Marine migratory species

The importance of understanding the migratory routes of marine species for managing extractive sector impacts on biodiversity

Key messages

- For extractive activities taking place in the marine realm, data on marine migratory species is important to understand, mitigate and avoid biodiversity impacts.
- Many marine migratory species are classed as Vulnerable, Endangered or Critically Endangered in the Red List of Threatened Species, or listed in Appendices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and act as important indicators for the status and trends of marine ecosystems.
- Managing risks and impacts on marine migratory species can be a challenge for businesses operating in the marine environment due to the geographical and temporal changes as species move to different areas at different times for different purposes.
- While some regional and national data layers exist, there is currently no global layer mapping migratory routes and aggregating areas. This lack of consolidated data can create challenges for businesses trying to assess and manage their impacts and risks.
- Reviewing access to relevant national, regional and global datasets for the private sector could assist with the inclusion of these resources into screening processes in order to mitigate impacts on marine migratory species.

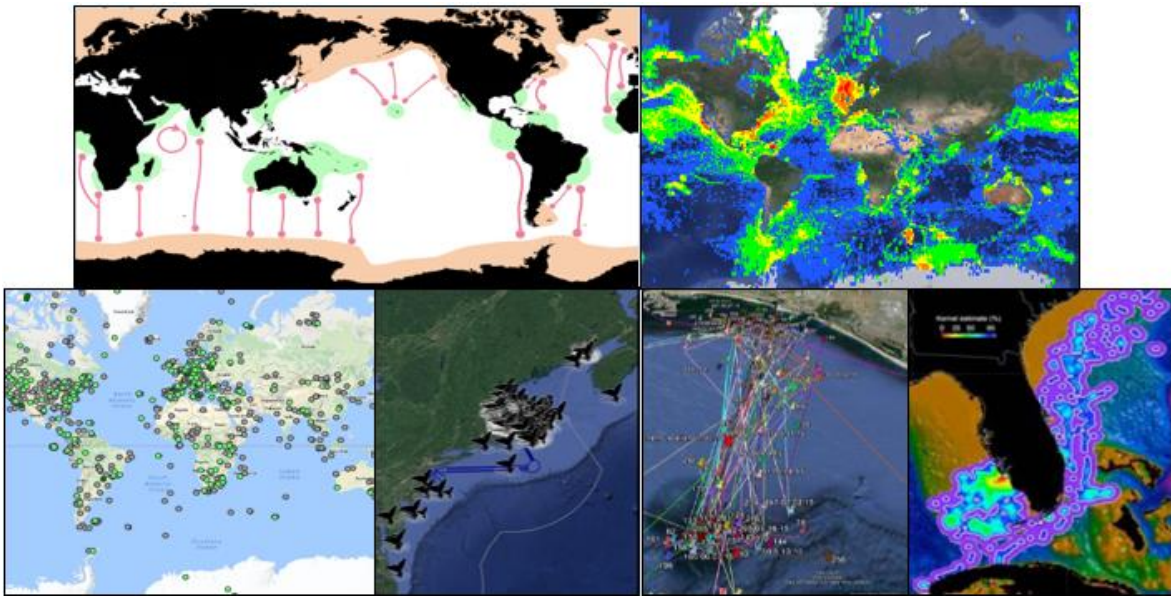

Figure 1: Examples of datasets showing the spatial distribution of migratory routes and breeding areas of specific marine species. Datasets include (clockwise): calving (shown in green) and feeding (shown in orange) grounds of Baleen whales (#8); spatially referenced observation data of marine megavertebrates (#15); movements of satellite tagged sharks in subtropical Atlantic (#30); satellite tracking of Pacific mammals (#29); observations of North Atlantic Right whales (#17); and satellite tagged migratory species shown at the global scale (#25). For more information on these datasets and more, please refer to **Annex 1**.

Introduction

Managing risks and impacts on marine migratory species can be a challenge for businesses operating in the marine environment. The environmental risk and impacts of operations on migratory marine species will change geographically and temporally as species move to different areas at different times for different purposes.

This briefing note explores the impacts and dependencies between the extractive industry and marine migratory species, as well as summarising the relevant existing data on these routes and aggregating areas.

Feasibility and challenges of filling data gaps are discussed as well as detailing next steps for Proteus Partners to access data.

Context

What is the importance of marine migration?

Many species of marine species undertake migrations as part of their life histories (Robinson et al 2009; Lascelles et al 2014). **Migrations typically take place between feeding / foraging and breeding grounds.** Some species are known to travel particularly long distances between their feeding and breeding grounds – for example, Green sea turtles travel over 2,200 km to return to their feeding areas off the coast of Brazil after breeding at Ascension Island in the middle of the Atlantic (Luschi et al 1998). Humpback whales have been recorded to travel 8,300km in less than one year, the greatest migration ever recorded in terms of distance (Rasmussen et al 2007).

Breeding areas encompass mating, spawning/calving and nursery grounds, which can be different to the habitats occupied by adult individuals. Such differences in habitat utilisation exist, for instance, in Thornback rays in the English Channel. The early life history stages (i.e. neonate and juveniles) of this species are found in shallower coastal waters, sheltered from strong tidal currents, and typically with softer sediments. This is in contrast to the habitats where young adults and older individuals are found (Martin et al 2012). In this context, **maintaining connectivity between these different habitats is of upmost importance** for migratory species survival (Crooks and Sanjayan, 2006).

Beyond connectivity issues, life cycle completion relies on **suitable habitat availability,** including during travel between different habitats. This is essential for the survival of marine migratory megavertebrates (i.e. large marine vertebrates), such as sharks, rays, sea turtles, and marine mammals. These species have typically low reproductive output (i.e. few offspring) due to late age of maturity, slow growth rates, and long lives. Many of these megavertebrates are classed as Vulnerable, Endangered or Critically Endangered in the Red List of Threatened Species (IUCN, 2018). A number are also listed in Appendices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS, 2018).

Marine migratory megavertebrates are **important indicators for the status and trends of marine ecosystems**, reflecting current environmental and community status. As such, they can be used as indicator species to indicate the presence of less easily detected species (Caro and O'Doherty, 1999; Branton and Richardson, 2010).

Although many fish populations have comparatively higher reproductive outputs compared to megavertebrates, their adult populations are under increasing fishing pressure. Almost a third (33.1%) of fish stocks were exploited at a biologically unsustainable level in 2015 (FAO, 2018). Hence it is important to **minimise pressure and impact on key habitats,** such as spawning areas, as they are essential components of their life cycles.

What are the threats to marine migratory species?

Migratory species face specific threats due to their migratory behaviour. Their mobile nature mean migratory species are potentially exposed to a wide array of threats across their range. Such threats include habitat destruction at key staging sites (resting and feeding areas), pollution, hunting and overexploitation at sites where they gather in large numbers (Lascelles et al 2014).

Extractive operations in the marine environment can have a number of potential impacts on migratory

species. These include direct habitat destruction, traffic collisions, pollution and noise and vibration impacts that can create non-physical barriers to migration routes (Avila et al 2018). This, coupled with the particular sensitivities of marine migratory species, is why it is important for businesses to understand and mitigate potential impacts on marine migration routes.

Global agenda

The global agenda for marine migratory species

The drivers to understand these impacts come from many sources, including legislation, standards and public perceptions. Box 1 lists the global frameworks relating to marine migratory species.

Box 1: Global framework supporting the conservation and protection of marine migratory species

International Finance Corporation Performance Standard 6 Critical Habitat Criterion 3, and to a lesser extent Criterion 1, are particularly relevant to screening processes in relation to migratory species.

The **Convention on the Conservation of Migratory Species of Wild Animals (CMS)** commits Parties to *"acknowledge the importance of migratory species being conserved and […] take action to this end whenever possible and appropriate" and "cover the whole of the range of the migratory species concerned".* The 2017 CMS **Manila Declaration on Sustainable Development and Migratory Species** (UNEP/CMS/Resolution 12.3) "*invites the private sector to engage in relevant dialogues with a view to finding common solutions and aligning policies and practices with the objectives of the Convention".*

The **United Nations Convention on the Law of the Sea** is convening an **Intergovernmental Conference on the conservation and use of marine biological diversity of areas beyond national jurisdiction** – including marine migratory species.

Sustainable Development Goals 14 'Life Below Water ', 13 'Climate Action' and 2 'Zero Hunger'.

Relevance to the extractives industry

Many migratory marine mammals (such as whales) are highly charismatic and well known by the public. Impacts on such species can lead to reputational risks for companies. Disruption of fish migratory routes can also have impacts on commercial and subsistence-based fishing communities.

Businesses may be required by national legislation and/or international lending standards (for example, the International Finance Corporation's Performance Standards) to accurately assess the impacts of their activities on the environment. Some of the criteria have specific requirements relating to the habitat of certain marine migratory species. The protection of migratory species is also being encouraged for inclusion in National Biodiversity Strategies and Action Plans (NBSAPs) as supported by the development of guidelines on the integration of migratory species into NBSAPs by the CMS Secretariat (CMS Secretariat and Prip, 2013).

For those companies that use the International Finance Corporation's Performance Standard 6 (IFC-PS6) (IFC, 2012) as a benchmark for biodiversity risk management, the spatial distribution of migration routes and breeding areas of marine species are particularly relevant to Critical Habitat Criterion 3, and to a lesser extent Criterion 1.

Migratory species conservation has been recognised and encouraged. For example, the targets of the CMS Strategic Plan for Migratory Species 2015-2023 (CMS Secretariat, 2014) have been developed in line with the Convention on Biological Diversity (CBD) Strategic Plan for Biodiversity 2011-2020 and Aichi Biodiversity Targets. Similarly, there has been recognition of migratory species linkages with Sustainable Development Goals (CMS Secretariat, 2017). These alignments highlight the importance of climate change and connectivity for migratory routes.

There are also changes to the legislative framework within which extractive industries may operate. The United Nations Conventions on the Law of the Sea (UNCLOS) is in the process of developing a new, international and legally binding instrument seeking to ensure the conservation and sustainable use of Biodiversity Beyond National Jurisdiction (United Nations, 2018). Although the text of the instrument has not yet been agreed, a new agreement may influence the minimum standards, scope, and content of

Environmental Impact Assessments, including the requirement for cross-sectoral activity assessments, Strategic Environmental Assessments, and consideration of transboundary impacts.

Assessment of transboundary impacts within Environmental Impact Assessments could cover activities occurring in Areas Beyond National Jurisdiction (ABNJ) that may have adverse transboundary impacts (CMS Secretariat, 2014) on coastal state Exclusive Economic Zones, and vice versa. Liability for transboundary impacts on ABNJ may change, even if businesses are operating solely within Exclusive Economic Zones.

Data availability

Data scoping

An initial review of data was carried out in 2017 as a desk-based scoping exercise. This identified 43 datasets, databases and data portals containing information on the spatial distribution of migratory routes and breeding areas of marine species (Annex 1). A summary list of biodiversity values represented across data resources is provided in Annex 2. Biodiversity values refer to specific species, habitats or ecosystems, and ecosystem services occurring at a project site that may be included in a biodiversity baseline study (Gullison et al 2015).

The scope of this review focuses on migratory species in the marine environment and does not include terrestrial species, such as migratory birds. Species covered were marine megavertebrates (due to their vulnerability and charismatic importance to the public) and fish (due to their value to fishing communities which could be affected by operations).

Although non-exhaustive, this review identified a multitude of datasets at the regional- and national scale relating to migratory routes, as well as a limited number of global-scale datasets. Although there are global layers showing modelled distribution (e.g. the IUCN Red List) there is currently no global layer compiling migratory routes for these species within their ranges.

However, the initiative by Duke University to develop the Migratory Connectivity in the Ocean (MICO) system (Marine Geospatial Ecology Lab, 2018) will provide an invaluable tool dedicated to marine migratory specific routes for seabirds, sea turtles, marine mammals, pelagic bony fish (e.g. tuna), and elasmobranchs (i.e. sharks and ray). MICO will display information on connectivity in terms of nodes (e.g. areas for feeding or breeding) and corridors (e.g. routes between nodes). Knowledge will be fed into global processes such as conservation in ABNJ, Ecologically and Biologically Significant Areas (EBSAs) and CMS multi-lateral agreements.

There is also mention of minimising impacts from deep sea mining through the development of strategic environmental plans under the International Seabed Authority. It is currently under review whether this resource will be available for screening purposes.

Data bias

There are a number of long-term, expansive mapping efforts, such as those focusing on whales (Dataset 17, 19 and 20 in Annex 1), sea turtles (Dataset 28 in Annex 1) and rays and sharks (Dataset 9 in Annex 1) However, this review recognizes a bias in terms of spatial and temporal availability of data. Datasets focus primarily on temperate regions in the Northern hemisphere, such as the North Atlantic Ocean and Mediterranean Sea. A temporal bias was identified to the last 10 years, although temporal ranges are unknown for one third of datasets. Such biases could be linked to improvements in technological development (e.g. drone surveying and tagging) and location of research bases (which are mainly in the Northern hemisphere).

Data limitations

This initial review has identified a number of challenges for using existing datasets for screening.

Resolution – The spatial extent of global-scale ranges of migratory species, such as those provided in the IUCN Red List, is typically very broad. The utility of datasets for screening purposes is limited, especially as it is not yet possible to identify which portion of the range (even if refined using highest occurrence probabilities) shows migratory or breeding behaviour. Global distribution patterns are lacking for marine mammals (compared to terrestrial species) and often use modelled data. Efforts have been taken to understand alignment of IUCN Red List distribution ranges with modelled distribution (O'Hara et al 2017). This showed overlap in

predictions but also highlighted instances of overestimation of species range. A global migratory routes map would therefore need to address such discrepancies between predicted and actual occurrence.

Lack of consolidation – There is a lack of consolidation of marine migratory routes with a large number of species-specific or location-specific efforts, but currently no global-scale layer consolidating all migratory species. Considerations should be given to resources available to identify and source existing regional and national-level datasets so as to create a global layer. Datasets are rarely available for download in a ready-for-use geographic format. The collation into one or more layers will not be straightforward from a scientific point of view due to contrasting methodologies used by the various datasets[1].

Licensing – Restrictions on commercial use of datasets are common. Access to data for screening purposes may be challenged by: i) lack of clarity of terms of use of datasets; ii) negotiations with data providers; and iii) costs incurring to projects in order to access datasets for commercial use.

Feasibility of a global layer

A feasibility assessment was carried out for each dataset identified in relation to the possible creation of a global layer for marine migratory species (Annex 2). This assessment is qualitative and expert-derived and takes into account ease of layer creation and relevance to high-level screening. Feasibility level does not take into account availability for commercial use at this stage.

A number of dataset types for advancing a global-scale data layer of migratory routes and breeding areas were considered, of which 10 were found to have high feasibility (see Annex 2).

Conclusion

The risks faced by marine migratory species are well documented and extractive companies are well aware of the importance of preserving critical habitat and species. The identification and avoidance of key migratory routes and aggregation areas is supported by a number of global frameworks and national and international legislation (Box 1). Consideration should therefore be given to maintaining connectivity between habitats for different life stages and preserving suitable habitat which serve as feeding or breeding sites to minimise pressure and impact.

A number of options were considered but only a few of these have high feasibility and therefore are viable in the near future (Annex 2).

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[1] See the following document for possible options to consider: http://proceedings.esri.com/library/userconf/proc15/papers/36_359.pdf

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The UN Environment World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organization. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.

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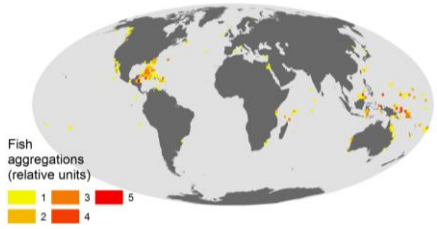
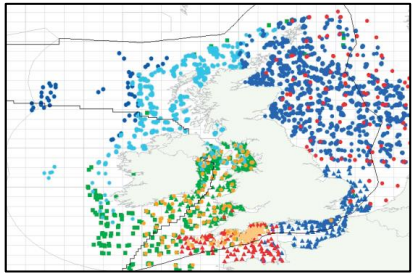
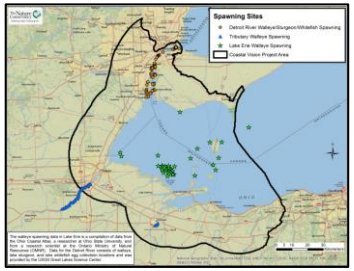
Marine migratory species: Annex 1

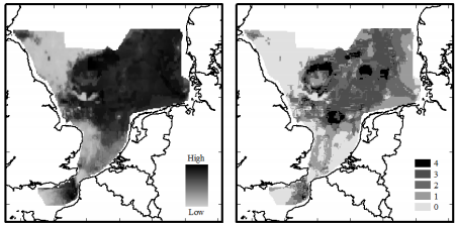
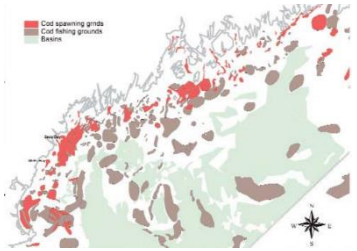
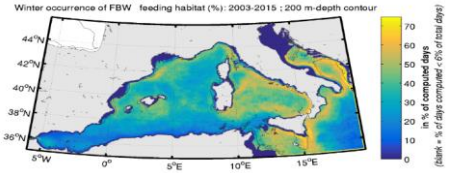
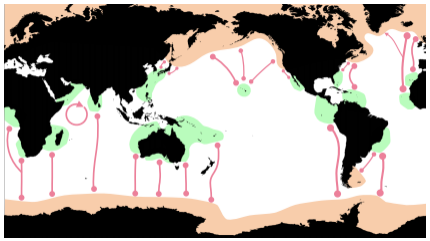
The importance of understanding migratory routes of marine species for mitigation of biodiversity impact by the extractives sector.

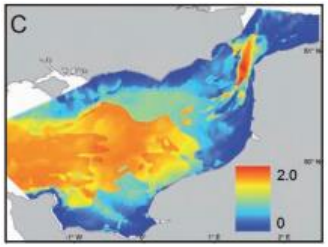
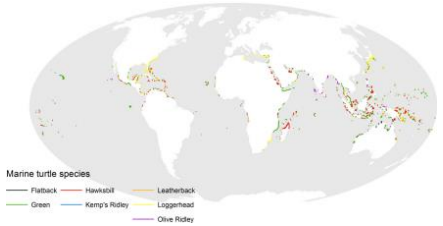
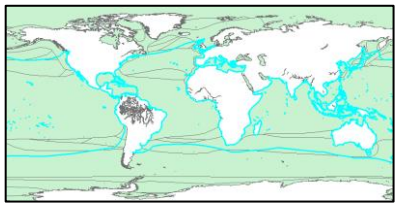
Annex 1: Non-exhaustive review of datasets, databases and data portals of relevance to creating global-scale data layer(s) showing the spatial distribution of migratory routes and breeding areas of marine species, in the context of high-level screening of biodiversity sensitivities by the corporate sector. Dataset categorisation' and 'Dataset ID' are from Weatherdon *et al.* (2015)[1].

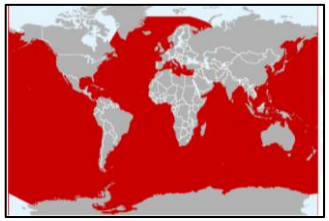
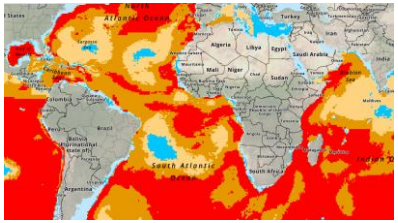
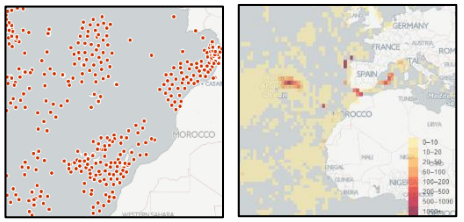
#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
Species habitat						
1	**SCRFA-001**	**SCRFA Fish Aggregation Database**	**Science and Conservation of Fish Aggregations (SCRFA)** http://www.scrfa.org/database/	2013 *Temporal range unknown*	This dataset contains key parameters describing the characteristics of fish aggregation including location, habitat, lunar and solar phase, fishing gear used, status, management and monitoring. Global-scale	

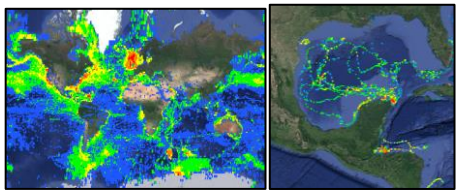
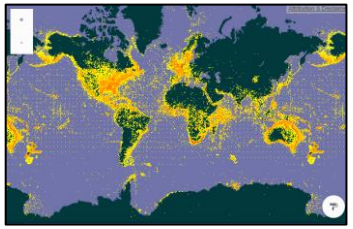
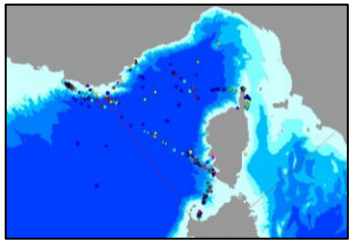
[1] Available at http://wcmc.io/MarineDataManual

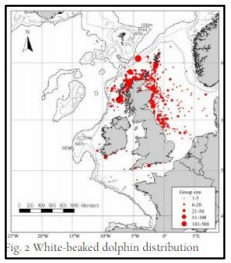
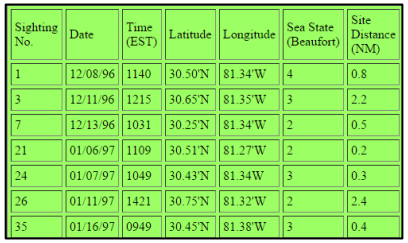
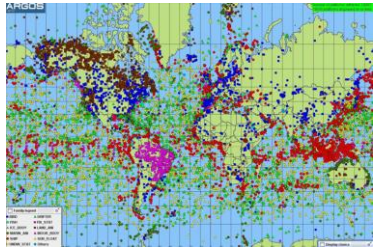
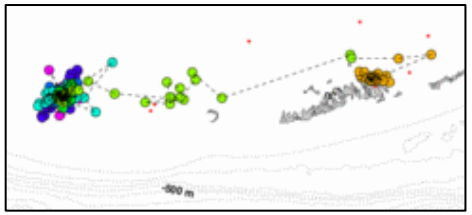
#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
2		**Spawning and nursery grounds of selected fish species in UK waters**	**Centre for Environment, Fisheries and Aquaculture Science (CEFAS)** and **Department for Environment, Food & Rural Affairs (DEFRA)** 2008: https://www.cefas.co.uk/media/52612/sensi_maps.pdf 2012: https://www.cefas.co.uk/publications/techrep/TechRep147.pdf	2008; 2012 *Species specific*	This dataset shows the nursey ground locations and spawning season for 22 fish species in the UK waters. National-scale	
3		**Forage Fish Spawning Maps Washington State**	**Washington Department of Fish and Wildlife** http://www.arcgis.com/home/item.html?id=19b8f74e2d41470cbd80b1af8dedd6b3	2014 *1991 – 2012*	This dataset shows the spawning grounds 1991 to 2012 for three species of fish in the Washington area: Sand lance; Surf smelt and Pacific herring. National-scale	
4		**Spawning Areas in Ohio**	**The Nature Conservancy** https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/wholesystems/greatlakes/coasts/wle/Documents/Walleye%20Spawning%20Areas.pdf	2015 *2011*	This dataset shows the spawning areas in Ohio. National-scale	

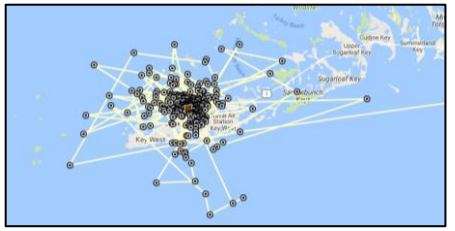
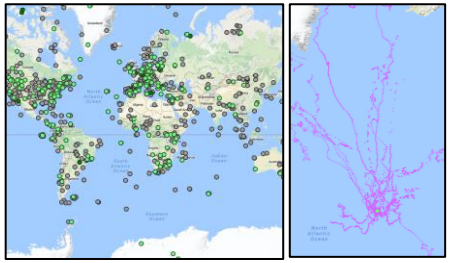
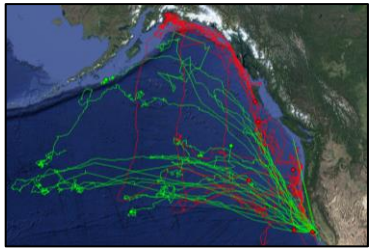
#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
5		**Delineating recurrent fish spawning habitats in the North Sea North Sea**	**Lelievre S, Vaz S, Martin CS, Loots C** (2014). Delineating recurrent fish spawning habitats in the North Sea. *Journal of Sea Research*, *91*, pp.1-14. http://archimer.ifremer.fr/doc/00185/29674/	2014 *Temporal range unknown*	This dataset shows the preferential recurrent fish spawning areas for four species of fish in the North Sea: dab; plaice; cod; and whiting. Regional-scale	
6		**Atlantic Cod stock structure in the Gulf of Maine**	**Ames EP** (2004). Atlantic cod stock structure in the Gulf of Maine. *Fisheries*, *29*(1), pp.10-28. http://www.penobscoteast.org/wp-content/uploads/ames_cod_paper.pdf	2004 *1920 – 2004*	This dataset shows the structure of the Gulf of Maine cod grouping by deriving the distribution, movements, and behaviour of population components from 1920s data and surveys of retired fishermen. National-scale	
7		**European FishReg: Fish Habitat**	**Joint Research Centre (JRC)** https://fishreg.jrc.ec.europa.eu/fish-habitat	2016 *Species specific*	This dataset shows the European feeding and breeding habitats (spatial and temporal) for: Atlantic Bluefin tuna; Fin whale; Hake; Yellow fin tuna; skipjack tuna; and small pelagic species, such as anchovy or sardine. Regional-scale	
8		**On modelling the macroecology of Baleen Whale migration**	**Watson J, Favetta B, Stock C** (2014). On Modeling the Macroecology of Baleen Whale Migration. *bioRxiv*, p.009753. http://biorxiv.org/content/early/2014/09/28/009753	2014 *Temporal range unknown*	This dataset shows the modelled location of baleen whale calving and feeding grounds around the world. Global-scale	

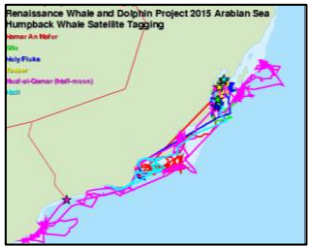
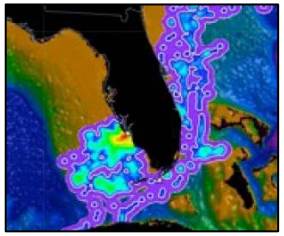
#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
9		**Modelled distribution of ten demersal elasmobranchs of the eastern English Channel in relation to the environment**	**Martin CS, Vaz S, Ellis JR, Lauria V, Coppin F, Carpentier A** (2012). Modelled distributions of ten demersal elasmobranchs of the eastern English Channel in relation to the environment. *Journal of Experimental Marine Biology and Ecology*, *418*, pp.91-103. http://doi.org/10.1016/j.jembe.2012.03.010	2012 *1991 – 2012*	This dataset shows the habitats of ten demersal elasmobranch taxa (five species of skate, four species of sharks and one species of stingray) in the eastern English Channel. Regional-scale	
10	**WCMC-007**	**Global distribution of Sea Turtle Nesting**	**UN Environment World Conservation Monitoring Centre (UNEP-WCMC)** WCMC.io/WCMC_007	1999 *Temporal range unknown*	This dataset shows the known locations of sea turtle nesting sites, for all seven species: hawksbill turtle, Kemp's ridley turtle, leatherback turtle, green turtle, loggerhead turtle, olive ridley turtle, and flatback turtle. Global-scale	
Species distribution						
11	**IUCN-001**	**Spatial Data for the Red List of Threatened Species**	***International Union for Conservation of Nature*** **(IUCN)** http://www.iucnredlist.org/technical-documents/spatial-data	Version 4. Updated biannually. *Species specific*	This dataset shows spatial data (polygons) for species assessed in the IUCN Red List of threatened Species (IUCN, 2016a), including details of seasonality. It does not contain specific geographic coordinates of actual occurrence. Global-scale	

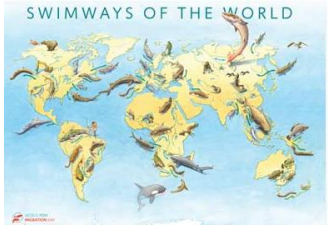
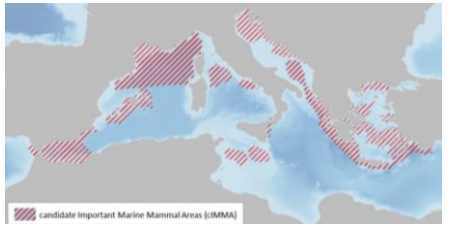
#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
12	**GROMS-001**	**Global Registry of Migratory Species (GROMS)**	**Global Registry of Migratory Species (GROMS)** http://www.groms.de/groms/databases.html **Convention of Migratory Species (CMS)** http://www.cms.int/en/species http://www.cms.int/reports/small_cetaceans/geographical%20grouping.htm	*Species specific*	This dataset shows the species-specific distribution maps and details of CMS-listed species and related daughter agreements, including: Mediterranean Monk Seal; Sharks; Western African Aquatic Mammals; Pacific Islands Cetaceans; Atlantic turtles; Dugongs; and Indian Ocean Sea turtles. Global-scale	
13	**Aquamaps -001, Kaschner-001, -002, -003, -004, -005, -006, -008, -009, -011 and -012**	**Aquamaps: Predicted Range Maps for Aquatic Species**	**FishBase** and **SealifeBase** http://www.aquamaps.org	2013	Standardized Distribution Maps for 17,300+ Marine Species. Via the Ocean Data Viewer (WCMC-039), it is possible to view the modelled global distribution ranges of 10 marine mammal species: Sperm whales; Sei whales; Bowhead whales; Northern Bottlenose whales; Melon-Headed whales; Grey seals; Hawaiian Monk seals; Northern Fur seals; Atlantic Spotted dolphins; Hector's dolphins. Global-scale	
14	**OBIS-003**	**Ocean Biogeographic Information System (OBIS)**	**Ocean Biogeographic Information System (OBIS)** http://www.iobis.org/	2016 *Species specific*	This dataset shows a 10-year, 80-nation collaboration of marine scientists working on new technologies that monitor and measure life within an emerging global ocean observing system. This dataset contains density and occurrence for more than 10,000 species. Global-scale	

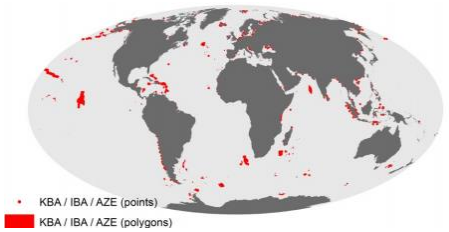
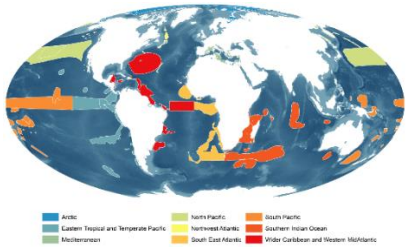
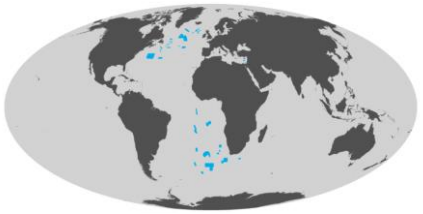
#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
15	OBIS-004	**OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations)**	**Ocean Biogeographic Information System (OBIS) and Duke University** http://seamap.env.duke.edu/	2016 *Species specific*	This dataset shows spatially referenced observation data of marine mammal, seabird, sea turtle, ray and shark from across the globe. This includes aversion of State of the World's Sea Turtles (SWOT) updated since Weatherdon *et al.* 2015 (dataset ID's SWOT-001, 002 and 003). Global-scale	
16	GBIF-001	**GBIF Species geo-referenced data**	**Global Biodiversity Information Facility (GBIF)** http://www.gbif.org/	2016 *Species specific*	This dataset shows global biodiversity occurrence data for many different species, with evidence for more than 1.6 million species collected over three centuries of natural history exploration and including current observations from citizen scientists, researchers and automated monitoring programmes. Global-scale	
17		**North Atlantic Right Whale Sighting Advisory System (SAS)**	**North Atlantic Right Whale Consortium and NOAA** http://www.nefsc.noaa.gov/psb/surveys/	2016 *1950 – 2016*	This dataset shows spatially referenced observation data of Right Whales since 1950's. Global-scale	
18		**REPCET system in the Mediterranean**	**REPCET (Real-time Plotting of Cetaceans)** http://www.repcet.com/	2014/15 *2012 – 2013*	This dataset shows spatially referenced observations recorded by ships between 2012-2013 for the Mediterranean. This app has the potential for expansion to the glboal scale Regional-scale	

#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
19		**UK and British Isles Sightings maps**	**Sea Watch Foundation** http://www.seawatchfoundation.org.uk/how-sightings-are-used/	2003 *1979 – 2003*	This dataset is comprised of more than 60,000 records (from >2000 observers) of spatially referenced observations of marine mammals. This is contributed to by ASCOBANS, DEFRA, JNCC and WWF. National-scale	
20		**Satellite Tagging Observation Program (STOP)**	**WhaleNet** http://whale.wheelock.edu/whalenet-stuff/stop_cover.html http://whale.wheelock.edu/whalenet-stuff/stop_cover_archive.html	2016 *1996 – 2016*	This dataset shows satellite tagging events of active and upcoming tags, as well as >170 archived tags, for a number of marine mammal species, including: Blue Whales; Right Whales; Sperm Whales; Harbour Porpoises; Elephant Seals; Gray Seals; Harbour Seals; Hooded Seals; and sea turtles. Global-scale	
21		**ARGOS marine animals tracking**	**ARGOS** http://www.argos-system.org/web/en/355-wildlife-monitoring.php	2016 *Temporal range unknown*	**This dataset shows** movements of **~1000 marine satellite tagged sea turtles** displaying migratory routes across the oceans. Data is provided by ARGOS in WGS84 coordinate system, updated on a daily basis. Global-scale	
22		**Sea Turtle Satellite Tracking and Analysis System (STAT)**	**SeaTurtle.org** http://www.seaturtle.org/tracking/index.shtml?archives=1	Present *2003 – 2016*	This dataset shows movements of **satellite tagged sea turtles, including:** >340 active tags of sea turtles; and >500 archive records (2003 – 2016). Data is provided by ARGOS in WGS84 coordinate system, updated on a daily basis. Global-scale	

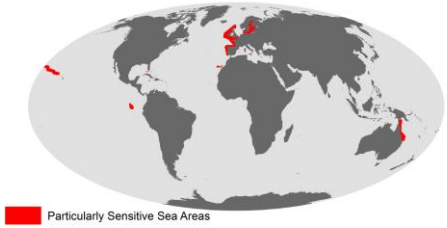
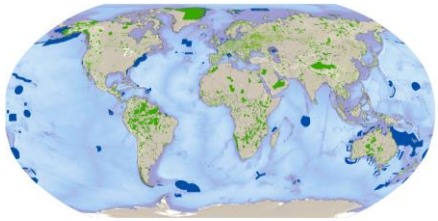
#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
23		**Sea Turtle Conservancy Sea Turtle Tracking**	**Sea Turtle Conservancy** http://www.conserveturtles.org/seaturtletracking.php	Present *Unknown – 2016*	This dataset shows movements of satellite tagged sea turtles, including 27 active tags of sea turtles and 319 archived records. Global-scale	
24		**Signals of Spring Marine Species datasets**	**Signals of Spring – sponsored by NASA and NOAA** http://www.signalsofspring.net/aces/maps_data_2008.cfm?user=visitor	2016 *2002 – 2016*	This dataset shows spatially referenced observations for a number of marine mammal species, including turtles, seals, and whales. Records date back to 2002 and show seasonality. Regional-scale	
25	**MovBnk-001**	**Movebank**	**Max Planck Institute for Ornithology, the North Carolina Museum of Natural Sciences, and the University of Konstanz** https://www.movebank.org/panel_embedded_movebank_webapp https://www.datarepository.movebank.org/browse?type=author	2016 *Species specific*	This dataset shows movements of **satellite tagged** for migratory species, including >60 data packages and >160 data files from >230 authors. Global-scale	
26	**TOPP-001**	**Tagging of Pelagic Predators**	**Global Tagging of Pelagic Predators (GTOPP)** http://www.topp.org/	2016 *Species specific*	This dataset shows movements of **satellite tagged pelagic predators including:** Pacific Blue Marlin; White/Salmon/Mako/Whale sharks; Atlantic/Pacific Bluefin tuna; Northern Elephant seals; and Leatherback turtles. Regional-scale	

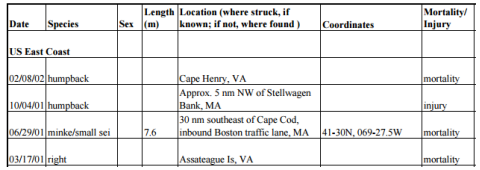
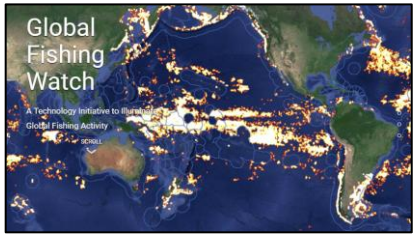
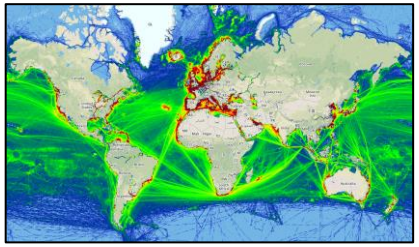
#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
27	SeaTur-001	**Wildlife Tracking**	**Wildlife Tracking – a service of SeaTurtle.org** http://www.wildlifetracking.org/	2016 *Species specific*	This dataset shows movements of **satellite tagged marine species from >300 projects for >100 species, including:** 150 sharks, 533 marine mammals, 3497 turtles. Data is provided from ARGOS. Global-scale	
28		**Trans-Atlantic Leatherback turtle tracking**	**Trans-Atlantic Leatherback Conservation Initiative (TALCIN)** http://www.conserveturtles.org/seaturtletracking.php?page=trackingprojects	2016 *1997 – 2016*	This dataset shows movements of >100 **satellite tagged** leatherback turtles collected from the collaboration of 13 international research teams. Regional-scale	
29		**Satellite tracking of Pacific mammals**	**Pacific Marine Mammal Centre** http://www.pacificmmc.org/satellite-tracking-1/	2016 *2013 – 2015*	This dataset shows movements of **satellite tagged marine mammals released from the** Pacific Marine Mammal Centre. Six-eight animals are tagged per year with a small sightings database of tagged individuals (~50 records). Regional-scale	
30		**Shark satellite tracking in subtropical Atlantic**	**University of Miami** http://sharkresearch.rsmas.miami.edu/education/virtual-learning/tracking-sharks	2016 *Species specific*	This dataset shows movements of **satellite tagged** sharks in subtropical Atlantic, including >120 individuals from 9 species, visualised in Google Earth. Regional-scale	

#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
31	UniDalh-001	**Ocean Tracking Network**	**Dalhousie University** http://oceantrackingnetwork.org/	2017 *Dataset specific*	This datasets shows electronic tags used to track over 100 keystone, commercially important, and endangered species in 20 countries and 16 ocean regions. This data would need to be filtered to identify migratory species. Global-scale	
32		**Swimways of the World**	**World Fish Migration Foundation: Swimway Project** http://www.worldfishmigrationfoundation.com/projects/4/swimway-project http://swimway.org/	2016 *2015 - 2016*	This dataset shows the migratory routes of fish species on a global scale. Note: This is available as a poster and not a downloadable dataset. Global-scale	
Areas of biodiversity importance						
33		**Important Marine Mammal Areas (IMMAs)**	**IUCN WCPA-SSC Joint Task Force on Marine Mammal Protected Areas (MMPATF)** http://www.marinemammalhabitat.org/first-imma-workshop-selects-41-candidate-immas-mediterranean	2016 *Temporal range unknown*	This dataset shows IMMA sites designated as such because of migration routes and/or breeding areas. Only the Mediterranean has been designated so far. Still to come in 2017/18: South Pacific; Northeast Indian Ocean; Northwest Indian Ocean; Southeast Pacific; waters of Australia-New Zealand and Oceania. Global-scale	

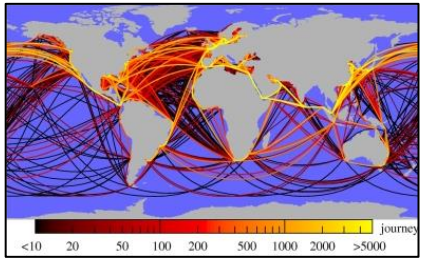
#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
34	**Birdlife-001**	**Key Biodiversity Areas (KBAs)**	***International Union for Conservation of Nature* (IUCN)** https://portals.iucn.org/union/sites/union/files/doc/a_global_standard_for_the_identification_of_key_biodiversity_areas_final_web.pdf	2016 *Temporal range unknown*	This dataset shows Key Biodiversity Areas (KBAs) which were included as Potential/Likely Critical Habitat in Martin *et al.* (2015), based on IFC (2012). This needs to be refined based on IUCN (2016a) by selecting sites triggering KBA Criteria A1[2] and D1/D3[3]. The mapping of Important Bird Areas (IBAs) has been completed. Global-scale	
35	**CBD-001**	**Global Distribution of Ecologically or Biologically Significant Marine Areas (EBSAs)**	**Secretariat of the Convention on Biological Diversity (CBD)** https://www.cbd.int/ebsa/	2015 *Temporal range unknown*	This dataset shows marine areas identified as EBSAs which provide important services to one or more species/populations of an ecosystem or to the ecosystem as a whole or otherwise meet the seven EBSA criteria. Global-scale	
36	**FAO-002**	**Global Distribution of Vulnerable Marine Ecosystems**	**Food and Agricultural Organisation of the United Nations (FAO)** http://www.fao.org/in-action/vulnerable-marine-ecosystems/background/vme-tools/en/#download_shapefiles	2015 *Temporal range unknown*	This dataset is shows the global distribution of Vulnerable Marine Ecosystems (VMEs) in relation to deep-sea fishing activities as delineated by five criteria. Global-scale	

[2] KBA Criterion A "Threatened Biodiversity", sub-criterion A1 "Threatened species".
[3] KBA Criterion D "Biological Processes", sub-criteria D1 "Demographic Aggregations", and D3. "Recruitment Sources".

#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
37	**IMO-001**	**Global Distribution of Particularly Sensitive Sea Areas**	**International Maritime Organisation (IMO)** http://pssa.imo.org http://www.maritimemaps.co.uk	2014 *Temporal range unknown*	This dataset shows the distribution of 13 Particularly Sensitive Sea Areas (PSSAs). PSSAs are intended to protect certain marine areas from damage by international maritime activities, such as shipping. Global-scale	
38	**WCMC-016**	**World Database on Protected Areas (WDPA)**	**United Nations Environment** and **the International Union for Conservation of Nature (IUCN);** managed by **UN Environment World Conservation Monitoring Centre (UNEP-WCMC).** http://WCMC.io/WDPA	2016 *Temporal range unknown*	The dataset shows the global distribution of terrestrial and marine protected areas as well as sites that do not meet the standard definition of a protected area but do achieve conservation in the long-term, generically referred to as other effective area-based conservation measures (OECMs). Global-scale	
Ecological status and impact						
39	**IWC-001**	**IWC Ship Strike Database**	**International Whaling Commission (IWC)** https://iwc.int/ship-strikes https://iwc.int/index.php?cID=872&cType=document	2010 *1870 – 2010*	This dataset is a global database showing collisions between vessels and whales (species, date, location), with each record verified by scientists. The information is used to build a better understanding of when, where and why collisions occur. Global-scale	

#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
40		**NOAA Ship Strike Database**	**National Oceanic and Atmospheric Association (NOAA)** http://www.nmfs.noaa.gov/pr/pdfs/shipstrike/lwssdata.pdf	2004 *1975 – 2002*	This dataset is a database based on a public request for information that NOAA Fisheries received for large whale ship strike records drawn from ship reports, marine mammal stranding reports, and NOAA Office of Law Enforcement reports. Regional-scale	
41		**Global Fishing Watch**	**Oceana, SkyTruth, Google and Leonardo Di Caprio Foundation** http://globalfishingwatch.org/	Real-time positions on a global scale.	This dataset analyses data from the Automatic Identification System (AIS), which is collected by satellites and terrestrial receivers, to identify apparent fishing behaviour based on the movement of vessels over time. Global-scale	
42		**Marine Traffic**	**MarineTraffic** http://www.marinetraffic.com	Real-time positions on a global scale.	This dataset provides the most comprehensive maritime database of marine traffic with more than 800 million vessel positions and 18 million vessel and port related events recorded monthly. Global-scale	

Date	Species	Sex	Length (m)	Location (where struck, if known; if not, where found)	Coordinates	Mortality/ Injury
US East Coast						
02/08/02	humpback			Cape Henry, VA		mortality
10/04/01	humpback			Approx. 5 nm NW of Stellwagen Bank, MA		injury
06/29/01	minke/small sei		7.6	30 nm southeast of Cape Cod, inbound Boston traffic lane, MA	41-30N, 069-27.5W	mortality
03/17/01	right			Assateague Is, VA		mortality

#	Dataset ID	Resource title	Organisation / Author(s) *link(s)*	Date published *temporal range*	Description	Screenshots of maps or datasets
43		**The complex network of global cargo ship movements**	**Kaluza P, Kölzsch A, Gastner MT, Blasius B** (2010). The complex network of global cargo ship movements. *Journal of the Royal Society Interface*, *7*(48), pp.1093-1103. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2880080/	2010 *2007*	This dataset shows the itineraries of 16,363 cargo ships during the year 2007 - constructing a network of links between ports. Global-scale	

Marine migratory species: Annex 2

The importance of understanding migratory routes of marine species for mitigation of biodiversity impact by the extractives sector.

Annex 2: Feasibility assessment of creating global-scale data layer(s) showing the spatial distribution of migration routes and breeding areas of marine species, in the context of high-level screening of biodiversity sensitivities by the corporate sector. Dataset categorisation is from Weatherdon et al. (2015). Dataset numbers (#) relate to those in **Annex 1** where further information on the datasets can be found. Feasibility level of data layer options (low, medium, high) is qualitative and expert-derived, and takes into account: ease of data access (i.e. data exist and/or can be readily accessed/collated), ease of layer creation (i.e. the underlying scientific rationale/justification is straightforward), and relevance to high-level screening. Feasibility level does not take into account availability for commercial use (see main text for details).

Dataset Category	Dataset type	Spatial scale	Suggested screening layer format	Comments, limitations	Relevant and/or example datasets	Feasibility level of data layer options
Species habitat	Fish spawning areas (observed)	Global	Layer showing spawning locations	Also shows feeding areas. Not available publicly at a fine scale (due to sensitivity around use by fishing fleets). Could be supplemented with spatio-temporal data on fishing fleets (#41) as proxy for fish aggregations (spawning/feeding)	#1	High
	Fish spawning and nursery areas (observed)	Regional and national	Layer showing spawning and/or nursery locations	Will be time-consuming to identify/source existing datasets	#2, #3, #4	Low
	Fish spawning areas (modelled)	Regional	Layer showing spawning locations with highest habitat suitabilities	Global-scale collation not straightforward (varying methodologies). Will be time-consuming to identify/source existing datasets	#5, #6, #7	Low
	Whale calving areas (observed) and associated migration routes (modelled)	Global	Layer showing calving locations and associated migration routes	Calving areas are broad-scale. Associated migration routes model the shortest path between calving and feeding regions	#8	High
	Nursery areas (modelled)	Regional	Layer showing nursery locations with highest habitat suitabilities	Global-scale collation not straightforward (varying methodologies). Will be time-consuming to identify/source existing datasets. Relevance higher for species listed in the Convention on Migratory Species' Appendix I & II[4], and for Critically Endangered / Endangered species (based on the Red List; IUCN, 2016b)	#9	Low

[4] CMS Appendix I 'Endangered migratory species' & II 'Migratory species conserved through Agreements'.

Dataset Category	Dataset type	Spatial scale	Suggested screening layer format	Comments, limitations	Relevant and/or example datasets	Feasibility level of data layer options
	Sea turtle nesting areas (observed)	Global	Layer showing nesting areas	Included as Potential/Likely Critical Habitat in Martin *et al.* (2015), based on IFC (2012) (IFC-PS6 Critical Habitat Criteria 1[5] & 3[6])	#10	High (demonstrated)
Species distribution	Expert-derived ranges	Global	Layer showing ranges of known migratory species	Ranges are too spatially broad for most marine species, and hence often unhelpful for screening. Relevance higher for species listed in the Convention on Migratory Species' Appendix I & II, and for Critically Endangered / Endangered species (based on the Red List; IUCN, 2016b)	#11, #12	Low
	Ranges (modelled)	Global	Layer showing locations with highest occurrence probabilities	Not possible to identify which portion of the range (even if refined using highest occurrence probabilities) shows migratory or breeding behaviour. Relevance higher for species listed in the Convention on Migratory Species' Appendix I & II[4], and for Critically Endangered / Endangered species (based on the Red List; IUCN, 2016b)	#13	Low
	In situ observation (point locations)	Global, regional, national	*To be determined*	Challenge of identifying/mapping migratory/breeding behaviour and important areas for these. Age information might be available in some cases. Issues with species misidentification unless collected by taxonomic experts	#14, #15, #16, #17, #18, #19, #29, #31, #32	Low
	Remotely-sensed observation (via satellite-linked tags or acoustic tags)	Global, regional, national	*To be determined*	Challenge of identifying/mapping important areas (e.g. consistently used migration routes/corridors vs. ad-hoc movements related to feeding), as well as highlighting seasonality. Will be time-consuming to identify/source existing datasets	#14, #15, #16, #17, #20, #21, #22, #23, #24, #25, #26, #27, #28, #29, #30, #31, #32	Low
Area of biodiversity importance	Important Marine Mammal Areas (IMMAs)	Global	Layer showing sites designated as such because of migration routes and/or breeding areas	IMMA sub-Criteria Ci/Ciii[7] (IUCN-MMPATF, 2016). Only one mapping workshop has taken place to date (in the Mediterranean), with more to take place in years to come. For each site, scientific justifications for the triggered criteria are recorded in a standard form ("pro-format")	#33	High (pending all IMMAs have been mapped)

[5] IFC-PS6 Critical Habitat Criterion 1 "Habitat of significant importance to Critically Endangered and/or Endangered species".
[6] IFC-PS6 Critical Habitat Criterion 3 "Habitat supporting globally significant concentrations of migratory species and/or congregatory species".
[7] IMMA Criterion C "Key Life Cycle Activities", sub-criteria Ci "Reproductive Areas", and Ciii "Migration Routes".

Dataset Category	Dataset type	Spatial scale	Suggested screening layer format	Comments, limitations	Relevant and/or example datasets	Feasibility level of data layer options
	Key Biodiversity Areas (KBAs)	Global	Layer showing sites designated as such because of migration routes and/or breeding areas	Included as Potential/Likely Critical Habitat in Martin *et al.* (2015), based on IFC (2012). Needs to be refined based on IUCN (2016a) by selecting sites triggering KBA Criteria A1[8] and D1/D3[9]. The mapping of Important Bird Areas has been completed	#34	High (demonstrated, with scope for refinement)
	Ecologically or Biologically Sensitive marine Areas (EBSAs)	Global	Layer showing sites *identified* as such because of migration routes and/or breeding areas	EBSA Criteria 2[10]/3[11]/5[12] (CBD Secretariat, 2008). For each site, full scientific justifications for the triggered criteria are available on the EBSA repository[13]	#35	High
	Vulnerable Marine Ecosystems (VMEs)	Global	Layer showing sites designated as such because of migration routes and/or breeding areas	VME Criteria i[14]/ii[15] (note that Criterion iv[16] is relevant to many megavertebrate migratory species – see footnote) (FAO, 2009). Note that triggered Criteria are not readily available for each site	#36	High
	Particularly Sensitive Sea Areas (PSSAs)	Global	Layer showing sites designated as such because of migration routes or breeding areas	PSSA Criteria "Spawning or Breeding Grounds"[17] (IMO, 2006) and/or relevant scientific justification given in official submissions to the Marine Environment Protection Committee of the International Maritime Organization	#37	High
	Protected Areas	Global	Layer showing sites designated as such because of migration routes and/or breeding areas	Sites mentioning migration routes and/or breeding areas in their management plan. Alternatively, automated selection of sites based on a list of relevant keywords	#38	High

[8] KBA Criterion A "Threatened Biodiversity", sub-criterion A1 "Threatened species".
[9] KBA Criterion D "Biological Processes", sub-criteria D1 "Demographic Aggregations", and D3. "Recruitment Sources".
[10] EBSA Criterion 2 "Special importance for life history stages of species".
[11] EBSA Criterion 3 "Importance for threatened, endangered or declining species and/or habitats".
[12] EBSA Criterion 5 "Biological productivity".
[13] https://www.cbd.int/ebsa
[14] VME Criterion i "Uniqueness or rarity; […] habitats of rare, threatened or endangered species that occur only in discrete areas; or nurseries or discrete feeding, breeding, or spawning areas".
[15] VME Criterion ii "Functional significance of the habitat – discrete areas or habitats that are necessary for the survival, function, spawning/reproduction or recovery of fish stocks, particular life history stages (e.g. nursery grounds or rearing areas), or of rare, threatened or endangered marine species".
[16] VME Criterion iv "Life-history traits of component species that make recovery difficult – ecosystems that are characterized by populations or assemblages of species with one or more of the following characteristics: slow growth rates; late age of maturity; low or unpredictable recruitment; or long-lived" (these are characteristics of many megavertebrate species).
[17] PSSA Ecological Criteria "Spawning or breeding grounds"

Dataset Category	Dataset type	Spatial scale	Suggested screening layer format	Comments, limitations	Relevant and/or example datasets	Feasibility level of data layer options
Ecological status and impact	*In situ* observation (point locations)	Global	Layer showing locations of ship strikes between vessels and migratory species.	Concentration is placed mainly on cetacean species (whales and dolphins) therefore not representative of smaller migratory species. Not all point locations have exact species and/or exact location.	#39, #40	High
Administration	Mitigation measures for ship strikes/ collisions	Global	Layer showing locations of mitigation measures related to the presence of migration routes and/or breeding areas	Spatial information on these measures would need to be sourced from official publications, mapped and collated in a global layer. These locations are limited in terms of the geographic coverage and number of species covered (and countries that have implemented measures. The information could be supplemented by spatial data on ship strikes/collisions (#39, #40) as proxy for the locations of impacted animals. Further, the usefulness of using maritime traffic intensity (#41, #42, #43) as proxy for the locations of vessels could be explored.	*To be created*	Medium (exploratory stage)

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