available even for download; for 3.2% of dataset specific Terms of Use are applied; 0.3% (1 dataset) is CC BY-ND and another (also representing the 0.3%) is totally unrestricted. Figure 2 show the results on a graphics.

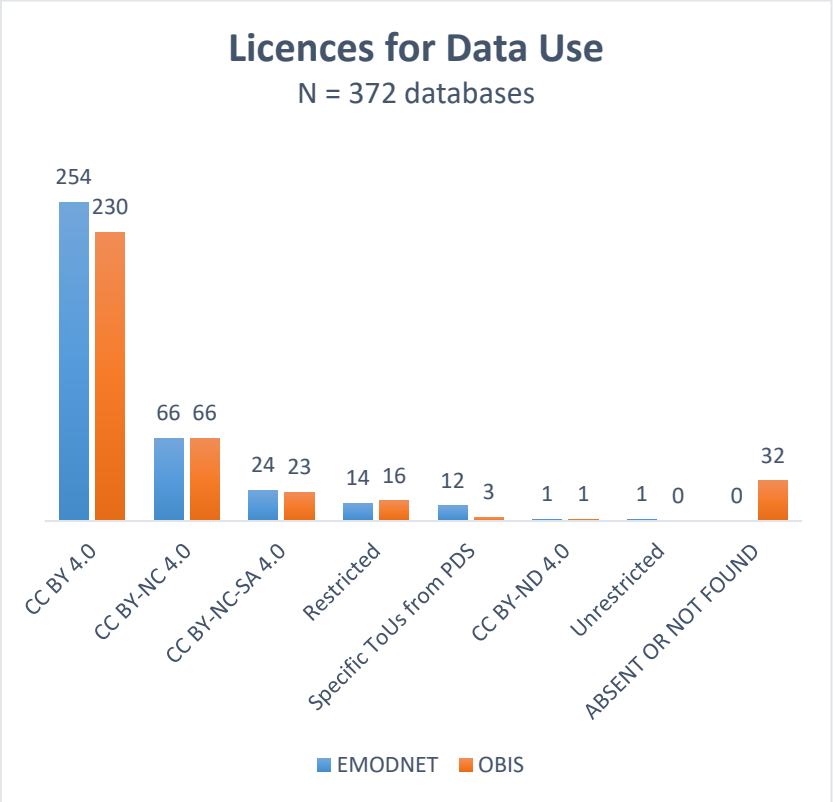


Figure 4. Proportion of licences assigned to datasets in OBIS. As it is possible to access datasets from either OBIS or from the EmodNet portal, we compared the information on the same dataset from the two portals and we discovered some inconsistencies. However, both portals point out the same trend on preferring the CC BY license.

With respect to the ASI and more in general for cetacean survey data directly or indirectly managed by ACCOBAMS, different options can be envisaged, based on two main approaches: developing specific terms of use (ToU); or adopting standard CC licences, for example taking advantage of the position supported by both OBIS and GBIF on this topic (See 6.1 Annex 1 – Approaches to licensing data and datasets):

- The advantage of developing specific ToUs is that any dataset being added afterwards to the download repository (for example after future cetacean survey projects), automatically falls under those ToUs, thus establishing standard conditions for downloading ACCOBAMS data. On the contrary, this option may prevent specific datasets to be included in the system, for example if data producers do not agree with the standard ToU for sharing their data.
- Alternatively, one of the available standard CC licences for the ASI dataset(s) can be attributed. It is possible to adopt a unique CC licence for all data distributed by ACCOBAMS, or different

CC licences can be attributed to single datasets (the ASI dataset(s) and future datasets included in the data management system).

- A combination of the above systems can also be envisaged. In this case, we may have general ToU for all downloadable data from the system, and specific licences (either CC or again specific ToU) linked to single datasets.

Key messages concerning licensing

The discussion on licensing is proposed because ACCOBAMS is willing to make available, i.e. redistribute, the data collected during the ASI project; in other words, ACCOBAMS wants to grant some rights to third parties for re-using such data. If this is not the case, then the discussion is meaningless, and the suitable choice is the "all rights reserved" approach. In this case, no rights are granted to third-parties, and there is no need to discuss about way to give access to data (through download services for example).

The willing for redistribution of data is therefore an underlying assumption of this discussion document, and all ACCOBAMS stakeholders involved in this process should bear this in mind clearly.

With these premises, in all cases (ToU, CC licensing, or a combination), the core of the discussion should be on the following features of data licensing: i) attribution, ii) modification, iii) production of derivative work, and iv) commercial use. For each of such features it should be agreed whether or not it is allowed, and under what conditions.

If standard CC features are considered adequate, then the corresponding combination of such features (described by the following codes: BY for attribution, SA for Share-Alike, ND for Non-Derivative, and NC for Non-Commercial) should be adopted. Otherwise, specific ToU should be developed in order to outline all additional conditions for re-use of data. Annex 6.2 – Licensing options provides a detailed description of each combination of CC features.

3.3 DATA ACCESS

Platforms analysed in this document show four main ways for accessing data:

- Mapping services. These are essentially web GIS tools that allow the user the view row species occurrence data displayed on a map in some website[12]. It is also generally possible to display data which have been processed by some institution and that represent the results of studies carried out in the past. Such processed data are usually referred to as *data products* in the platforms like EmodNet, Copernicus and similar[13].
- Download services. Such services are provided through catalogues or toolboxes, on a dataset by dataset basis. Also, download services are provided from the aforementioned GIS tools, where aggregated data from different datasets can be downloaded.
- Webservices. Such services are generally employed to view data without physically export them (i.e. without downloading). It is possible indeed to show data from a given platform in a different website, or in a desktop GIS software, by linking to the original database through a webservice. However, it also possible to use web services to retrieve data from distant servers.
- R packages. An interesting feature of OBIS, is the development and maintenance of an R package which data can be accessed and processed from. This requires installing and using R

[12] For example : http://www.emodnet.eu/geoviewer/

[13] For example: yearly gridded abundance maps from 1980 to 2010 of marine mammals in the North Sea. http://www.emodnet-biology.eu/data-catalog?page=image&p=search&dasid=5457

or RStudio, which limits of course the number of users, but has the great advantage of accessing the most updated version of a constantly evolving database.

3.4 PROCESSING AND ANALYSIS

Some systems provide tools for data analysis and processing. Among these, the EU Biodiversity Observation Network developed the European Biodiversity Portal (EB Portal)[14]. This portal not only provides data access (*inter alia* through connections established with GBIF data), but also analysis tools which can be used directly through a web interface (e.g. the GeoCAT online tool, available from the EB Portal, allows performing rapid geospatial analysis on some elementary ecological parameters of species[15]).

Therefore, the EU BON European Biodiversity Portal represents a source of updated information on analytical methods (i.e. algorithms for ecological analyses such as occupancy, species distribution modelling, etc.) which have reached a high level of maturity. We mean as "maturity", a property of an algorithm to be re-used and give high quality results regardless of the changing conditions in which it is employed (different data sources, different species, different survey protocols for data collection, etc.).

We consider that the adoption of internationally accepted standards for data collection and reporting (such as the DwC standard) has the potential of accelerating the path of ecological algorithms towards higher level of maturity. Otherwise, data can generally be accessed and processed on a case-by-case basis by experienced operators (e.g. researchers) through R packages as provided by OBIS.

3.5 FUNDING AND SUSTAINABILITY

For this work we consider relevant to highlight the general mechanisms that allow such systems to be sustainable, particularly for open data platforms. It is possible to show that European Union bodies are present among the funding or co-funding entities of almost all initiatives analysed here:

- the European Marine Observation and Data Network (**EMODnet**) is financed by European Union under Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund[16].
- The Copernicus Marine Environment Monitoring Service (**CMEMS**), is funded by the European Commission as the service component of the Copernicus Space Programme driven by the EC Directorate Entreprise and Industry[17].
- The **Red List of Threatened Species**™ indicates ten major donors, including the European Commission, one industrial actor, and several private foundations[18].
- Concerning the **ICES**, co-funding is allocated by the European Commission and OSPAR for specific projects; however, it seems that the ICES data portals are maintained through structural funds (probably regular contributions from Contracting Parties). A more detailed analysis of the ICES functioning is recommended to highlight mechanisms that might be reproduced in the Mediterranean.
- About **OBIS**, in section 2.2 we pointed out that the initiative was adopted as a project under IOC-UNESCO's International Oceanographic Data and Information (IODE) programme in 2009,

[14] http://biodiversity.eubon.eu/web/guest/home
[15] http://geocat.kew.org/
[16] Statement available on http://www.emodnet.eu/
[17] http://marine.copernicus.eu/about-us/about-eu-copernicus/
[18] Link to the sponsors' page of the Red List of Treatened Species: http://www.iucnredlist.org/sponsors

and that resources are covered by UNESCO's regular programme, through extra-budgetary projects, by donations from the private sector and governments as well as in-kind contributions to core activities. Also, the website indicates as sponsoring partners the European Commission, EmodNet (as a standalone body), the Flemish Government, and Les Grands Explorateurs (Canadian private company)[19].

- Finally, the **GBIF** website indicates 44 agencies from national governments[20] that make annual financial contributions to GBIF. Further, additional funds are supplied by the European Union, by the EU BON project (funded in turn through the 7th Framework Programme of the EU, FP7), EmodNet, the Ministry of the Environment of Japan, and the University of Copenaghen.

[19] http://iobis.org/about/sponsor/
[20] https://www.gbif.org/funders

3.6 COMPARATIVE ANALYSIS

A summary table was built with the aim of providing a comprehensive and synthetic overview of the systems we analysed and described in the previous sections. 4 main features are considered in the comparison: i) the accessibility to data, i.e. how access to data is proposed to the user; ii) Data and/or dataset licensing; iii) Funding sources; and iv) availability of data processing tools. Finally, global strengths and weaknesses of systems are highlighted.

System template	*Access*	*Licences*	*Funding*	*Processing*	*Points of interest*	*Weaknesses*
Local MPA manager (N2000 site)	Manual download	No licence found	Structural	No	Simple and cheap, give simple access to information	Static system, information may not be updated, no clear legal framework (IP rights, licensing, etc.)
Academic data producer (University or Research institute)	No or limited access (through manual download)	Restrictive ToUs	Structural and project-based	No	Well adapted to data collected by that group	Little visibility on work done, no connection with other systems, potentially non-interoperable and/or non-standard
National environmental agency (INPN)	Manual download Mapping	Light restrictions	Structural	No	High potential to inform and support decision making and management	Primarily informative, data not meant for re-use
National regulatory body (MISE)	Manual download Mapping	CC BY	Structural	No	Clear licensing and IP rights, dynamic and updated	Primarily informative, no clear standardisation
International body (OSPAR, ICES)	Manual download Mapping Webservices	light restrictions	Structural + co-funding	No	Wide accessibility, interconnected and interoperable with other systems	Some elements of the ToU are little readable; need for external funding may impede a complete financial stability; data heterogeneity (no clear domain addressed but a mix of different domains instead)
International body (IUCN)	Manual download Mapping Webservices	Commercial use explicitly forbidden	Varied sources	No	Wide accessibility, interoperable, users can access row data and refined information	Very restrictive concerning commercial re-use; potentially unstable due to varied financial sources
Open Data Platform (OBIS)	Manual download Mapping Webservices R package	By dataset, prevalence of CC BY	UNESCO, co-funds	Yes	Wide accessibility, interoperable, standardised	Licensing system (by dataset) hard to comply with for aggregate data; potentially unstable due to varied financial sources
Open Data Platform (Copernicus)	Manual download Mapping Webservices	Attribution requested	EU	No	Wide accessibility, interoperable, straightforward licensing system	No means provided for processing data (but the system appear complete and with negligible or no clear weaknesses)
Open Data Platform (EU BON)	Manual download Mapping Webservices	By dataset, prevalence of CC BY	EU	Yes	Wide accessibility, interoperable, standardised processing tools available	Licensing system (by dataset) hard to comply with for aggregate data; need for external funding may impede financial stability;

4 PROPOSALS FOR THE ASI

Based on the analysis reported in chapter 3, different combinations of features (data access, processing/analysis, data licensing, funding) can be considered for a system suitable for the management of data produced during the fieldwork phase of the ASI project. We remind here that with the term "data", we mean both row data like sightings and/or effort data, and analysed data such as maps including row matrices underlying the maps (e.g. in ESRI format, kml, txt or further formats).

Two drivers appear of importance:

- The choices made concerning terms and conditions for data re-use appear to influence the impact[21] of ACCOBAMS's activities beyond the specific results linked to surveys like ASI: Should ACCOBAMS promote, or create the conditions for data to be re-used including in different contexts? By other people? For initiatives having different scopes from cetacean conservation? And how much time show elapse before data are made available and accessible?
- Technological complexity increases along with the ambition of the system: should it provide the largest data accessibility as possible or is it built for ACCOBAMS internal use? Should it provide processing tools to enable meaningful re-use of such data (and so act as a capacity building tool)? The funding framework appear then to be a consequence of the ambition sought for the system.

Considering these premises, the two drivers, terms and conditions for data access and technological complexity, are addressed separately in the following sections.

4.1 CONCERNING TERMS AND CONDITIONS OF USE FOR DATA

With respect to licensing, if ACCOBAMS adheres to OBIS and GBIF position on this topic, then the CC0 (no rights reserved, see 7.2.3 of Annex 2) should be proposed. However, as shown in figure 3 above, most datasets found in OBIS adopt a Creative Commons Attribution licence (CC BY), where the citation of the work is required from third parties. Therefore, **in this document we propose to consider the adoption of either CC0 or CC BY as the preferred licensing system for data re-use**, regardless of the choice made for the other features (data access and availability of processing tools).

In the case of a CC BY licence, a **standard citation formula** should be developed and recommended.

Beyond the specific choice on licensing approach, another point is the time elapsed between the data collection phase and the moment data are made available for access. It is reasonable indeed to plan making data available for access only after a certain amount of time following the completion of the data collection phase. For example, this may occur after the analysis phase is finished and/or after knowledge produced has been appropriately communicated (during ACCOBAMS meetings, to Contracting Parties, through scientific journals, etc.). This point should be discussed and agreed among people involved in the ASI project.

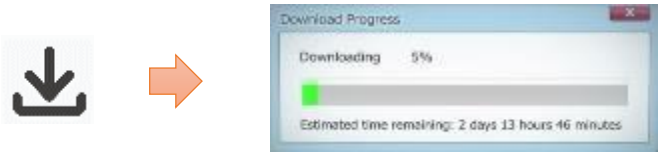
[21] Here "impact" means the positive influence that surveys may have on decision making concerning marine wildlife conservation and environmental management.

4.2 CONCERNING FUNCTIONALITIES AND APPLICATIONS

As anticipated above, the technological complexity is a result of choices on data accessibility and processing tools to be included in the system. Three possible combinations are presented in the following sections, along with increasing technological complexity.

4.2.1 SYSTEM 1 – BASIC FRAMEWORK WITH MANUAL DOWNLOAD

Data access: **Manual download**. The ACCOBAMS or NETCCOBAMS website may suite this framework. A page dedicated to the ASI project could contain the data to be accessed through a conventional downloading service (i.e. *click to download*).



Processing and analysis: **no**. In such a system, no tools are provided for the processing of data, for example for deriving habitat and/or distribution and/or abundance maps of cetaceans. This allows keeping the developing effort, and therefore the costs, as low as possible.

Technology: no high technological demand is linked to this configuration, and conventional web technologies are needed to ensure the availability of the ASI database for download (from the ACCOBAMS or NETCCOBAMS websites).

Such a system does not require specific long-term management or maintenance. The only management needed is for the usual functioning of the website, and therefore the need for funding appear to be very low or null (i.e. likely already covered by current regular/structural fund of ACCOBAMS).

*Table 4. Summary of characteristics of **System 1***

Access	*Licences*	*Funding need*	*Processing*	*Points of interest*	*Weaknesses*
Manual download	Standard CC0 or CC BY	Very low	No	Simple and cheap, gives simple access to data	Static system, low impact in the long run

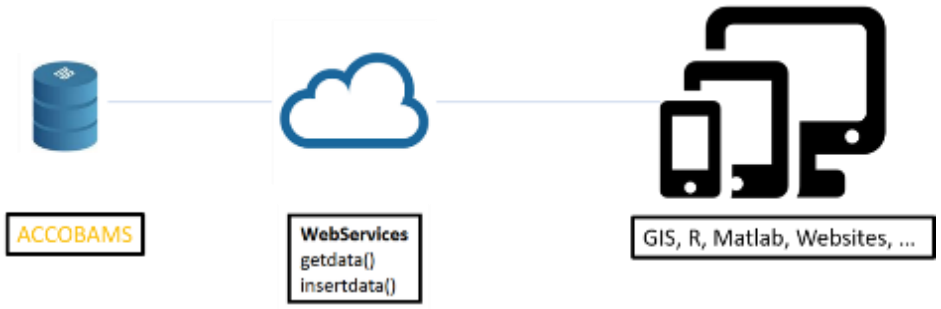
This system does not ambition to become a knowledge hub for the ACCOBAMS area and is not integrated, interoperable, and connected with other systems. No data exchange is possible with other data repositories containing different kinds of biological, ecological, oceanographic and further kinds of data. Instead, it is possible to upload such data to aggregator platforms (such as OBIS).

4.2.2 SYSTEM 2 – WIDENING ASI DATA RE-USE

Data access: **Manual download, Mapping service and webservices**. In such a case, 3 ways of giving access to data are provided, therefore allowing for a wider re-use of data. The NETCCOBAMS website may also suit for this framework.

The establishment of a mapping service implies not only that data can be displayed on a map in the website, but also that they can be explored and filtered in order to download only data that are required by the user.

The implementation of a webservice means that ACCOBAMS provide a key for the user to directly connect to the database through the internet from different tools. For example, it is possible to connect through MATLAB, R or any other programming language to the database by using a webservice, without physically downloading it database. In no case a webservice allows modifying the content of the database. Instead, it allows getting the most updated data as the system manager update, improve, or feed the database with new data.



In order to keep the costs for development and maintenance low, processing and analysis tools are not included in this system. In term of technology, conventional modern web features are used to create mapping and web services. The funding need appear low, and a pilot system with characteristics described here may be implemented in the framework of the ASI project.

Access	*Licences*	*Funding*	*Processing*	*Points of interest*	*Weaknesses*
Manual download Mapping Webservices	Standard CC0 or CC BY	Low	No	Wide accessibility, interconnected and interoperable with other systems	Some maintenance needed to keep it updated and functioning

This system would enable opening, at least from a technological point of view, the re-use of data outside the domain of cetacean ecology.

4.2.3 SYSTEM 3 – STRUCTURED PLATFORM

This system is an extension of the case presented in section 4.2.2. It has additional features concerning the connections with other databases and for the processing and analysis data. This characteristic appears interesting from two points of view:

- Capacity building. The system provides a set of tools that may be used by a wide range of users: documentation on analysis methodologies, algorithms written in common processing languages, and online "click-based" functions for the use these algorithms directly on the website
- Proposing standardised analyses (e.g. The MAXENT framework for habitat suitability modelling, or more elementary analysis of ecological parameters)

It is not the objective of this document to discuss the best technology or the best development framework (cf section 3.1), but it is worth noting that the technology is available to reach this stage. However, the cost for the implementation of such a system are higher due to the development time required (including the testing phase) and the maintenance.

A structured platform like this is probably disproportioned for the ASI project. Instead it could be considered for future development if ACCOBAMS discovers frequent needs for accessing both row or analysed data, not limited to cetacean survey data, and if this is clearly justified by either increased efficiency for the achievement of the goals of ACCOBAMS in the long run, or reduced costs of today's expensive tasks. These points are better discussed in the following chapter (7 – PERSPECTIVES)

Access	***Licences***	***Funding***	***Processing***	***Points of interest***	***Weaknesses***
Manual download *Mapping* *Webservices*	By dataset, prevalence of CC BY	EU	Yes	Wide accessibility, interoperable, standardised processing tools available	Licensing system (by dataset) hard to comply with for aggregate data; need for external funding may impede financial stability;

5 PERSPECTIVES

Multiple perspectives are on the table and the final shape of an ACCOBAMS Data Management System will be figured out as long as needs are clarified. ACCOBAMS should try to predict their future needs and qualify them, for example:

- Need to access row data on cetaceans or other marine environmental parameter (no need, occasional, frequent, regular)
- Needs to produce rapid information/assessment/progress report, etc. on some ecological indicator, not limited to cetacean survey data (no need, occasional, frequent, regular)
- Need to assess elementary parameters concerning the conservation of cetaceans e.g. number of sightings of species, global stranding indicators, etc; (no need, occasional, frequent, regular)
- Need to assess threats, e.g. by producing simple pressure indicators for dedicated workshops or meetings (no need, occasional, frequent, regular)

Questions listed above deal with the different internal uses, likely made by the ACCOBAMS Secretariat, to address specific tasks that could benefit from the setting up of a platform. Further relevant questions could be addressed concerning the tasks that are foreseen (or not) for ACCOBAMS as a player of cetacean conservation:

- Supplying data to third parties (Y/S)
- Supplying tools to provide periodical reporting (e.g. reports from Focal Points, Y/S)
- Only supporting and/or managing project, including transboundary surveys (Y/S)

Annex 4 (Section 6.4) presents the main questions identified in this document (including the questions listed above) that would help establishing a roadmap for the setting up of a data and information management system. The following sections explore first scenarios from two perspectives: the diversity of data potentially needed in the future; and the role of ACCOBAMS as an actor of marine conservation in its competence area.

5.1 CONCERNING MARINE DATA

The objectives of ACCOBAMS are to preserve a favourable conservation status of cetaceans. To do that, periodical assessments of cetacean status and of threats should be done as stated in the Agreement. Many threats have been identified and addressed since the entry into force of the Agreement, such as by-catch, ship strikes, underwater noise, chemical pollution, marine litter, and it is obvious that knowledge required to monitor and assess cetacean status and threats need many kinds of raw data. Concerning cetology (not exhaustive):

- Sighting data (coming from boat or aerial surveys such as ASI)
- Stranding data
- Telemetry data
- Acoustics
- Genetics

Concerning environmental, biological and ecological variables (e.g. for habitat modelling):

- Oceanography (Temperature, Salinity, Currents)
- Geology (seafloor nature, sediment type)

- Bathymetry
- Primary production
- Prey stocks
- Seabed habitats

And concerning threats (not exhaustive),

- Ship traffic, including passenger and commercial shipping, fisheries, etc.
- Data on fisheries, including catch and by-catch
- Noise pollution data
- Seismic exploration activities
- Other offshore human activities (platform constructions, underwater cable deployment, renewable energies, military activities, and more)

Though ACCOBAMS is not a research institute or a management service, in the past years the Secretariat supported in many ways projects and/or initiatives aimed at gathering data as a basis for improving knowledge. Apart from the ASI, we report here a sample of such initiatives that resulted in the production of data or databases:

- Overview of the noise hotspots in the ACCOBAMS area – Part 1, Mediterranean Sea (2015)
- Production of a GIS layer of ship traffic for 2017 based on AIS data, in the entire ACCOBAMS Agreement area (2018)
- ACCOBAMS Collaborative Effort To Map High-Use Areas By Beaked Whales in the Mediterranean (2010-2012)
- Involvement of ACCOBAMS in the implementation of the impulsive noise register in its Agreement area
- The Mediterranean Database of Cetacean Strandings (MEDACES, since 2005)

All these projects produced data aimed at answering specific questions on single threats to cetaceans. However, the absence of a structured system prevents further uses in an effective way, and even simple analysis such as overlaps of layers in a GIS is difficult due to absence of metadata. Annex 3 (Example of datasets produced by of for ACCOBAMS in recent years) present a sample of data that were produced under the initiative of ACCOBAMS.

As a first approach, it is highlighted here the need to **capitalize the efforts done in the past to serve future initiatives**. Therefore, an ACCOBAMS data management system could be built to organise data produced in the past, lay down the rules for re-use, and to be regularly fed with data from the different initiatives supported by ACCOBAMS.

Subsequently, this system could also include other marine data, and metadata, used or useful for analyses inherent cetacean conservation. As already highlighted in this document, the **technology to handle complex databases is available and strategies for cost-effectiveness could be studied**.

5.2 CONCERNING THE POSSIBLE ROLES OF ACCOBAMS

The final step of this document is aimed at outlining what role, with respect to data, ACCOBAMS may have as an actor of marine conservation of the Mediterranean and Black Sea regions. The following facts are taken as basis of this outline:

- In the Mediterranean and Black Sea regions area there is no historical initiatives like ICES, i.e. an international database fed with marine data coming from data collection programmes promoted (and usually implemented jointly) by institutions from different countries.

- Recent European initiatives (such as the CMEMS and EmodNet programmes) cover all or part of the Agreement area but are rarely focused on cetaceans.
- Other international and regional initiatives cover the Agreement area: OBIS and related geographical or thematic nodes, such as EurOBIS and OBIS-SeaMap, respectively.
- The UNEP/MAP has planned to develop an information system related to the implementation of the EcAp process. This system is aimed at centralising the information on monitoring and assessment programmes in the competence area of UNEP/MAP.
- The different practical initiatives undertaken by ACCOBAMS resulting in the production of data and databases on cetaceans (and threats). These are better described in section 6.3

Considering such facts, and obviously the goals of ACCOBAMS which are tightly linked to cetacean conservation, two main roles may be envisaged as outlined hereafter.

- **Promoter/supporter of a regional data hub for cetacean conservation**. In this case, ACCOBAMS is not the leader, the developer or the coordinator of the data hub, but rather a stakeholder, as for example a user of cetacean data and/or knowledge contained in the data hub. Therefore, this role contemplates lobbying and upstream actions such as:
    - promoting the creation of a steering group that would establish a roadmap
    - participating and/or organising meetings and workshops with relevant goals, and similar actions.
- **A regional data hub for cetacean conservation.** From this perspective, data can be used for periodical assessments, and hence this role contemplates the tasks already being undertaken with regards to the MSFD Descriptor 11 and EcAp Ecological Objective 11 (Energy including underwater noise). Likewise, ACCOBAMS could aspire to have the same role for Descriptor 1 of the MSFD and/or Ecological Objective 1 of the EcAp (Biodiversity). In this role, ACCOBAMS may act as:
    - The manager of data collected through initiatives coordinated by ACCOBAMS
    - An aggregator of external data from existing platforms, e.g. from EU, UNEP/MAP, or international initiatives like OBIS
    - A provider of cetacean data to those platforms.

Such possibilities represent extreme scenarios and many intermediate solutions can be drawn.

6 ANNEXES

6.1 ANNEX 1 – APPROACHES TO LICENSING DATA AND DATASETS

Due to the particular nature of data and datasets, the licensing and/or the attribution of terms of use is a matter of debate in the scientific community. From a general point of view, Creative Commons licenses replace individual contracts (that the copyright owner and the user of a work may negotiate) with a standardized license (Hagedorn et al., 2011). Managing individual licenses incurs a high legal and management overhead (which induces many publishers not to negotiate licenses, but rather to demand total transfer of copyright). The availability of a set of such standard contracts for a spectrum of use cases is an important feature of CC licenses. However, different CC licenses exist, as well as other kind of licenses specific to data and datasets. Alternatively, specific Terms and Conditions of Use must be developed.

In order to orientate in this vast domain and as a potential landmark for future discussions, we report here a synthesis of argumentations supported and adopted by OBIS and GBIF, concerning the preferred way for licensing datasets on biodiversity. The full text (available at http://community.canadensys.net/2012/why-we-should-publish-our-data-under-cc0) is proposed by Canadensys, a Canada-wide community of scientists based at the Biodiversity Centre of the University of Montréal, and participating to the GBIF initiative.

As a first approach, it is worth understanding that copyright only applies to the creative aspect of the dataset, not the facts (Desmet, 2012). Copyrightable content may be some text in the comment/remarks field of datasets, the data format or database model chosen or created, and pictures. Considering the Darwin Core standard for biodiversity data (as used by OBIS and GBIF for example), creative content is even further reduced.

In the argumentation employed by Canadensys, CC0 is recommended for data and databases and is used by hundreds of organizations. It is especially recommended for scientific data and thus encouraged by Pensoft (Penev et al., 2011) and Nature (Schofield et al., 2009). Although CC0 doesn't legally require users of the data to cite the source, it does not take away the moral responsibility to give attribution, as is common in scientific research (more about that below). CC0 is therefore the preferred option by OBIS and GBIF. Publishing data under CC0 removes any ambiguity and red tape. Copyright is waived on possible creative content and data get the legal status of public domain. They can no longer be copyrighted by anyone.

The next paragraphs describe the different types of licences usually attributed to data and datasets.

6.2 ANNEX 2 – LICENSING OPTIONS

Recalling that licenses only apply to the creative aspect of the dataset, not the facts, we list and describe here existing licence types.

6.2.1 ALL RIGHTS RESERVED

The user cannot use the data(set) without the permission of the owner

6.2.2 OPEN DATA COMMONS PUBLIC DOMAIN DEDICATION AND LICENSE (PDDL)

There are no restrictions on how to use the data. This license is very similar to CC0. This license was a precursor of CC0, however it is less well known and maybe not as legally thorough as CC0. CC0 made

a huge effort to cover legislation in almost all countries and the Creative Commons community is working hard to improve this even further (more information: https://opendatacommons.org/licenses/pddl/summary/ .

6.2.3 CREATIVE COMMONS NO RIGHTS RESERVED (CC0)

CC0 is a universal public domain dedication that may be used by anyone wishing to permanently surrender the copyright and database rights (where they exist) they may have in a work, thereby placing it as nearly as possible into the public domain. CC0 is a legal tool that improves on the "dedication" function of our earlier, U.S.-centric public domain dedication and certification. CC0 is universal in form and may be used throughout the world for any kind of content without adaptation to account for laws in different jurisdictions. And like our licenses, CC0 has the benefit of being expressed in three ways – legal code, a human readable deed, and machine-readable code that allows works distributed under CC0 to be easily found.

CC0 can be particularly important for the sharing of data and databases, since it otherwise may be unclear whether highly factual data and databases are restricted by copyright or other rights. Databases may contain facts that, in and of themselves, are not protected by copyright law. However, the copyright laws of many jurisdictions cover creatively selected or arranged compilations of facts and creative database design and structure, and some jurisdictions like those in the European Union have enacted additional sui generis laws that restrict uses of databases without regard for applicable copyright law. CC0 is intended to cover all copyright and database rights, so that however data and databases are restricted (under copyright or otherwise), those rights are all surrendered. CC0 is also particularly relevant to scientific data. More information: https://creativecommons.org/share-your-work/public-domain/cc0/

Tens of relevant examples exist of the use of this licence (https://wiki.creativecommons.org/wiki/CC0_use_for_data). Among these, we report the example of the European Union *guidelines on recommended standard licences, datasets and charging for the reuse of documents* (European Comission, 2014). In such guidelines it is stated: "Open standard licences, for example the most recent Creative Commons (CC) licences (version 4.0), could allow the re-use of public sector information (PSI) without the need to develop and update custom-made licences at national or sub-national level. Of these, the CC0 public domain dedication is of particular interest. As a legal tool that allows waiving copyright and database rights on PSI, it ensures full flexibility for re-users and reduces the complications associated with handling numerous licences, with possibly conflicting provisions."

6.2.4 CREATIVE COMMONS ATTRIBUTION-NO DERIVATIVES (CC BY-ND)

The user cannot build upon the data(set), which is what most data use involves[22].

6.2.5 CREATIVE COMMONS ATTRIBUTION-NON COMMERCIAL (CC BY-NC)

The user cannot use the data(set) for commercial purposes[23]. This seems fine from an academic viewpoint, but the license is a lot more restrictive than intuitively thought. For example, from a legal point of view, this might be restrictive for publishing in scientific journals (Hagedorn et al., 2011).

[22] http://creativecommons.org/licenses/by-nd/3.0/
[23] http://creativecommons.org/licenses/by-nc/3.0/

6.2.6 Creative Commons Attribution-Share Alike (CC BY-SA) or Open Data Commons Open Database License (ODbL)

The user has to share any work based upon the data(set) under a license that is identical or similar to the one used. This may lead to some problems for an aggregator like OBIS or GBIF: if they are mixing and merging data with different SA licenses, which one do they choose? They might be incompatible [24].

6.2.7 Creative Commons Attribution (CC BY) or Open Data Commons Attribution License (ODC-By)

The user has to attribute the data(set) in the manner specified by the owner. This condition is also present in the three licenses above. this can lead to impractical "attribution stacking". If an aggregator (OBIS or GBIF) or a user of that aggregator is using and integrating different datasets provided under a BY license, they legally have to cite the owner for each and every one of those in the manner specified by these owners (again, for the potential creative content in the data) [25].

6.3 Annex 3 – Example of datasets produced by of for ACCOBAMS in recent years

Hereafter are shown samples of data produced during initiatives steered by ACCOBAMS:

- Overview of the noise hotspots in the ACCOBAMS area – Part 1, Mediterranean Sea (2015)
- Production of a GIS layer of ship traffic for 2017 based on AIS data, in the entire ACCOBAMS Agreement area (2018)
- Accobams Collaborative Effort To Map High-Use Areas By Beaked Whales in the Mediterranean (2010-2012)
- Implementation of the impulsive noise register in its Agreement area (since 2016)
- The Mediterranean Database of Cetacean Strandings (MEDACES, since 2005)

Such examples are shown with a view to highlight the existing opportunities in terms of capitalization of past efforts for future initiatives, and for stimulating new research on cetacean conservation.

[24] http://creativecommons.org/licenses/by-sa/3.0/ and http://opendatacommons.org/licenses/odbl/summary/
[25] http://creativecommons.org/licenses/by/3.0/ and http://opendatacommons.org/licenses/by/summary/

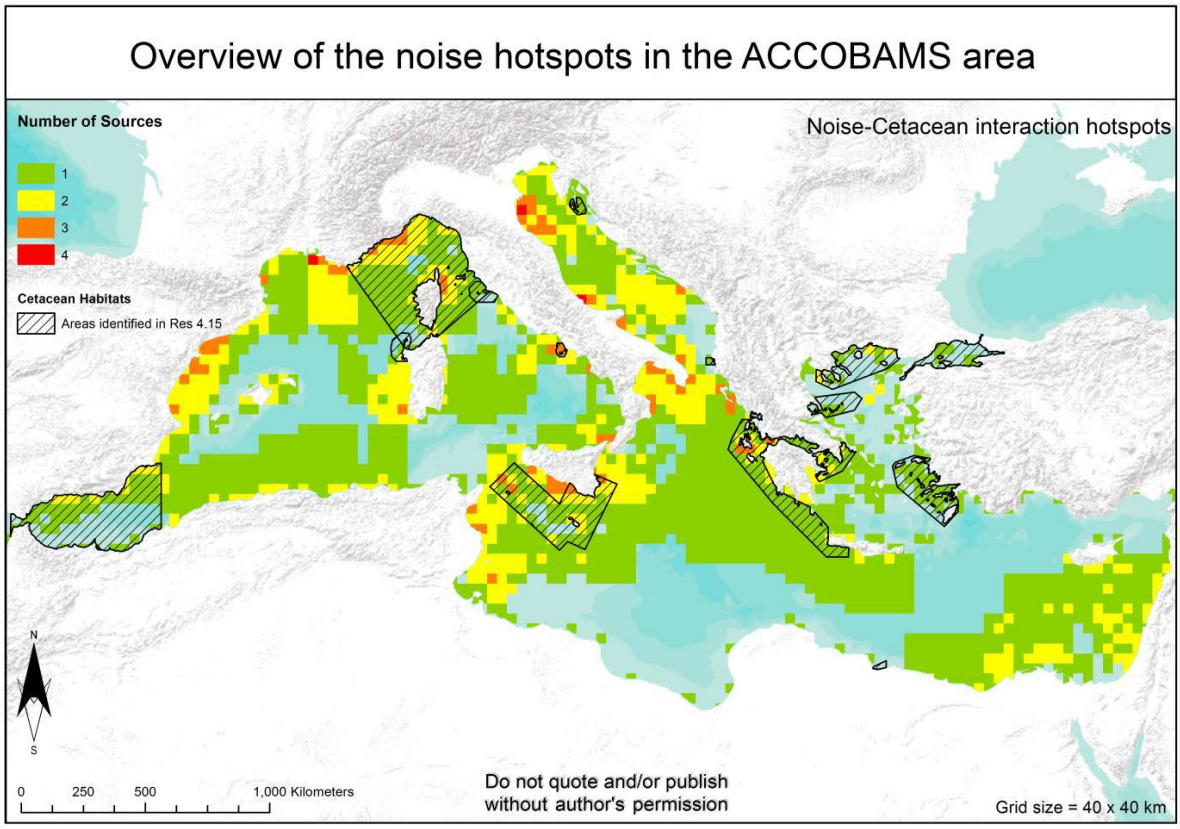


Figura 1. Noise-Cetacean interaction hotspots (Maglio et al., 2016)

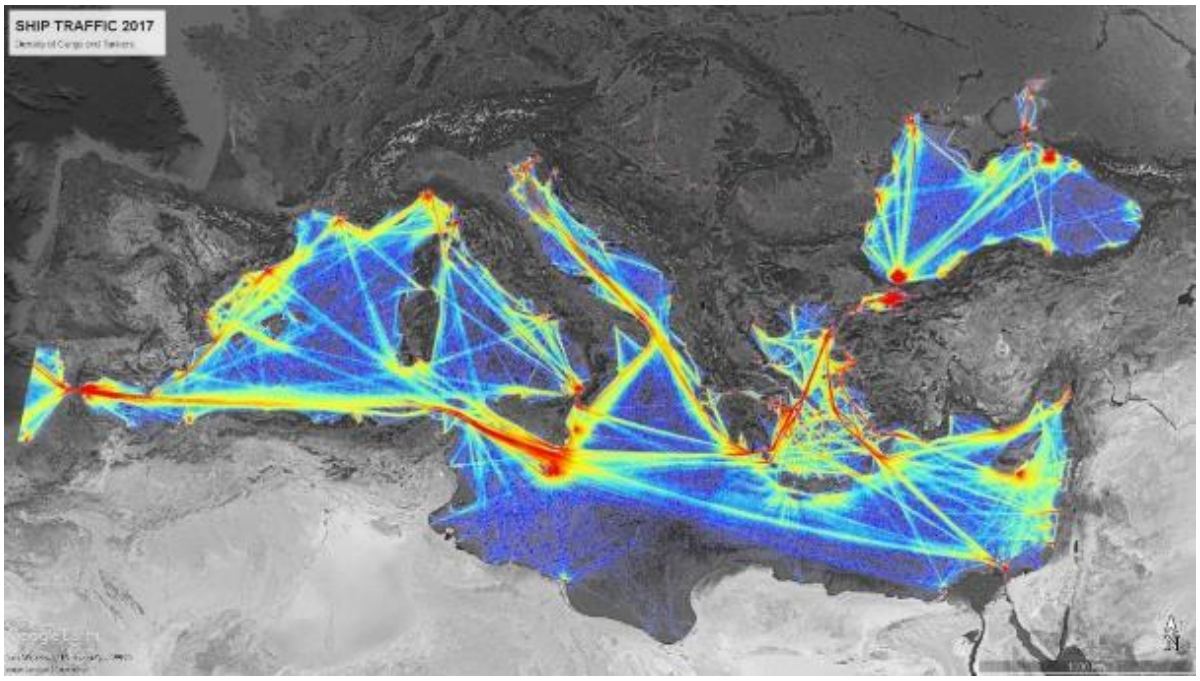


Figura 2. Cargo and Tanker density based on AIS data for 2017.

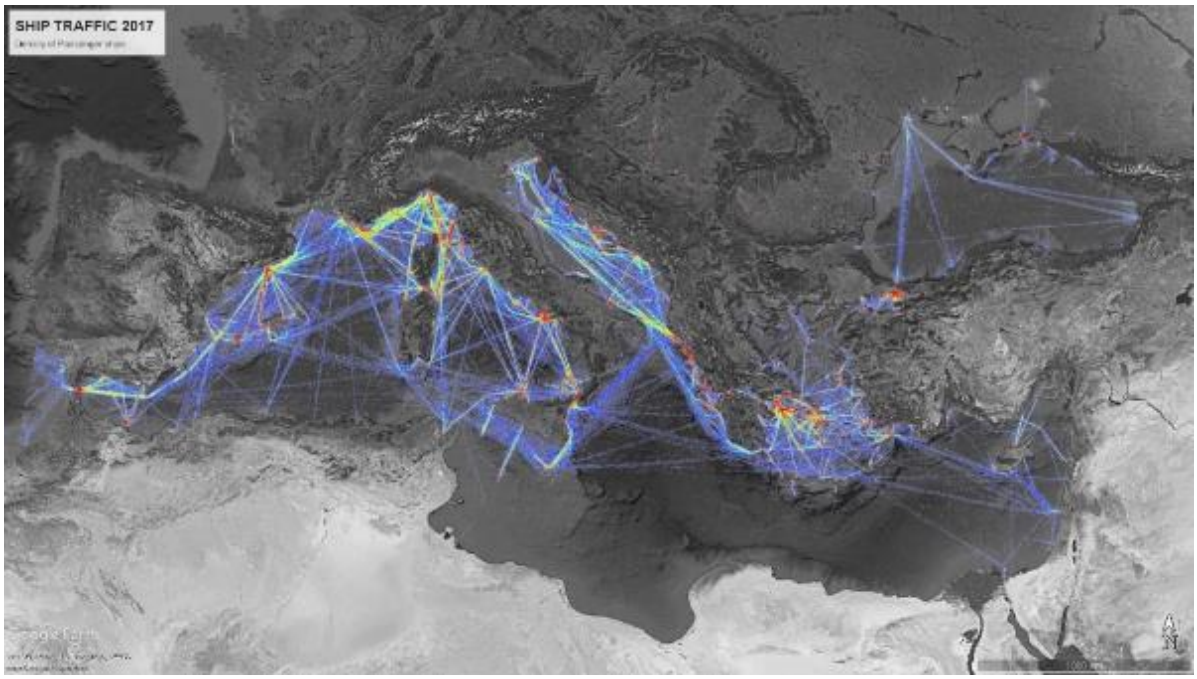


Figura 3. Passenger ship density based on AIS data for 2017.

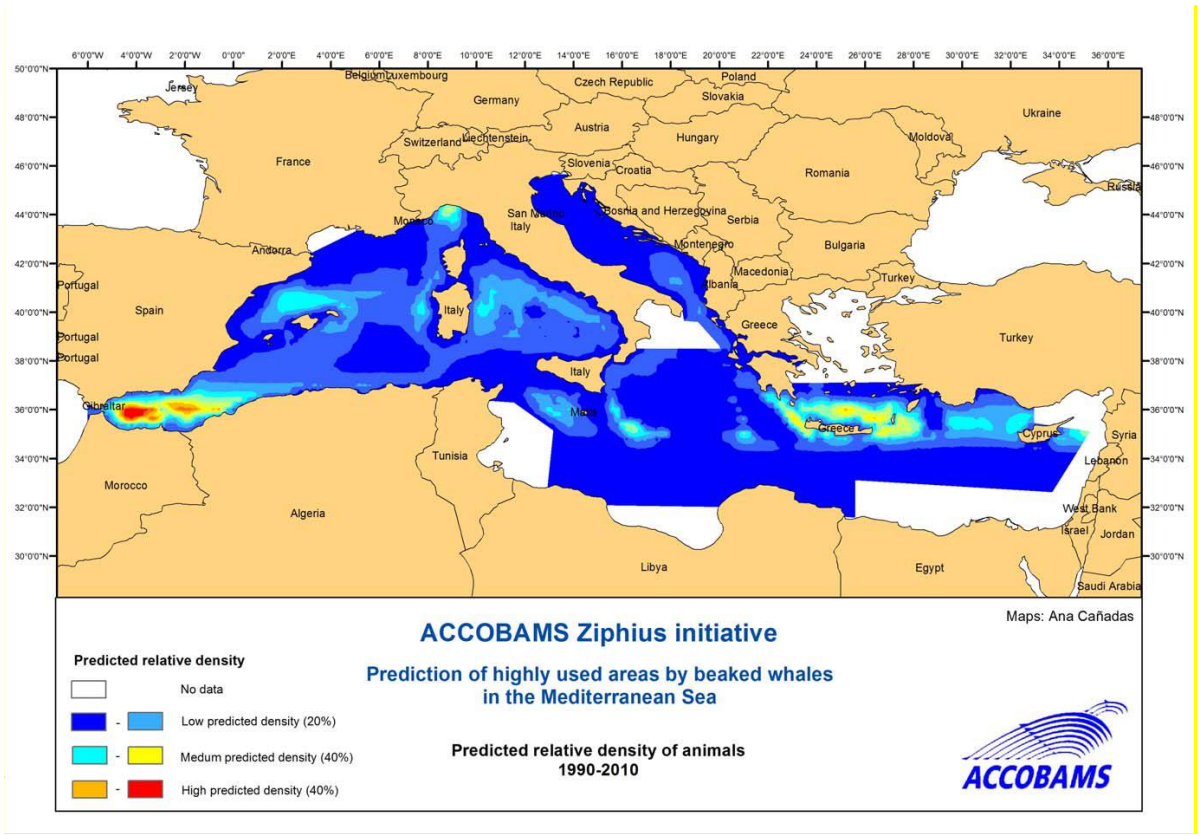


Figura 4. Predicted density of Cuvier's Beaked whale (Cañadas et al., 2012)

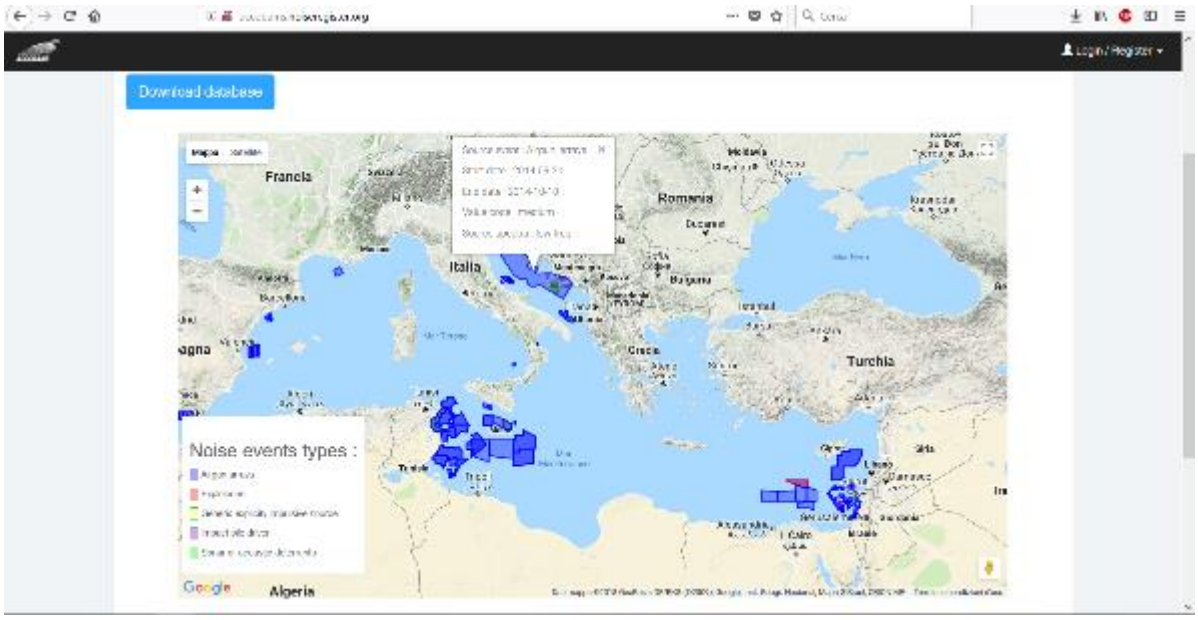


Figura 5. Screenshot of the impulsive noise register.

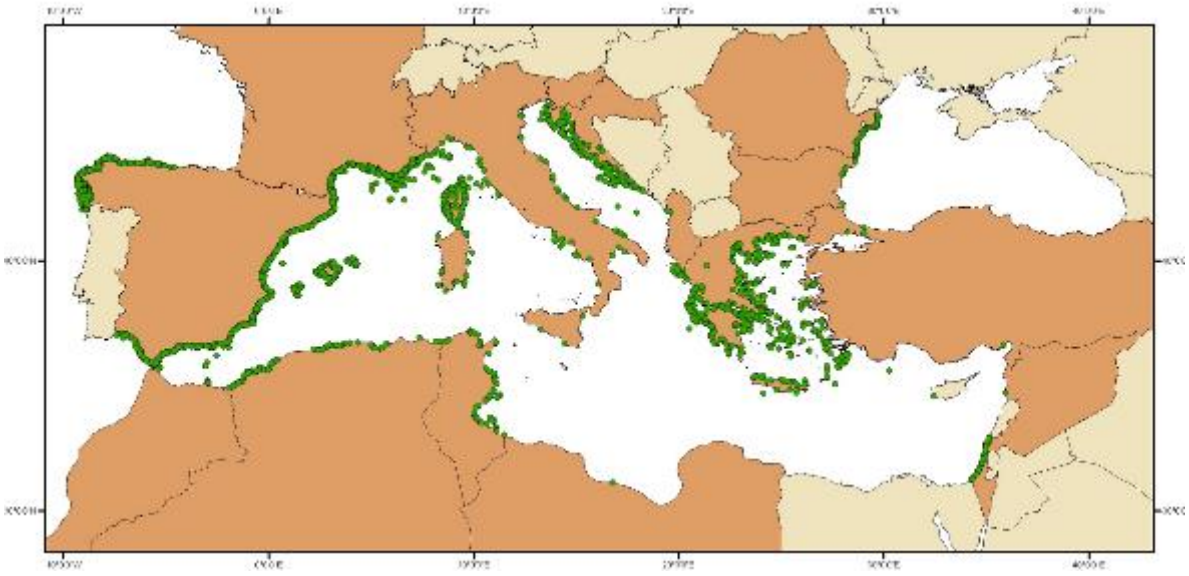


Figura 6. Stranding map exemple available at http://medaces.uv.es/maps/All%20cetacean%20strandings.jpg

6.4 ANNEX 4 - MAIN QUESTIONS TO ESTABLISH A ROADMAP

We report here the main topics, and relative questions, that may be helpful to drive the definition of a system for managing data and information within ACCOBAMS.

Ambition

The system is designed to

1. Store data collected during the ASI
2. Establish rules for redistribution of data hold by ACCOBAMS (including ASI data) to quickly manage frequently incoming requests for data
3. Promoting adoption of conservation measures through decision makers
4. Increasing public awareness on cetacean conservation
5. Promoting science and capacity building

Impact

The system is addressed to:

1. The ACCOBAMS Secretariat for internal use
2. The ACCOBAMS "narrow ecosystem" (partners, parties, experts, working group members, etc.)
3. The ACCOBAMS larger ecosystem (partner organisations and fora, non-partner stakeholders such as Universities, NGOs, etc.)
4. Any possible user of cetacean survey data and further data hold by ACCOBAMS

Licensing features sought

If the answer is "yes" to at least question 1 and 2 of both *ambition* and *impact* topics, then the redistribution of data is the minimum wanted goal, and hence it is relevant to outline ways to achieve this goal. Otherwise, if data (row and analysed) are not meant to be re-used, including within the ACCOBAMS bodies and partners, for future works, publications, expertise or any other work, then the "All rights reserved" formula is likely the wanted solution.

In all the other cases, we need to understand how the following features are understood:

- Attribution (i.e. properly citing the data and projectsm their authors/owners/coordinators, and/or other stakeholders involved in claiming copyrights) = mandatory, desirable, not important
- Redistribution conditions = same than granted (i.e. Share Alike) or not
- Derivative work = allowed or not
- Commercial re-use = allowed or not; and if yes, to what conditions
- Any other relevant term

if no further conditions are looked for, existing CC license appears as the good choice; otherwise, specific ToUs should be developed

Technological features

Discussion on best available technology is considered meaningless for the scope of this document because several possibilities, equally working and with very similar costs, are already available but will rapidly change or evolve along with ongoing technological development.

However, quotations may be collected by the Secretariat to better understand the foreseeable extent of the effort required for developing and maintaining a system.

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