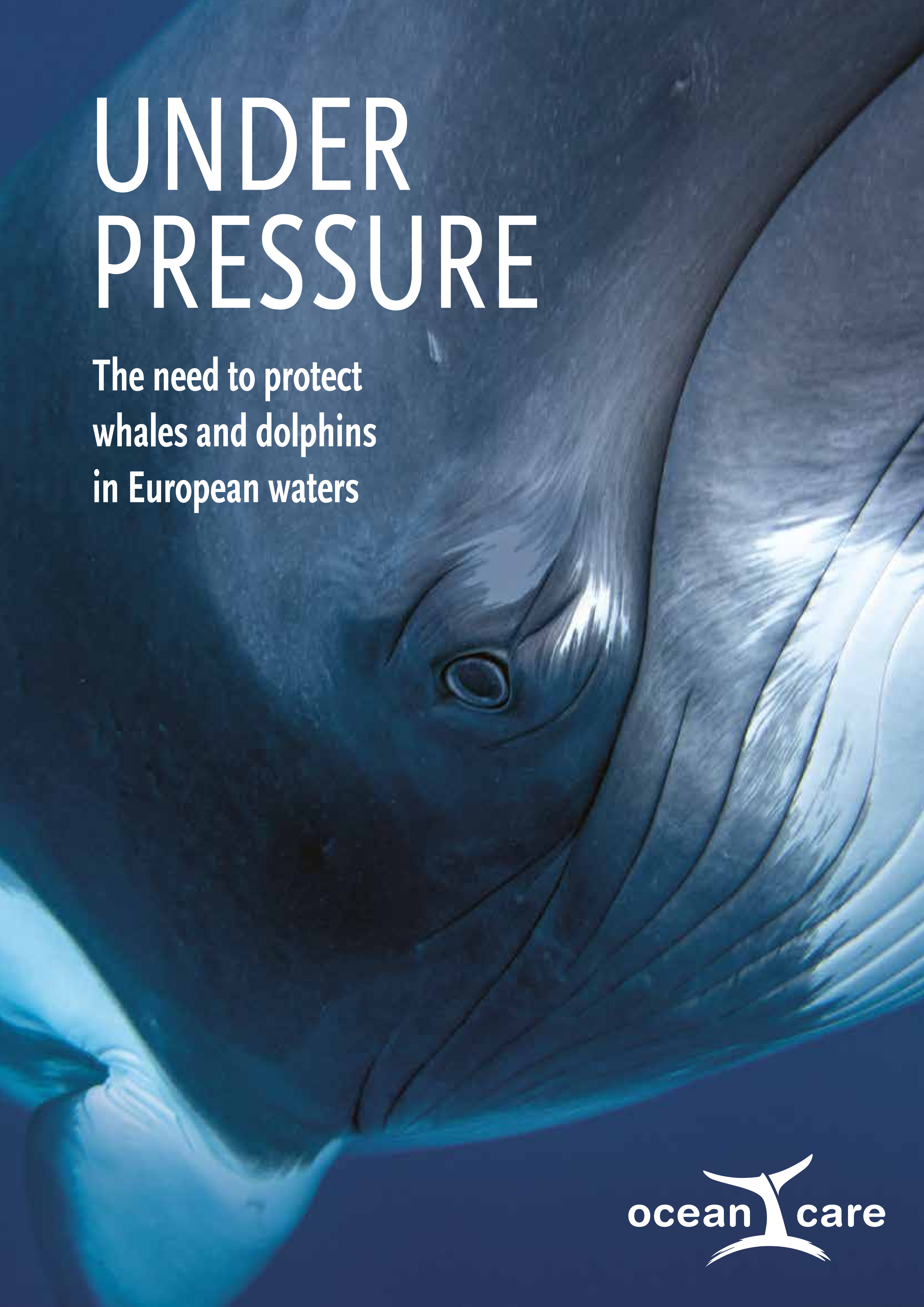
UNDER PRESSURE

The need to protect whales and dolphins in European waters



ocean care

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The need to protect whales and dolphins in European waters

April 2021
An OceanCare report.

ISBN 978-3-033-08516-9

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Cover image: © gettyimages
Design: Roman Richter

Suggested citation:
OceanCare (2021) Under Pressure: The need to protect whales and dolphins in European waters. An OceanCare report.

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OceanCare has been committed to marine wildlife protection since 1989. Through research and conservation projects, campaigns, environmental education, and involvement in a range of important international committees, OceanCare undertakes concrete steps to improve the situation for wildlife in the world's oceans.

OceanCare holds Special Consultative Status with the Economic and Social Council of the United Nations (ECOSOC) and is a partner of the General Fisheries Commission for the Mediterranean (GFCM), the Convention on Migratory Species (CMS), and the UNEP/CMS Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS), as well as UNEP/MAP. OceanCare is accredited observer at the Convention on Biological Diversity (CBD). OceanCare has also been accredited as a Major Group to the United Nations Environment Assembly (UNEA), which is the governing body of UNEP and is a part of the UNEP Global Partnership on Marine Litter.

OceanCare has been an observer at the IWC since 1992.

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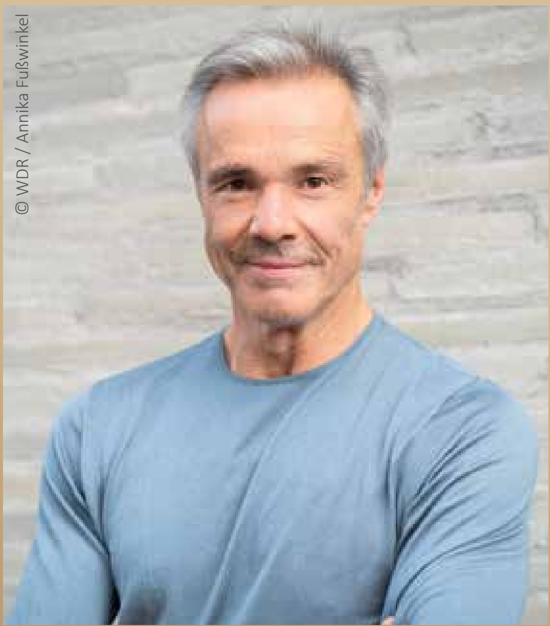
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Cetaceans. Known as whales, dolphins and porpoises. Powerful, majestic, source of our inspiration and symbol of freedom.

Very few animals attract us and stimulate our imagination as strongly as these fascinating marine mammals that also serve as ambassadors of our oceans. I myself had the honour and pleasure to film and experience whales and dolphins in the wild. It's stunning, it's amazing, it's breathtaking.

When confronted with disturbing images of dolphins and porpoises entangled in fishing gear, with stranded and hunted whales, many of us think about regions far away from Europe. But, sadly, that's wrong. It's happening right here in European waters, seemingly invisible to us, but waiting to be exposed.

This report intends to do exactly what needs to be done. It’s a fact and science based exposure, a call to action. Each chapter paints an overall image that is disturbing. The Mediterranean Sea is among the most polluted seas in the world. Thousands of small whales, dolphins and porpoises are being killed in European waters. Norway is the world’s commercial whaling nation number one. Unbearable noise blasts through almost all waters during the continuing search for new oil and gas drilling sites, another activity which should have been stopped a long time ago. The harbour porpoise in the Baltic Sea, the orca in the Strait of Gibraltar and the common dolphin in the Gulf of Corinth are all critically endangered. This OceanCare report illustrates that conservation mostly happens on paper, not in practice. It provides a way forward on how EU Member States and other European States can scale up actions to truly protect the unique and rich biodiversity of these waters.

Thank you, OceanCare, for this report. It is a crucially important document with strong evidence and profound information. It’s an urgent call on decision makers in Europe: we, the people, expect to see whales, dolphins and porpoises, and their homes, fully and effectively protected.

I wish OceanCare great success with their efforts and I’m proud to be able to support their campaign.

Sincerely yours,

Hannes Jaenicke
Actor, documentary filmmaker, environmentalist

Opinion Piece: On the Conservation of European Cetaceans and Life at Sea

Giovanni Bearzi, *Dolphin Biology and Conservation, Italy*

A commitment to "cetacean conservation" carries the basic assumption that it is *possible* to conserve cetaceans. As the assumption goes, conservation can be achieved by eliminating (or at least mitigating) the threats resulting in population decline and displacement, as well as those causing damage to individual animals. When it comes to direct mortality generated by whaling and other deliberate takes, conservation strategies turn out to be relatively straightforward: all that really needs to be done is reducing the killings. If those killings stop, most cetacean populations should be able to recover and be spared from eradication.

Cetacean conservation, however, becomes a much more challenging and ambitious task when the threats originate from widespread human encroachment and consumption patterns. The question then is: can the well-meaning scientists and managers protect whales and dolphins from human impacts that tend to be global and pervasive? And more importantly: *how* can cetaceans be effectively protected from calamities such as the widespread loss of marine biodiversity caused by intensive fishing, ever-increasing ship traffic, anthropogenic noise and other forms of pollution, or the changes resulting from ocean warming and acidification?

In these cases, cetacean conservation blurs into the much wider objective of influencing and reshaping human behaviour. Maintaining a focus on cetaceans while addressing the deeply rooted and complex human dynamics that ultimately endanger these animals is, indeed, a daunting task. We simply cannot deal effectively with a crisis unless we confront the economic, social and political reality that generated it. As they enter such a territory, conservation practitioners must be willing to approach new disciplines, liaise with other experts (for instance, environmental lawyers), and explore new and more effective communication and outreach strategies (Bearzi, 2020).

Because complexity is inherently hard to tackle, many are tempted to give precedence to the most obvious and discernible offences. Direct and tangible threats to cetaceans are easier to document and communicate, as compared to pervasive threats resulting from convoluted webs of ecosystem-level dynamics. For instance, if some whales become stranded with plastic bags in their stomach, or carry wounds caused by ship propellers, they may attract scientific interest and get the occasional press coverage. By contrast, threats that are more subtle and indirect in nature are often overlooked, or dismissed altogether—even when they affect entire populations.

One glaring example is the over-exploitation of marine life caused by intensive fishing, which combines with the damage inflicted by "ghost" nets and destructive fishing gear. Indiscriminate fishing is known to cause major changes to marine ecosystems, resulting in dramatic alterations of marine food webs. When food webs are "fished down", top predators are often the first to be affected—either because fisheries target them directly, or because overfishing depletes their prey resources. When cetaceans are forced to live in waters impoverished by fishing, within areas where their prey has been depleted, the scientists may not find direct evidence of cetacean mortality: whale and dolphin populations will simply move away, or else stay, devote more time and effort to foraging, and reproduce less effectively. With time, the least resilient cetacean species will fade away, sometimes to be replaced by more opportunistic and flexible ones—with net losses in terms of diversity.

Preserving ecosystem health and ensuring that whales and dolphins persist and thrive within reasonably pristine habitats is the most fundamental management goal. Historically, however, the practice of cetacean conservation has been driven by a desire to spare whale populations from over-hunting, and at times by a longing to protect individual animals and improve their welfare. Let's be clear on one point: efforts to reduce the direct mortality of cetaceans and improve their welfare certainly have value, and they must be supported. And yet, in our globalized world, we have become painfully aware that cetacean conservation can fail miserably if the larger scenario is overlooked. Pretending to protect cetaceans while neglecting their habitat and their prey does not represent a far-reaching conservation strategy.

Marine Protected Areas (MPAs) make superb conservation tools, and have the potential of sparing some trouble to whales and dolphins occurring within their range (Hoyt, this Report). Regrettably, in European waters these areas often turn out to be paper parks that provide little protection. A recent article (Dureuil *et al*., 2018) has shown that human impact, and fishing in particular, may increase within European MPAs. All too often, management action within protected areas may be farcical, to the point of banning windsurfing while allowing bottom trawling and high-intensity noise from oil and gas prospection. And in many cases, the surface covered by MPAs is so small that they hardly make a difference to wide-ranging whales and dolphins. For instance, only 6% of the Mediterranean Sea is currently protected, and a mere 0.2% benefits from truly meaningful protection (Claudet *et al*., 2020). Robust marine conservation targets are clearly far-off.

The case of the Adriatic Sea is particularly instructive. It is one of the most intensively trawled areas, worldwide. For decades, it has been exposed to over-exploitation and destructive fishing practices that have combined with the effects of climate warming, pollution, geoseismic prospecting, maritime traffic, and a variety of other human impacts. Fish communities have suffered sharp declines (for instance, elasmobranchs have declined by more than 90%; Ferretti *et al*., 2013), and the once-abundant common dolphins *Delphinus delphis* have nearly vanished (Bearzi *et al*., 2004). The loss of biodiversity has been exacerbated by the mechanical and biological damage to the seabed caused by destructive fishing methods (primarily beam trawls, otter trawls, and hydraulic dredges), known to cause dramatic alterations of the seabed and reduce the biomass and biodiversity of benthic ecosystems. In the overexploited northern and central portions of the Adriatic only bottlenose dolphins *Tursiops truncatus* persist. The persistence of bottlenose dolphins, however, is no reason for complacency, as the overall scenario clearly has shifted from a pristine "sea of plenty" to a highly degraded and fished-down ecosystem where only the sturdy stands the ghost of a survival chance.

Protecting bottlenose dolphins (and whatever fauna has managed to persist within areas devastated by human impact) makes a worthwhile management objective. However, preserving these animals should not mean losing sight of true environmental recovery. Emphasis on the most proximate threats to cetaceans is good—but it shouldn't divert attention from the most ubiquitous and pervasive basin-wide offences. In the Adriatic and other dismal European scenarios, transitioning to a respectful and sustainable use of marine resources is bound to be difficult. And yet it is not impossible, as long as we keep our collective focus on management action leading to a real improvement of environmental conditions, which must include a serious reduction of destructive human impacts.

Sadly, our environmental baselines and perceptions continue to shift towards ever more impoverished oceans (Pauly, 2019). As a consequence, we may end up considering as healthy (or "least concern", in the IUCN Red List terminology) those cetacean populations that have merely not declined across the past several decades—as if a human life span makes a meaningful conservation baseline. We must counter this "shifting baselines syndrome" and commit to rewilding our seas by restoring environmental quality and richness, so that cetaceans won't be merely allowed to survive, within waters hosting a smidgen of the life they used to host just a few generations ago.

This Report, produced by OceanCare in partnership with cetacean science and conservation authorities, is inspired by the above-mentioned credo that it is, indeed, possible to protect cetaceans while also preserving their habitat. Such an ambitious task must rest upon a rigorous use of the available science, as well as multi-disciplinary efforts, appropriate lobbying and strategic media campaigns.

As a whole, the Report shows that the main threats to cetacean populations in European waters have been documented rather compellingly, and conducting more research is no longer the highest priority. The highest priority is, instead, implementing and enforcing the conservation actions outlined in a plethora of scientific articles and management plans. The Report recalls that European whales and dolphins have long been the target of conservation agreements, but precious few concrete actions were taken. The remarkable information presented here will make stakeholders, politicians and anyone who cares aware of past management failures, and better informed on the actions that desperately need to be taken.

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Executive Summary

© Dolphin Biology and Conservation

Many of the cetaceans (whales, dolphins and porpoises) living in European waters[1] are facing an uncertain future, despite being included in a wealth of international agreements, conventions and regulations which should be providing them with adequate protection. Indeed, cetaceans are, in theory, among the most protected wildlife in Europe but the reality is that they are facing many challenges, both as individuals, when all too often their health and welfare is being adversely impacted, and also as populations.

OceanCare's "UNDER PRESSURE. The need to protect whales and dolphins in European waters" report brings together leading experts on key issues and builds on robust scientific knowledge to provide governments, conventions, international fora, Multilateral Environmental Agreements (MEAs) and decision-makers with the information and recommendations needed to further the protection of cetaceans.

Firstly, this report provides an up-to-date assessment of the status of the 33 cetacean species regularly occurring in European waters. Secondly, it considers the various threats that they are facing and their legal standing. The expert reviews show that:

- European waters are home to a wide diversity of cetacean species, including the largest animals ever to have lived on Earth (the blue whale, *Balaenoptera musculus*, and the fin whale, *Balaenoptera physalus*), the deepest diving whales (the sperm whale, *Physeter macrocephalus*, and several beaked whale species), wide-ranging species that live in the open oceans, and populations found in discrete ranges nearshore. This diversity of species and habitats implies that, while some threats affect many of them, no single conservation regime will fit all and conservation efforts have to take into account the biology and needs of each population, as well as local circumstances.

- Some populations of European cetaceans need to have their conservation status updated and others still need to be assessed for the first time. As scientists have become aware of new distinct populations, all too often it has simultaneously become apparent that these populations are threatened. This has been the case, for example, with the orca (*Orcinus orca*) population in the Strait of Gibraltar, which was recently recognised as a discrete entity and immediately designated as Critically Endangered.

- Despite recognising the threats facing cetaceans, some northern European countries still hunt these marine mammals for reasons that are clearly commercial, or in the context of "subsistence" hunting. Surprisingly high numbers of animals are killed: over 50,000 whales, dolphins and porpoises were killed by Greenland, Iceland, Norway and the Faroe Islands between 2010 and 2020. These takes substantially undermine the conservation initiatives undertaken by other European countries, and, in the case of Norway, defy the global moratorium on commercial whaling. More often than not, hunting does not take into consideration that targeted species are facing a number of other threats, and that direct takes may expose some populations to unnecessary and unsustainable pressure. Beyond the killing and removal of individuals, such hunts can also negatively impact the welfare, reproductive potential and social organisation of the populations that the animals are taken from.

- Bycatch (the incidental capture of cetaceans in fishing operations) is highlighted as an extremely serious threat, with thousands of cetaceans dying in both legal and illegal fishing nets throughout European waters each year. Activities aimed at reducing or ending bycatch are not fully developed or implemented across Europe. Advice from the International Council for the Exploration of the Sea (ICES) regarding fisheries closures and the use of acoustic deterrent devices needs to be closely followed to attempt to reduce bycatch of populations at particular risk such as the harbour porpoise (*Phocoena phocoena*) in the Baltic Sea. It is imperative that bycatch is monitored and that concerted actions are taken immediately to end it. Entanglement of cetaceans is also a significant welfare issue, with some of the largest cetaceans, for example, capable of dragging fishing gear away and then being subject to a very slow and painful death. The removal of ghost nets and the prevention of illegal drift net fishing are high priorities.

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[1] The term "European waters" is used here to include the marine territories of the states that belong to the European Union and those European nations that do not belong to the European Union.

- Other significant threats that are reviewed by experts in this report include noise, chemical and plastic pollution, ocean warming and ocean acidification. All of these require action including, for example, banning oil and gas exploration activities, limiting ship speeds, ensuring the safe disposal of chemical pollutants, preventing plastics from entering the marine environment and reducing our consumption of fossil fuels.

- This report also covers the current legal protection of cetaceans, including in European Union legislation such as the Habitats Directive and the Marine Strategy Framework Directive (MSFD), as well as international and regional conventions which seek to tackle bycatch, illegal hunting and trade, with the aim of ensuring a good environmental status. These regulations include two regional agreements focused exclusively on cetaceans, i.e. ASCOBANS (to protect small cetaceans in the North and Baltic Seas) and ACCOBAMS (protecting all cetaceans in the Mediterranean, Black Sea and adjacent waters). The various chapters focused on specific threats also detail some of the relevant transnational legal approaches in place[2].

- The benefits of Marine Protected Areas (MPAs) for cetacean conservation are also emphasized, including the importance of carefully choosing such sites to genuinely protect species and habitats. However, within Europe, countries have differed in their approaches to establishing MPAs and cetaceans are sometimes still not sufficiently protected even within the areas designated for them.

- One chapter highlights that valuable information regarding cetacean health can be derived from stranded animals, e.g. based on the assessment of pathogens and chemical pollutants. It is essential that all countries have well-managed stranding networks which allow for postmortems to be carried out following established protocols. Stranding networks are also useful for gathering data relating to bycatch in fishing gear.

- Whale and dolphin watching has been promoted as a way of encouraging countries to value their cetacean populations, as opposed to hunting them. One of the chapters in this report focuses on the pros and cons of this form of nature tourism. In some areas, failure to regulate the whale watching industry has put certain cetacean populations at risk from increased disturbance and boat traffic, which can negatively affect cetacean behaviour and, sometimes, results in displacement. Whale and dolphin watching should also incorporate education, science and conservation components.

- Europe's whales, dolphins and porpoises are heavily exposed to chronic and acute noise pollution emanating from shipping, construction, oil and gas exploration, naval activities and other sources, and this can have physical and behavioural impacts on them. In some cases, noise has resulted in mass mortality of cetaceans.

- Chemical pollutants can suppress cetacean immune systems, making them more vulnerable to infectious diseases, and can also negatively impact their reproduction. Although some chemical pollutants in Europe have declined or are declining, polychlorinated biphenyls (PCBs) are still found at very high levels in some cetacean populations, and new toxic compounds are taking the place of banned contaminants.

- The Mediterranean Sea and parts of the Greenland and Barents Seas are hotspots for plastic debris, including macro and microplastics. The Mediterranean Sea has been identified as a "great accumulation zone of plastic debris" where the average density of plastic is comparable to that described for the five other marine gyres, with a high ratio of microplastic abundance to plankton abundance. Cetaceans that ingest or become entangled in plastic debris may suffer long-term negative impacts or succumb to injuries. Reducing the amount of plastic debris in European waters as well as removing ghost nets and other discarded fishing gear can contribute to cetacean conservation.

- Climate breakdown is an extremely challenging threat for all marine diversity including cetaceans. The final part of this report focuses on how raising ocean temperatures and the related issue of ocean acidification are affecting cetaceans in European waters. Direct impacts include thermal stress, while indirect impacts concern changes

[2] As a disclaimer, we note that a review of all the existing legislation of European states was not within the scope of this report.

in prey availability or distribution. Climate change has the potential to affect migration patterns and seasonality of breeding, while also increasing the occurrence of epizootics. While some species may be able to adapt, for example by changing their distribution, others may not. Subpopulations of cetaceans living in enclosed basins such as the Black Sea may be at higher risk. The phasing out of hydrocarbon exploration projects would not only help tackle climate change, but also eliminate one of the most severe sources of man-made noise in European waters.

Through the lens of expert opinions, the report shows that European cetaceans occur in habitats that are far from pristine. They are exposed to multiple stressors with potentially synergistic effects.

Despite cetaceans being the focus of extensive and progressive legal frameworks and being among the most protected wildlife "on paper", the report clearly reveals the need to take urgent actions, exposing many severe risks that could cause further deterioration to whale, dolphin and porpoise populations. Coordination, implementation and enforcement of existing legislation and conservation provisions are challenges which need to be addressed immediately. This leads to the conclusion that we have to act in a swifter, more precautionary and more joined-up manner if we want to conserve Europe's cetaceans whilst simultaneously protecting their health and welfare.

List of Abbreviations

ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area
ADD	Acoustic Deterrent Device
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
ALDFG	Abandoned, Lost or otherwise Discarded Fishing Gear
AMO	Atlantic Multidecadal Oscillation
ASW	Aboriginal Subsistence Whaling
ASW sonar	Anti-submarine warfare sonar
BAT	Best Available Techniques
BBNJ	Biodiversity in areas beyond national jurisdiction
BEP	Best Environmental Practice
CBD	Convention on Biological Diversity
CeMV	Cetacean morbillivirus
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CO_2	Carbon dioxide
CR	Critically Endangered (IUCN Red List category)
dB	Decibel
DD	Data Deficient (IUCN Red List category)
DDT	Dichlorodiphenyltrichloroethane
DG MARE	Directorate General for Maritime Affairs and Fisheries
EBM	Ecosystem-based management
EBSA	Ecologically or biologically significant (marine) area
ECHO Program	Enhancing Cetacean Habitat and Observation Program

EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EN	Endangered (IUCN Red List category)
EU	European Union
FAO	Food and Agriculture Organization
GES	Good Environmental Status
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GOBI	Global Ocean Biodiversity Initiative
HBCD	Hexabromocyclododecane
HCB	Hexachlorobenzene
HELCOM	Convention on the Protection of the Marine Environment of the Baltic Sea Area – the Helsinki Convention
Hg	Mercury
Hz	Hertz
IBA	Important bird and biodiversity area
ICES	International Council for the Exploration of the Sea
ICRW	International Convention for the Regulation of Whaling
IMMA	Important marine mammal area
IMO	International Maritime Organization
IKI	International Climate Initiative
IUCN	International Union for Conservation of Nature
IUU fishing	Illegal, unreported and unregulated fishing
IWC	International Whaling Commission
JPI Oceans	Joint Programming Initiative Healthy and Productive Seas and Oceans
JRC	Joint Research Centre of the European Commission
kHz	kilohertz
kts	knots

LC	Least Concern (IUCN Red List category)
LFA sonars	Low-frequency active sonars
MAP	Mediterranean Action Plan
MARPOL	International Convention for the Prevention of Pollution from Ships
MEA	Multilateral Environmental Agreement
MEDACES	Mediterranean Database of Cetacean Strandings
MEPC	Marine Environment Protection Committee
MP	Microplastic
MPA	Marine Protected Area
MMT	Mean Maximum Temperature
MRSA	Methicillin-resistant *Staphylococcus aureus*
MSFD	Marine Strategy Framework Directive
NA	Not Applicable (IUCN Red List category)
NAMMCO	North Atlantic Marine Mammal Commission
NGO	Non-governmental organisation
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen oxides
NP	Nanoplastic
NT	Near Threatened (IUCN Red List category)
OCPs	Organochlorine pesticides
OPFRs	Organophosphorus Flame Retardants
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PA	Protected Area
PAHs	Polycyclic aromatic hydrocarbons
PBDEs	Polybrominated diphenyl ethers
PBT	Persistent, bioaccumulative and toxic chemicals

PCBs	Polychlorinated biphenyls
POPs	Persistent organic pollutants
PSSA	Particularly Sensitive Sea Area
REM	Remote Electronic Monitoring
RMP	Revised Management Procedure
RMS	Revised Management Strategy
SAC	Special Area of Conservation
SCANS	Small Cetaceans in European Atlantic waters and the North Sea
SDGs	Sustainable Development Goals
SOx	Sulphur oxides
SPAMI	Specially Protected Area of Mediterranean Importance
SPL	Sound Pressure Level
SST	Sea Surface Temperature
UK	United Kingdom
UME	Unusual Mortality Event
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
USA	United States of America
USD	United States Dollar
USSR	Union of Soviet Socialist Republics
UV	Ultraviolet
VU	Vulnerable
WPC	World Parks Congress
µPa	Micropascal

Overview of Cetacean Species in European Waters (including Red List Status)

***Giuseppe Notarbartolo di Sciara**, Tethys Research Institute, Milan, Italy and*
***Laetitia Nunny**, Wild Animal Welfare, La Garriga, Spain*

“I am surprised and concerned that so many cetaceans in Europe are more threatened than their counterparts elsewhere. Europe has the knowledge and the means to do better. Unless dedicated action comes soon, future generations may not enjoy porpoises, dolphins and whales in European waters and that would be a terrible loss.”
Giuseppe Notarbartolo di Sciara

Introduction

European Cetaceans (Order Cetartiodactyla) include 33 species, eight of which belong to Suborder Mysticeti (baleen whales), and 25 to Suborder Odontoceti (toothed whales, dolphins and porpoises). A list of species and subspecies is contained in Table 1.

Other cetacean species, which are not resident, can appear on occasion in European waters from distant regions, but they are not included here because they are not represented in Europe by viable populations that need to be the object of conservation effort. For example the single Gray whale (*Eschrichtius robustus*) individual, (a species currently limited to the North Pacific) which appeared in the Mediterranean Sea, first off Israel and later off Barcelona, in May 2010 (Scheinin *et al.*, 2011).

All 33 species have been assessed in the International Union for Conservation of Nature's (IUCN) Red List at the global level to determine their risk of extinction. Of these, one is listed as Critically Endangered (CR), two are listed as Endangered (EN), two are Vulnerable (VU), one is Near Threatened (NT), 21 are Least Concern (LC), and six are Data Deficient (DD). Some subspecies and subpopulations have been assessed in European waters, either in Europe in general, specifically in one of Europe's marine basins (Baltic, Mediterranean or Black Seas) or in specific areas such as the Straits of Gibraltar. Of these, four are Critically Endangered, seven are EN, seven are VU, one is NT, four are LC, and fourteen are DD. Three species have not been assessed for European waters and seven were assessed as Not Applicable (NA) in 2007 because of their marginal occurrence or vagrant status, however these assessments need to be updated (see recommendations in Table 1).

In terms of percentages, at the global level 18% of the species found in Europe are assessed as being in a threatened or almost threatened category (CR, EN, VU or NT); 64% are considered not threatened (LC) and 18% are DD. Of the 22 species which were assessed at the European level, 27% are in a threatened or almost threatened category (CR, EN, VU or NT), 18% are considered not threatened, and 55% are DD. Of the 15 species which were assessed as subspecies or subpopulations, 87% were in a threatened category (CR, EN or VU) and 13% were DD. It can be concluded that cetaceans in Europe are considerably more threatened than their global counterparts, and that a greater level of uncertainty exists in Europe than at the global level about the status of some species. Concern for the overall status of cetaceans in Europe would probably be significantly greater were the recommended assessments of some subpopulations carried out.

Recommendations for status assessments

The status of many taxa can still not be properly assessed due to a lack of robust data on population sizes and trends, despite clear evidence of existing anthropogenic factors likely to affect their conservation status. These include, at the global level, species that are particularly difficult to monitor at sea due to their cryptic behaviour and occurrence in low densities (e.g. Ziphiidae) or species whose taxonomic status is still problematic (e.g. the killer whale (*Orcinus orca*) is likely to be split into several species as ecological, morphological and genetic knowledge progresses (Morin *et al*., 2010)). The same situation is reflected at the regional level (Notarbartolo di Sciara, 2016), although in the case of smaller subpopulations, concentrating efforts to focus on knowledge increase should be less problematic and lead to improved status assessments. This was the case of Cuvier's beaked whale (*Ziphius cavirostris*) in the Mediterranean which was recently moved from DD to VU (Cañadas and Notarbartolo di Sciara, 2018).

Many regional Red List assessments are now outdated because they were performed a decade ago or more. For many of these species the situation is unlikely to have remained the same. On the one hand, knowledge has improved allowing increasingly robust evaluations, and, on the other hand, pressures have increased, diversified, or exerted their effects for a longer period, alone and cumulatively with other factors. Some Mediterranean and Black Sea taxa, such as fin whales (*Balaenoptera physalus*), sperm whales (*Physeter macrocephalus*), harbour porpoises (*Phocoena phocoena*), common dolphins (*Delphinus delphis*), common bottlenose dolphins (*Tursiops truncatus*), Black Sea harbour porpoises (*P. phocoena relicta*), Black Sea common dolphins (*D. delphis ponticus*) and Black Sea bottlenose dolphins (*T. truncatus ponticus*) are currently in the process of being reassessed.

Finally, there are special cases in which local cetaceans warrant being considered as subpopulations and these should be the focus of urgent attention in view of existing evidence of their highly concerning conservation status. The Strait of Gibraltar killer whale (Esteban and Foote, 2019) and the Gulf of Corinth common dolphin subpopulations (Bearzi, Bonizzoni and Santostasi, 2020) have recently both been added to the Red List with a status of CR. The Red List assessments of the Gulf of Ambracia common bottlenose dolphins (Gonzalvo *et al*., 2016), the Gulf of Corinth striped dolphins (Bearzi *et al*., 2016) and the Mediterranean long-finned pilot whale subpopulations (*Globicephala melas*) (Verborgh *et al*., 2016) are currently being reviewed. The Mediterranean Sea rough-toothed dolphins (*Steno bredanensis*) (Kerem *et al*., 2016) and the Iberian/North West African subpopulation (Fontaine, 2016) of harbour porpoises are also being assessed.

Table 1: European Cetaceans *(33 species, 3 subspecies), their Red List statuses (both global and, where applicable, subsets including subpopulations, regional assessments and subspecies) and recommended actions.*

Common name	Scientific name	Global range	European range	Red List (global)	Red List (subsets)	Recommendations
Mysticeti – Balaenidae (2 species)						
Bowhead whale	*Balaena mysticetus*	Circumpolar in Arctic and Subarctic regions.	Northern coasts of Iceland, Norway, Russia; East Greenland; Svalbard; Barents Sea.	Least Concern (2018)	East Greenland-Svalbard-Barents Sea subpopulation: **Endangered** (2018)	
North Atlantic right whale	*Eubalaena glacialis*	North Atlantic, mostly western part, from Florida to north of Iceland.	Formerly found from northwest Africa to East Greenland, Iceland and North Norway.	**Critically Endangered** (2020)	Europe: **Critically Endangered** (2007) Appears to be effectively extirpated from the eastern North Atlantic.	Update status for Europe to RE (Regionally Extinct).
Mysticeti – Balaenopteridae (6 species)						
Common minke whale	*Balaenoptera acutorostrata*	A cosmopolitan species found in all oceans and in nearly all latitudes, from nearly 70°S to 80°N.	Found throughout the European seas except in the Baltic and Black Seas. Occurs only occasionally in the Mediterranean.	Least Concern (2018)	Europe: Least Concern (2007)	
Sei whale	*Balaenoptera borealis*	A cosmopolitan species, with a mainly offshore distribution.	Occurs off the northeast Atlantic waters from northern Norway to the Canary Islands, including the North Sea but excluding the Baltic, Mediterranean (except a few extralimital records) and Black Seas.	**Endangered** (2018)	Europe: **Endangered** (2007)	Update Europe assessment.
Bryde's whale	*Balaenoptera edeni*	Circumtropical, but extending its range to subtropical waters in places, to 40° N and 40° S.	European occurrence limited to Madeira and the Canary Islands.	Least Concern (2017)	No relevant subpopulation assessed.	

Common name	Scientific name	Global range	European range	Red List (global)	Red List (subsets)	Recommendations
Blue whale	*Balaenoptera musculus*	A cosmopolitan species, found in all oceans.	From the Arctic waters of northern Siberia and Norway to the Canary Islands; absent from the Baltic, Mediterranean and Black Seas.	**Endangered** (2018)	Europe: **Endangered** (2007)	Update Europe assessment.
Fin whale	*Balaenoptera physalus*	Occurs worldwide mainly, but not exclusively, in offshore waters of the temperate and subpolar zones.	From Arctic waters around the Svalbard Islands to the Canary Islands, including the North and Mediterranean Seas. Absent from the Black Sea.	**Vulnerable** (2018)	Europe: **Near Threatened** (2007) Mediterranean Sea: **Vulnerable** (2011)	(Mediterranean reassessment in progress).
Humpback whale	*Megaptera novaeangliae*	A cosmopolitan species found in all major ocean basins.	Found throughout the European seas from Siberia to the Canary Islands, except in the Baltic and Black Seas. Occurs only occasionally in the Mediterranean.	Least Concern (2018)	Europe: Least Concern (2007)	
Odontoceti – Physeteridae (1 species)						
Sperm whale	*Physeter macro-cephalus*	Found in nearly all marine regions, from the equator to high latitudes.	Found throughout the European seas except in the Baltic and Black Seas.	**Vulnerable** (2019)	Europe: **Vulnerable** (2007) Mediterranean subpopulation: **Endangered** (2006).	(Mediterranean reassessment in progress).
Odontoceti – Kogiidae (2 species)						
Pygmy sperm whale	*Kogia breviceps*	Known from outer continental shelf and deep waters in tropical to warm temperate zones of all oceans.	Found from the North Sea to the Canary Islands. Has not occurred in the Baltic, Mediterranean and Black Seas.	Least Concern (2019)	Europe: Not applicable (because species is of marginal occurrence) (2007).	Assess status in Europe.
Dwarf sperm whale	*Kogia sima*	Widely distributed in offshore waters of tropical and warm temperate zones of all oceans.	Found in Atlantic waters from northern Spain to the Canary Islands. Only found twice (stranded) in the Mediterranean Sea.	Least Concern (2020)	Europe: Not applicable (because species is of marginal occurrence) (2007).	Assess status in Europe.
Odontoceti – Ziphiidae (6 species)						
Northern bottlenose whale	*Hyperoodon ampullatus*	Found only in the North Atlantic, from Greenland to temperate latitudes.	Occurs in the eastern North Atlantic from Svalbard to Gibraltar. A few extra-limital records from the Baltic and Mediterranean Seas.	Data Deficient (2008)	Europe: Data Deficient (2007)	Assess status globally and in Europe.

Common name	Scientific name	Global range	European range	Red List (global)	Red List (subsets)	Recommendations
Sowerby's beaked whale	*Mesoplodon bidens*	Occurs exclusively in sub-arctic to temperate waters of the North Atlantic.	Occurs in the eastern North Atlantic from northern Norway to the Canary Islands. One extra-limital record from the Mediterranean Sea.	Data Deficient (2008)	Europe: Data Deficient (2007)	Assess status globally and in Europe.
Blainville's beaked whale	*Mesoplodon densirostris*	Circumglobal in tropical and temperate waters.	Found in the eastern North Atlantic from the south coast of Iceland to the Canary Islands. One extra-limital record in the Mediterranean.	Data Deficient (2008)	Europe: Data Deficient (2007)	Assess status globally and in Europe.
Gervais' beaked whale	*Mesoplodon europaeus*	Probably continuously distributed in deep waters across the tropical and temperate Atlantic Ocean, both north and south of the equator.	Found off the eastern North Atlantic from Scotland to the Canary Islands. One extra-limital record in the Mediterranean.	Data Deficient (2008)	Europe: Data Deficient (2007)	Assess status globally and in Europe.
True's beaked whale	*Mesoplodon mirus*	Has a disjunct, anti-tropical distribution, occurring both in the temperate/ sub-tropical North Atlantic, and in the southern Atlantic and Indian oceans.	Found off the eastern North Atlantic from the south of the British Isles to the Canary Islands. Has never been observed in the Mediterranean Sea.	Data Deficient (2008)	Europe: Data Deficient (2007)	Assess status globally and in Europe.
Cuvier's beaked whale	*Ziphius cavirostris*	Widely distributed in offshore waters of all oceans, from the tropics to the polar regions in both hemispheres.	In the eastern North Atlantic from south of Iceland to the Canary Islands, and throughout the Mediterranean Sea. Absent from the Baltic and Black Seas.	Least Concern (2008)	Europe: Data Deficient (2007); Mediterranean subpopulation: **Vulnerable** (2018)	Update Europe assessment.
Odontoceti – Phocoenidae (1 species, 1 subspecies)						
Harbour porpoise	*Phocoena phocoena*	Found over the continental shelf in cold temperate to sub-polar waters of the Northern Hemisphere	In the eastern North Atlantic found from the Arctic south of Svalbard, in Siberian waters, Norway, Iceland and east Greenland, south to the Canary Islands. Few extralimital records in the west Mediterranean Sea. A separate subspecies inhabits the Black Sea (below).	Least Concern (2020)	Europe: **Vulnerable** (2007); Baltic Sea subpopulation: **Critically Endangered** (2008)	Update regional assessments. Urgently assess the southern ecotype inhabiting the upwelling waters off the Atlantic coast of the Iberian Peninsula and Northwest Africa as a separate subpopulation.

Common name	Scientific name	Global range	European range	Red List (global)	Red List (subsets)	Recommendations
Black Sea harbour porpoise	*Phocoena phocoena relicta*		Endemic to the Black and Marmara Seas; spills over into the northern Aegean Sea (Mediterranean Sea).		Black Sea: **Endangered** (2008)	(Reassessment in progress).
Odontoceti – Monodontidae (2 species)						
Beluga	*Delphinapterus leucas*	Widely distributed in Arctic regions, occurring throughout northern waters of Russia, Alaska, Canada, West Greenland, and Svalbard.	Limited to Arctic waters adjacent to Svalbard, Jan Mayen, Franz Josef Land and the Siberian coast.	Least concern (2017)	Europe: Not applicable (because species is of marginal occurrence) (2007).	
Narwhal	*Monodon monoceros*	Found in Arctic waters, including northeastern Canada, northern Greenland, Svalbard, and waters of northern Russia as far east as the East Siberian Sea.	Limited to Arctic waters along the east coast of Greenland, north Svalbard, Jan Mayen, and Franz Josef Land.	Least concern (2017)	Europe: Not applicable (because species is of marginal occurrence) (2007).	
Odontoceti – Delphinidae (13 species, 2 subspecies)						
Common dolphin	*Delphinus delphis*	Widely distributed in tropical to cool temperate waters of the Atlantic and Pacific Oceans, from nearshore waters to thousands of km offshore.	In the eastern North Atlantic from southern Norway to the Canary Islands, including the Mediterranean Sea. A separate subspecies inhabits the Black Sea (below).	Least concern (2008)	Europe: Data Deficient (2007); Mediterranean: **Endangered** (2003); Gulf of Corinth: **Critically Endangered** (2020)	(Mediterranean reassessment in progress).
Black Sea common dolphin	*Delphinus delphis ponticus*		Found throughout Black Sea waters.		Black Sea: **Vulnerable** (2008)	(Reassessment in progress).
Short-finned pilot whale	*Globicephala macrorhynchus*	Found worldwide in warm temperate to tropical waters, generally in deep offshore areas.	In the eastern North Atlantic from northern Spain to the Canary Islands. One extra-limital record in the Mediterranean.	Least concern (2018)	No relevant subpopulation assessed.	
Long-finned pilot whale	*Globicephala melas*	Shows an antitropical distribution in temperate and sub-polar zones of the Northern (limited to the North Atlantic) and Southern Hemispheres.	In the eastern North Atlantic, from north of Norway to the Canary Islands. Extends into the Mediterranean Sea, but limited to the western basin.	Least concern (2018)	Europe: Data Deficient (2007); Mediterranean: Data Deficient (2010)	(Mediterranean reassessment in progress).

Common name	Scientific name	Global range	European range	Red List (global)	Red List (subsets)	Recommendations
Risso's dolphin	*Grampus griseus*	Widely distributed in the tropics and temperate regions of both hemispheres, primarily in waters of the continental slope and outer shelf (especially areas with steep bottom topography).	In the eastern North Atlantic from south of Norway, British Isles, France and Spain south to the Canary Islands; extends into the Mediterranean Sea, but not in the Black Sea.	Least Concern (2018)	Europe: Data Deficient (2007); Mediterranean subpopulation: Data Deficient (2010)	(Mediterranean reassessment in progress).
Fraser's dolphin	*Lagenodelphis hosei*	The species has a pantropical distribution, mainly between 30°N and 30°S in all three major oceans.	Limited to Madeira, the Azores and the Canary Islands.	Least concern (2018)	Europe: Not applicable (because species is a vagrant) (2007).	Assess status in Macronesia.
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Cold temperate to subpolar waters of the North Atlantic.	In the eastern North Atlantic from south of Svalbard and east Greenland south to northern France.	Least Concern (2019)	Europe: Least Concern (2007)	Update assessment for Europe.
White-beaked dolphin	*Lagenorhynchus albirostris*	Cold temperate and sub-polar waters of the North Atlantic	In the eastern North Atlantic from west of Svalbard, Novaya Zemlya and east Greenland, south to northern Portugal.	Least Concern (2018)	Europe: Least Concern (2007)	Update assessment for Europe.
Killer whale	*Orcinus orca*	Occurs in virtually any marine habitat but is most common in cold water areas of high marine productivity, particularly at higher latitudes.	Occurs throughout European Atlantic waters. Rare in the Mediterranean. Absent from Black and Baltic Seas.	Data Deficient (2017)	Europe: Data Deficient (2007); Strait of Gibraltar subpopulation: **Critically Endangered** (2019)	
False killer whale	*Pseudorca crassidens*	Found in tropical to warm temperate zones, generally in relatively deep, offshore waters in all three major oceans.	In the eastern North Atlantic from southern Norway and British Isles south to Canary Islands. Occasional visitor to the Mediterranean. Absent from Baltic and Black Seas.	**Near Threatened** (2018)	Europe: Not applicable (because species is of marginal occurrence) (2007).	Assess status in Europe.
Striped dolphin	*Stenella coeruleoalba*	Found in tropical and warm-temperate waters of the Atlantic, Pacific, and Indian oceans, as well as many adjacent seas.	In the eastern North Atlantic from about 50°N south to the Canary Islands. Abundant in the Mediterranean. Absent from Baltic and Black Seas.	Least Concern (2018)	Europe: Data Deficient (2007); Mediterranean subpopulation: **Vulnerable** (2010)	(Mediterranean reassessment in progress).

Common name	Scientific name	Global range	European range	Red List (global)	Red List (subsets)	Recommendations
Atlantic spotted dolphin	*Stenella frontalis*	Found in tropical and warm-temperate waters of the Atlantic Ocean from 50°N to 25-30°S.	Limited to Madeira, the Azores and the Canary Islands.	Least Concern (2018)	No relevant subpopulation assessed.	
Rough-toothed dolphin	*Steno bredanensis*	A tropical to subtropical species, which generally inhabits deep, oceanic waters of all three major oceans, rarely ranging north of 40°N or south of 35°S.	In the eastern North Atlantic from the west coast of France south to the Canary Islands. In the Mediterranean it is frequently observed in the Levantine Sea; occasional elsewhere.	Least Concern (2018)	Europe: Not applicable (because species is of marginal occurrence) (2007).	Update Europe status to reflect that species is present in North Atlantic particularly around the Canary Islands. (Mediterranean reassessment in progress).
Common bottlenose dolphin	*Tursiops truncatus*	Distributed worldwide through tropical and temperate inshore, coastal, shelf, and oceanic waters.	In the eastern North Atlantic from the Faeroes and Shetlands south to the Canary Islands. Common throughout the Mediterranean Sea. A separate subspecies inhabits the Black Sea (below).	Least Concern (2018)	Europe: Data Deficient (2007); Mediterranean: **Vulnerable** (2009)	(Mediterranean region reassessment and Gulf of Ambracia subpopulation assessment are in progress). Recommend assessing other subpopulations within the Mediterranean.
Black Sea bottlenose dolphin	*Tursiops truncatus ponticus*		The subspecies' range includes the Black Sea proper, the Kerch Strait along with the adjoining part of the Azov Sea, and the Turkish Straits System.		Black Sea: **Endangered** (2008)	(Reassessment in progress).

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The Regulatory Framework for Whales, Dolphins and Porpoises in European Waters

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"No EU citizen wants to eat fish that has been caught at the expense of iconic species like dolphins or whales. The legal framework to prevent the killing of marine mammals exists, now it is just a matter of political will to implement it."
Andrea Ripol

Introduction

Interest in whale conservation began in earnest in the late 1940s largely as a response to the unsustainable pressure placed on whale populations by intensified commercial whaling. At first, the aim was to conserve populations in order to continue harvesting them. In the 1970s, as environmental activism heightened, several international agreements for nature protection were signed, including the Bern Convention on the Conservation of European Wildlife and Natural Habitats and the Convention on the Conservation of Migratory Species of Wild Animals (CMS). Today, in addition, cetaceans in European Union (EU) waters are strictly protected by the EU's Habitats Directive, as well as the Marine Strategy Framework Directive, which intends to prevent human-induced decline of biodiversity, targets various pressures and threats and tries to achieve a good environmental status in EU waters.

Legal framework in Europe

Habitats Directive and the Natura 2000 network

The protection of cetaceans in the EU is primarily driven by the Habitats Directive (Council Directive 92/43/EEC), a cornerstone of EU legislation for nature protection, adopted in 1992 (Council of the European Communities, 1992). The Habitats Directive represents the most ambitious and large-scale initiative ever undertaken to conserve Europe's natural heritage from the land to the sea. The Directive protects important habitats and species through the establishment of protected areas, known as Natura 2000 sites, collectively forming the Natura 2000 network[1]. To date, the Natura 2000 network comprises 3,797 marine sites, protecting over 11% of the EU marine territory (Fraschetti *et al*., 2018). The species covered by the Natura 2000 network are found in Annex II of the Directive. In addition, the Habitats Directive aims to establish and implement a strict protection regime for those animal species listed in Annex IV(a) of the Directive throughout EU waters (Articles 12 and 16 Habitats Directive). Both tools (Natura 2000 network and species protection) aim to bring the EU's most remarkable and vulnerable species and habitats back to a Favourable Conservation Status. For species, the factors that define Favourable Conservation Status include population dynamics, natural range and size of natural habitat.

Two species of cetaceans, the bottlenose dolphin (*Tursiops truncatus*), and the harbour porpoise, (*Phocoena phocoena*) are listed in Annex II of the Habitats Directive '*Animal and plant species of community interest whose conservation requires designation of special areas of conservation*'. Therefore, EU Member States are required to designate the species' core habitat as a Natura 2000 site and to manage it in accordance with the ecological needs of the species. For aquatic species ranging over large areas (e.g. migratory species), sites that clearly represent areas essential for their life and reproduction should be designated as Natura 2000 areas. When proposed to the EU as a 'site of community importance', the Member State has the obligation to prevent deterioration of the species' habitats as well as any significant disturbance of the species within the designated area (Article 6(2) Habitats Directive). To achieve this, Member States must undertake an Appropriate Assessment of plans or projects likely to have a significant effect on the site, and must implement only those plans/projects that will not adversely affect the integrity of the site (Article 6(3) Habitats Directive). Jurisprudence of the Court of Justice of the European Union has previously ruled that fisheries should be considered as a plan/project and are therefore subject to an Appropriate Assessment, including those fisheries well-established in the area[2].

Within 6 years of the site's designation as a Special Area of Conservation (SAC), the Habitats Directive requires all necessary conservation measures for the protection of the species to be in place (Article 6(1) Habitats Directive). The protection of human health, public safety and other imperative reasons of overriding interest can supersede these requirements but only if the country has shown that there is no alternative solution and has taken all necessary compensatory measures (Article 6(4) Habitats Directive).

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1 https://ec.europa.eu/environment/nature/natura2000/

2 Judgment of the Court (Grand Chamber) of 7 September 2004. Landelijke Vereniging tot Behoud van de Waddenzee and Nederlandse Vereniging tot Bescherming van Vogels v Staatssecretaris van Landbouw, Natuurbeheer en Visserij. Reference for a preliminary ruling: Raad van State- Netherlands.
Directive 92/43/EEC- Conservation of natural habitats and of wild flora and fauna- Concept of "plan' or "project'- Assessment of the implications of certain plans or projects for the protected site. Case C-127/02. Available at: http://curia.europa.eu/juris/liste.jsf?language=en&num=C-127/02

All cetaceans found in EU waters are listed on Annex IV of the Habitats Directive meaning they require a strict protection regime applied across the entire range of the species, both within and outside Natura 2000 sites. Deliberate capture, killing or disturbance of these species in the wild is prohibited, as well as the deliberate destruction of breeding and resting sites. The Directive and additional jurisprudence from the Court of Justice of the European Union define that 'a strict protection regime' compels Member States to adopt 'a set of coherent and coordinated measures of a preventive nature', which include ensuring that Environmental Impact Assessments (EIAs) take into account the impacts on those species protected and included in national conservation plans. In the case of cetaceans, this is relevant when considering sea-based oil and gas extraction platforms which must be subject to EIAs prior to licencing. When considering incidental catches, Member States must establish and implement a system to monitor the incidental capture and killing of animals listed in Annex IV and ensure these factors do not have a significant impact on the species concerned.

Derogations to the system of strict protection are possible in very specific situations. A request for derogation must be justified by one of the reasons listed in Article 16 of the Directive, which include inter alia to prevent serious damage to fisheries or for reasons of public health and safety. In any case, a derogation can be granted only if a particular activity will not harm the overall aim of conserving biodiversity.

Conflicts with EU fisheries legislation

Despite the creation of the Habitats Directive more than 25 years ago, most marine Natura 2000 areas still do not have management measures in place and many cetacean species under strict protection have not reached Favourable Conservation Status. Cetaceans are at high risk of incidental capture (bycatch) in fisheries (as discussed in chapter 6 of this report).

The Habitats Directive clarifies that when an activity is likely to place significant impact on protected species, conservation measures should be taken. However, regarding fisheries, Member States cannot always take unilateral measures to restrict fishing activities. In the EU, fisheries are regulated by the Common Fisheries Policy (Regulation (EU) No 1380/2013), an exclusive competence of the EU. Beyond 12 nautical miles, a Member State cannot restrict certain fisheries of its own accord, for instance, to stop cetacean bycatch, because of the likelihood that vessels from other Member States also fish there. Article 11 of the Common Fisheries Policy allows Member States fishing in a specific area and protected under EU law (Habitats Directive or Marine Strategy Framework Directive) to produce a Joint Recommendation of fisheries management measures to achieve the conservation objectives of the area, which is then adopted by the European Commission in a delegated act, if the Parliament and Council do not oppose. However, negotiating Joint Recommendations among Member States sharing a fishing interest has proven lengthy and prone to political trade-offs leading to the adoption of a limited number of fisheries management measures that are weak in their protection and enforcement measures.

Since cetaceans are at high risk of bycatch from fishing vessels, a specific regulation (EU Regulation 812/2004) was adopted in 2004 to minimise the worst impacts of fishing activities on cetaceans. It included clear monitoring and reporting requirements which should have allowed Member States to better understand pressures on cetacean populations. The Regulation specifically addressed mitigation measures to prevent cetacean incidental catches, mainly by using acoustic deterrent devices, i.e. pingers, and by having on-board sea observers for specific boats. The Regulation was not well implemented by Member States and it was repealed in 2019. Mitigation measures to reduce incidental catches of cetaceans (and other sensitive species) are now included in the broader Regulation (EU) 2019/1241 on the 'conservation of fisheries resources and the protection of marine ecosystems through technical measures' which was adopted by the European Parliament in June 2019 to support the Common Fisheries Policy. The legislation prohibits certain types of gears to be installed in fishing vessels, provides specifications for gear design and use, and refers to minimum mesh sizes for nets and to selective gear to reduce unwanted catches. While progress compared to previous legislation is clear, shortcomings in the governance mechanisms for fisheries management in the EU leave the door open to wide differences in how Member States will implement the Regulation and how effective ensuing protection against bycatch will be.

The Marine Strategy Framework Directive (Marine Directive)

In 2008, the Marine Directive (Directive 2008/56/EC) established a framework for community action in marine environmental policy that represents the first EU legislative instrument addressing threats to marine biodiversity in a holistic manner[3]. The overall objective of the Directive was to achieve Good Environmental Status (GES) of EU marine waters by 2020, while ensuring the sustainable use of marine resources. The responsibility for achieving this objective is placed at national and regional levels, meaning that Member States can choose specific measures to address pressures and impacts on marine biodiversity, provided they reach the Directive's goal. In 2012, the Marine Directive reserved a 6-year implementation cycle comprising a series of steps each Member State should perform, including an assessment of marine waters, definition of GES and setting of targets and the establishment and implementation of monitoring programmes and programmes of measures.

Member States interpret the meaning of GES using eleven qualitative descriptors which describe a healthy marine environment. These descriptors were further defined through a set of criteria and standards in Commission Decision 2017/848 on good environmental status of marine waters (European Commission, 2017). For cetaceans (mammals), GES is defined through the following criteria:

- The mortality rate per species from incidental bycatch is below levels which threaten the species, such that its long-term viability is ensured.
- The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.
- The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions.
- The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species.

Regarding cetaceans, in addition to the main threat of bycatch from fisheries, the Marine Directive addresses three other threats strongly correlated to the health of cetaceans: the concentration of contaminants (Descriptor 8), marine litter (Descriptor 10) and ocean noise (Descriptor 11). The aim of the Directive is to ensure that the levels of these threats are below levels at which harm can occur to the marine environment. A 2018 analysis by the European Commission of the Member States' programme of measures concluded that the measures are not ambitious and highlighted that with current measures, GES would not be reached by 2020 (European Commission, 2018). The level to which cetaceans are addressed in these measures is unknown and would require a country by country analysis. Based on the cumulative number of pressures on cetaceans in European seas, ranging from fisheries bycatch to pollution and interference with human activities, there is no doubt, however, that GES was not achieved by 2020. As a specific example, Peltier *et al*. (2019) found that the rate of ship strikes on large cetaceans along French coasts alone meant that GES of marine mammal populations would not be met.

The situation of the UK

At the time of writing, the United Kingdom has recently left the EU which puts it and its extensive waters outside of EU law. This means that the measures listed above are no longer directly relevant to the UK but, of course, conservation measures in the UK can still be compared with those applied within the EU block. For cetacean conservation, the UK's other international commitments will become more important – for example the ASCOBANS agreement which is described below.

[3] https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm

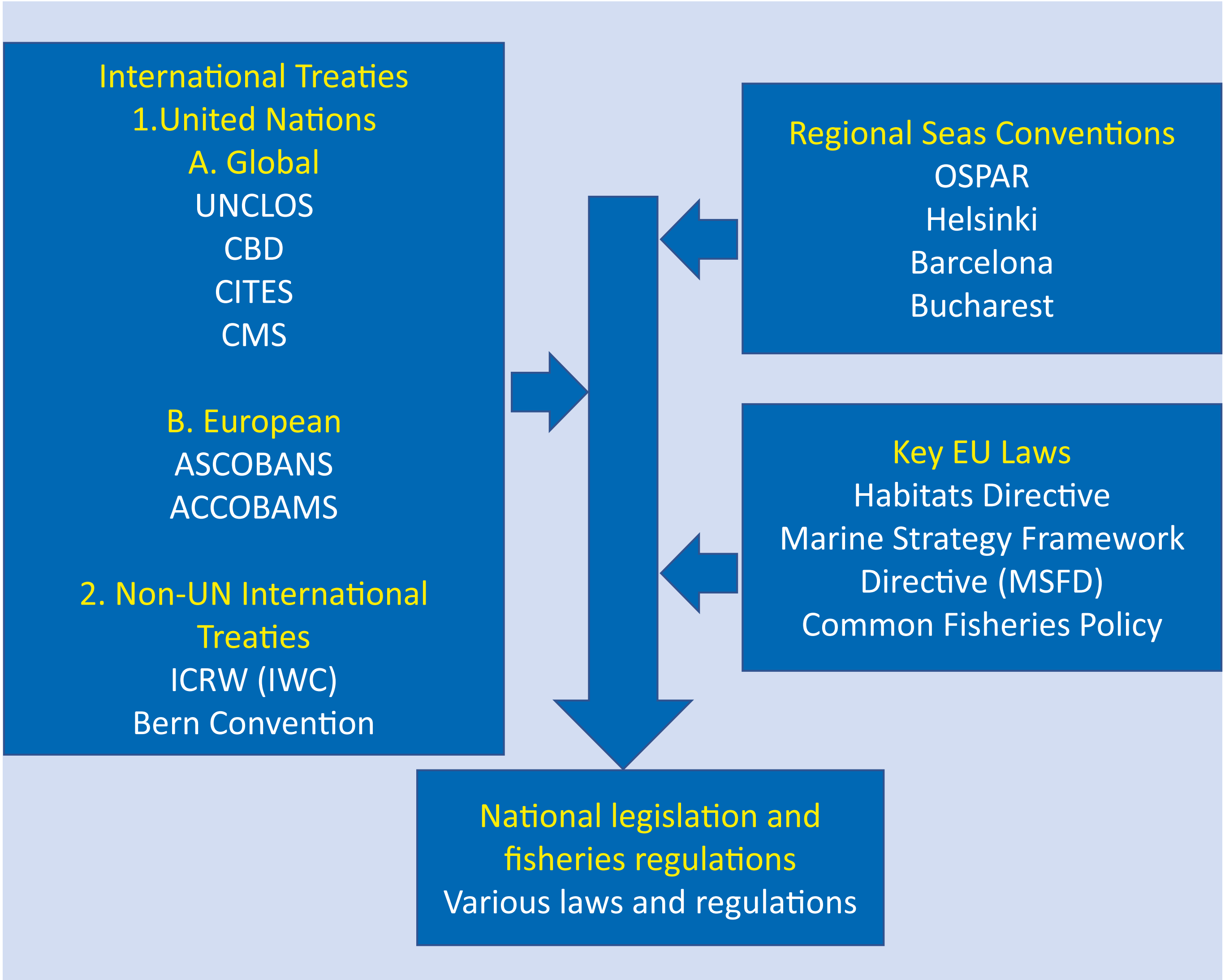

Figure 1: The International Legal Regime Affecting Cetaceans (see text for fuller details)

EU Biodiversity Strategy for 2030

In May 2020, the EU Biodiversity Strategy for 2030 was adopted as part of the European Green Deal through which the Commission shows its commitment to turning the tide on environmental degradation and biodiversity collapse[4]. The EU Biodiversity Strategy for 2030 aims to get Europe's biodiversity on the road to recovery by 2030 by protecting wildlife and combating the illegal wildlife trade. It specifically mentions the need to address the problem of bycatch of sensitive species, not only through the necessary mitigation measures but also by stepping up the collection of scientific data. The Biodiversity Strategy highlights the need for GES of marine ecosystems and states that the full implementation of the Common Fisheries Policy, the Marine Directive and the Birds and Habitats Directives is essential (European Commission, 2020). The Biodiversity Strategy also aims to promote areas of very high biodiversity value or potential with a goal of strictly protecting at least 10% of EU seas. Moreover, it commits to publishing an action plan for the conservation of fisheries resources and the protection of marine ecosystems, by 2021. Under such an action plan, the adverse impacts that fishing has on the marine environment will be addressed, and where necessary, measures to limit the use of fishing gear most harmful to biodiversity will be introduced.

[4] https://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm

International legal framework

International Convention for the Regulation of Whaling

In 1946, The International Convention for the Regulation of Whaling (ICRW), which established the International Whaling Commission (IWC), was signed. The main objectives of this convention were to establish a system of international regulations to manage the whale fisheries, protect whales from overhunting and promote whale conservation. Recently, new issues have started to be addressed such as reducing bycatch, entanglement, ocean noise, chemical pollution, marine litter, ship strikes and promoting sustainable whale watching, have been added. The convention, therefore, now provides a holistic approach to whale conservation.

The IWC currently comprises 88 member states[5]. In 1982, due to the near collapse of several commercial whale species, the IWC announced a ban on commercial whaling. Today, all the EU nations that are members of the IWC and the UK and Monaco are strong supporters of the moratorium on commercial whaling. The 1946 Convention does not define 'whale', although a list of twelve species was annexed to the Convention. Some IWC members believe that the IWC has the legal competence to regulate catches of the so-called 'Great Whales' only. Other members believe that all cetaceans, including the smaller dolphins and porpoises, fall within IWC jurisdiction. The IWC has never regulated small cetacean hunts and no consensus has so far been reached. See chapter 5 for further discussion about the IWC.

Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)

In 1979, the Bern Convention was signed, establishing the first international treaty aimed at protecting both habitats and species and promoting European cooperation on the issue of nature conservation (Council of Europe, 1979). It covers all national European marine waters up to Exclusive Economic Zone (EEZ) boundaries. The Bern Convention emphasizes the importance of protecting endangered habitats and species and addresses the challenge of the conservation of migratory species. Within this convention, thirty cetacean species are listed as *strictly protected* species (Annex II) and the remaining (those not mentioned in Annex II) as *protected* species (Annex III).

For species classified as 'strictly protected', the following are prohibited: deliberate capture and deliberate killing; deliberate damage or destruction of breeding and resting sites; deliberate disturbance of wild fauna and the possession and trade of these animals. The Bern Convention was a pioneer in introducing the concept of "deliberate" as "acceptance of foreseeable consequences". For species listed as 'protected', exploitation should be regulated to keep populations out of danger. To achieve the conservation targets of the Convention, a network of protected areas, named the Emerald Network, was set up, preceding the aforementioned EU Natura 2000 network[6].

Convention on the Conservation of Migratory Species of Wild Animals (CMS)

The CMS Convention (also known as the Bonn Convention) was signed in 1979 and is overseen by the United Nations Environment Programme (UNEP)[7]. The CMS Convention covers the conservation of all migratory animals, including many cetaceans[8]. Migratory species in danger of extinction are listed on Appendix I of the Convention. Fifteen cetacean species or subspecies are currently on Appendix I, nine of which are found in European waters. CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. Besides establishing obligations for each State joining the Convention, CMS promotes concerted action among the Range States for many of these species.

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[5] https://iwc.int/members
[6] https://www.coe.int/en/web/bern-convention/emerald-network
[7] https://www.cms.int/en/convention-text
[8] See https://www.cms.int/en/species for CMS listings.

Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. For this reason, the Convention encourages the Range States to conclude global or regional agreements. The conservation of migratory species is particularly challenging, as species can be affected by multiple threats across several of their habitats. For protection to be effective, all core and transitional habitats need to be protected. Eighteen of the 42 cetacean species or subspecies currently listed on Appendix II are found in European waters.

Regional agreements for the conservation of cetaceans: ASCOBANS and ACCOBAMS

Today, all European states bordering the Mediterranean and Black Seas, except Bosnia-Herzegovina and the Russian Federation, are signatories and parties to the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) which was signed in 1996 and entered into force in 2001. Based on its text ACCOBAMS may be seen as a strong conservation and protection agreement for cetaceans. The Treaty foresees that Parties shall prohibit and take all necessary measures to eliminate, where this is not already done, any deliberate taking of cetaceans. Parties shall also cooperate to create and maintain a network of specially protected areas to conserve cetaceans. The Conservation Plan, Annex 2 of the Treaty, specifies further action such as Parties shall, among others, "work out and implement measures to minimize the fishing negative effects on the conservation of cetacean", "require impact assessments to be carried out in order to provide a basis for either allowing or prohibiting the continuation or the future development of activities that may affect cetaceans or their habitat in the Agreement area, including fisheries, offshore exploration and exploitation, nautical sports, tourism and cetacean watching, as well as establishing the conditions under which such activities may be conducted", as well as "to establish and manage specially protected areas for cetaceans corresponding to the areas which serve as habitats of cetaceans and/or which provide important food resources for them."

The role, history, progress and contribution to conservation of ASCOBANS has recently been comprehensively considered by Evans (2020). The Agreement was concluded in 1992 as the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas and entered into force in 1994. In February 2008, an extension of the agreement area came into force which changed the name to "Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas".

In all, 36 of the world's 90 cetacean species have been recorded within the ASCOBANS Agreement Area (Evans, 2020). Of these, 27 species are small cetaceans within the infraorder Odontoceti, the toothed whales, for which the ASCOBANS Agreement currently applies. Many, but not all, range states are parties. The ASCOBANS aims and agreement text are similar to those of ACCOBAMS but it has been criticised as being a 'softened' version of ACCOBAMS (Simmonds, 2020). Nonetheless, it may be increasingly important because it applies to the UK's extensive marine territory which is no longer directly subject to EU protection for cetaceans.

United Nations Convention on the Law of the Sea (UNCLOS)

UNCLOS was signed in 1982 and it came into force in 1994. It is often considered the *Constitution for the Oceans*, as it established a global framework for the exploitation and conservation of marine resources (United Nations, 1982). UNCLOS splits the ocean into territorial waters (up to 12 nautical miles from the coastline), Exclusive Economic Zone (EEZ; 200 nautical miles from the coastline) and the high seas (beyond the EEZ) and attributes governance powers accordingly. Cetaceans found in territorial waters are governed directly by the coastal state. Similarly, in the EEZ, the coastal state has exclusive rights and obligations regarding the exploration and exploitation of marine resources. Cetaceans are addressed within Articles 65 and 120. Accordingly, coastal states should cooperate for the conservation, management and study of cetaceans.

Convention on Biological Diversity (CBD)

The CBD was signed in 1992 and currently has 196 parties (168 signatures)[9]. It is the most widely supported of all international environmental agreements and commits member governments to protecting biological resources through conservation and sustainable use of biological resources. The CBD calls for the establishment of effectively managed protected areas with conservation measures implemented to preserve and monitor biodiversity, identify and control destructive activities and, importantly, integrate consideration of biodiversity within national decision-making. The CBD covers countries' EEZs as well as the high seas and calls for the cooperation of member states to address protection in those areas. The CBD has given rise to talks about high seas conservation and provides the basis for the establishment of Marine Protected Areas (MPAs) in international waters, particularly sensitive areas for migratory species such as cetaceans.

Regional Seas Conventions

Four regional seas conventions cover European waters:

- The Convention for the Protection of the Marine Environment of the North-East Atlantic of 1992 – the OSPAR Convention (OSPAR)
- The Convention on the Protection of the Marine Environment in the Baltic Sea Area of 1992 – the Helsinki Convention (HELCOM)
- The Convention for the Protection of Marine Environment and the Coastal Region of the Mediterranean of 1995 – the Barcelona Convention (UNEP-MAP)
- The Convention for the Protection of the Black Sea of 1992 – the Bucharest Convention.

These conventions aim to protect the marine environment, while promoting cooperation among member states and neighbouring countries that share marine waters. All four conventions work on similar principles; calling for action to reduce human-related threats and preserve marine biodiversity via the sustainable use of marine resources. The conventions promote the establishment of a system of coastal and offshore marine protected areas. One important achievement of the Barcelona Convention has been the establishment of the Pelagos Sanctuary, a Specially Protected Area of Mediterranean Importance (SPAMI) spanning over 87,500 square kilometres in the Western Mediterranean; an area subject to an agreement between Italy, Monaco and France. Its sole purpose is the protection of marine mammals living in the area. The agreement invites countries to create joint initiatives to protect cetaceans from various disturbances, such as bycatch, pollution and noise. Its effectiveness is, however, questionable as countries have not yet put in place any fisheries regulations to stop bycatch which is, arguably, the largest threat to the animals living there.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES is an international agreement which ensures that international trade in specimens of wild animals does not threaten their survival[10]. Species listed on Appendix I are threatened with extinction and trade in these species is only permitted in exceptional circumstances. Appendix II species may not be threatened with extinction, but trade must be controlled so that they are not exploited in a way which is incompatible with their survival. All cetacean species are listed on either Appendix I or Appendix II. There are 183 Parties to CITES[11]. CITES is implemented in the EU through the EU Wildlife Trade Regulations, where all cetacean species are listed in Annex A which is equivalent to Appendix I CITES, giving them a high level of protection from international trade[12]. CITES is highly relevant to cetacean conservation, including any potential live trade and has recently been invoked in the consideration of trade in live Black Sea bottlenose dolphins (*T. truncatus ponticus*).

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[9] https://www.cbd.int/information/parties.shtml
[10] https://cites.org/eng/disc/how.php
[11] https://www.cites.org/eng/disc/parties/index.php
[12] https://ec.europa.eu/environment/cites/legislation_en.htm

Conclusion

Cetaceans are highly protected across much of Europe in both EU and international law. Consideration of how effective this is in practice is outside of the scope of this chapter but is considered in other chapters in this volume. The application of laws to the marine environment offers some challenges and spotting offences may be especially difficult.

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Benefits and Pitfalls of MPAs as a Conservation Tool for Cetaceans

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"I would like to see many more marine areas being highly protected such that the whales, dolphins and porpoises themselves notice the difference."
Erich Hoyt

Introduction

Protected areas as a tool for conservation have a long history as seen in national parks, reserves, sanctuaries and many other named areas with various levels of protection, public access, and commercial use. Marine protected areas (MPAs), especially those that would protect whales, dolphins and porpoises (cetaceans), however, are only a few decades old (Hoyt, 2011). In many ways, MPAs are a work in progress with various conservation bodies and agreements, e.g., International Union for Conservation of Nature (IUCN) Marine Mammal Protected Areas Task Force, Convention on the Conservation of Migratory Species of Wild Animals (CMS) regional agreements, Convention on Biological Diversity (CBD), as well as certain national governments, trying to ensure habitat protection for cetaceans. However, the route to effective protection takes funding as well as time – on the order of 5-10+ years – from the identification of suitable habitat, to the government and public stakeholder process necessary for approval of an area to be set aside, followed by the management plan and management body, and building the kind of on-the-ground support needed to create an effective MPA.

The definition of a protected area (PA), according to the IUCN, is "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008). A marine protected area is a PA in the marine realm which extends from the intertidal zone to the deep ocean. As with PAs, MPAs are a common generic term for hundreds of variously named areas in countries around the world. Just as with PAs, not all MPAs are created equal—in fact far from it. The IUCN divides protected areas into categories representing a continuum from stricter protection to regimes designed for sustainable resource use as shown in Table 1 (Dudley, 2008; Day *et al.*, 2012).

Category	Definition	Main management goal
Ia	Strict nature reserve	for science
Ib	Wilderness area	to preserve wilderness or natural condition
II	National park	ecosystem protection and recreation
III	Natural monument or feature	conservation of specific natural or cultural features and recreation
IV	Habitat/species management area	conservation of particular species or habitats, often through management intervention
V	Protected landscape/seascape	to protect and sustain landscapes/seascapes and associated nature conservation and other values created by interactions with humans through traditional management practices
VI	Protected area with sustainable use of natural resources	sustainable use of ecosystems

Table 1. Definition of the various IUCN MPA/PA categories
Source: adapted from Dudley (2008).

Many MPAs have only one category but, increasingly, multiple categories are employed within a single MPA in order to achieve various management objectives through zoning, often using the biosphere reserve model (Agardy, 2010; Hoyt, 2011). Table 2 outlines the diversity of management objectives which can be achieved by each category.

In general, MPAs are set up to protect vulnerable species and ecosystems, to conserve biodiversity and minimize extinction risk, to re-establish ecosystem integrity, to segregate uses to avoid user conflicts, and to enhance the productivity of fish and marine invertebrate populations (Pauly *et al.*, 2002; Hooker and Gerber, 2004). MPAs may be created to take into consideration threats to species and habitats (Halpern *et al.*, 2008; Agardy *et al.*, 2007). MPAs are also useful in terms of providing a public focus for marine conservation (Agardy, 1997). A given MPA may have any one or several of the above goals. A highly protected MPA, or marine reserve, set aside as a no-take, or so-called IUCN Category I, area could be useful for marine mammal conservation by helping predators and prey to recover (Bearzi *et al.*, 2006). Of course, setting up an MPA around cetaceans which function as umbrella species can often result in positive effects for many other species (Simberloff, 1998; Hoyt, 2011).

MPAs for cetaceans require targeted management measures to address species and ecosystem threats either as part of the MPA itself or through laws and regulations in each country. Currently, in terms of conservation of most cetacean populations, most MPAs are too small, too few in number, and weak in their protection and enforcement measures; many are "paper reserves"—MPAs in name only (Hoyt, 2011). The best MPAs, however, hold promise for marine species and ecosystems with their focus on substantial highly protected zones, their use of ecosystem-based management (EBM) principles, and their inclusion as part of larger MPA networks. A few MPAs are already showing conservation results for cetacean populations such as gray whales (*Eschrichtius robustus*) (Hoyt, 2011, 2015) and New Zealand Hector's dolphins (*Cephalorhynchus hectori*) (Gormley *et al.*, 2012). Good overall indicators of MPA effectiveness are given by Edgar *et al.* (2014) who identified five characteristics of a successful MPA based on statistically significant outcomes on fish population metrics, including: "no-take, well enforced, old (>10 years), large (>100km²) and isolated by deep water or sand". A sixth essential characteristic, though harder to measure, is having supportive stakeholders.

Management objective	**IUCN MPA/PA category**						
	Ia	Ib	II	III	IV	V	VI
Wilderness protection	A	A	B	C	C	na	B
Scientific research	A	C	B	B	na	B	C
Species or genetic diversity	A	B	A	A	A	B	A
Environmental services	B	A	A	na	A	B	A
Natural or cultural features	na	na	B	A	C	A	C
Tourism, recreation, including commercial whale watching	na	B	A	A	C	A	C
Education	na	na	B	B	B	B	C
Sustainable use	na	C	C	na	B	B	A
Cultural attributes	na	na	na	na	na	A	B
Notes: A = primary objective; B = secondary objective; C = may be applicable; na = not applicable. Note that the IUCN category can represent an entire MPA or one zone in an MPA. Thus many MPAs contain multiple zones each with its own category.							

Table 2. The management objectives of the various IUCN MPA/PA categories
Source: adapted from Green and Paine (1997) and Hoyt (2011).

Global targets for MPAs

In 2010, the CBD countries of the world met in Nagoya, Japan, and agreed 20 Aichi biodiversity targets. Among them, directed partly at cetacean conservation, was a strategic goal to improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity. Aichi Target 11 declared that by 2020, at least 17% of terrestrial and inland waters, and 10% of coastal and marine areas, especially areas of importance for biodiversity and ecosystem services, must be conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures. As of October 2020, terrestrial areas had 15% coverage, but only 5% of them are effectively managed, short of the target. Marine areas were further behind, with 7.6% coverage and as little as 1% effectively managed[1].

In 2014, the sixth IUCN World Congress on Protected Areas or World Parks Congress (WPC), in Sydney, recommended that the target should be 30% of coastal and marine areas conserved and effectively managed by 2030. Since then, many NGOs and scientists, as well as the United Kingdom (UK) and other governments, have joined the "30 by 30" call, providing a strong benchmark to guide implementation efforts[2].

Some countries have met or exceeded their 10% commitment but many have not even come close. Obviously, 10%, or even 30%, is just a target and what matters is careful selection of the areas needing protection and effective, enduring protection of those habitats. Of note is that the targets to date have only been achieved with the designation of very large areas, especially in the Pacific, mainly through efforts stimulated by the Pew Global Ocean Legacy Program. To some extent the targets fulfilled by European countries have also fallen into this category.

Marine Protected Areas and other spatial protection measures in Europe

Most coastal or island European countries have made some progress toward marine habitat protection in their waters, including protection for cetaceans (Hoyt, 2005, 2011). In terms of fulfilling Aichi Target 11, however, the targets have mainly been filled in territorial waters far from continental Europe. Thus, the UK government designated the 638,000 sq km Chagos Islands MPA in the Indian Ocean, as well as Pitcairn, South Georgia, Tristan da Cunha, and South Sandwich Islands, yet equivalent conservation actions in waters around the UK itself have languished for years. Similarly, France has made declarations in its extensive overseas estate, including the Agoa Sanctuary (Guadeloupe and Martinique waters) in the Caribbean and New Caledonia in the western Pacific. Although not on the same scale, Spain and Portugal have more readily made MPAs in their offshore areas or territories, the Canary Islands (Spain) and the Azores and Madeira (Portugal), with modest-sized MPAs along their mainland coasts. An exception is the 87,500 sq km Pelagos Sanctuary for Mediterranean Marine Mammals, which was designated in 1999 as a transborder MPA in the national waters of France, Italy, and Monaco and partly on the high seas. In 2001, it was declared a Specially Protected Area of Mediterranean Importance (SPAMI) under the Barcelona Convention (Notarbartolo di Sciara *et al.*, 2008). More recently, however, this "MPA" has been criticized for failing to offer real protection (Notarbartolo di Sciara, 2011; Notarbartolo di Sciara and Agardy, 2016). Ship strike and noise remain as primary threats to fin (*Balaenoptera physalus*) and sperm (*Physeter macrocephalus*) whales in the Pelagos Sanctuary, as well as in the outside area west of the sanctuary, and executing a comprehensive, effective management plan remains a challenge.

Throughout most of Europe, the most prominent use of the MPA tool for conservation of cetaceans has been the European Union (EU) Habitats Directive with its network of special areas of conservation (SACs). Put in place in 1992, the Habitats Directive applies to all EU states, including the Azores, Madeira and the Canary Islands. Parts relevant to cetaceans include: Annex II (Animal and plant species of community interest whose conservation requires the designation of SACs), which, for cetaceans, includes only bottlenose dolphins (*Tursiops truncatus*) and harbour porpoises (*Phocoena phocoena*); and Annex IV (Animal and plant species of community interest in need of strict protection) which covers all the cetacean species in the marine areas of the EU, but has not been used to create habitat protection for the cetacean species requiring it.

Soon after the EU Habitats Directive was approved, a number of countries (notably Spain, Ireland, the UK, at least for bottlenose dolphins) embraced the measure, declaring various candidate areas, many of which were later approved. Portugal, Italy, Croatia and others were in the second tranche of countries whose efforts were a decade or more later, while other countries such as Greece are only recently coming up to speed, at least in terms of identifying cetacean areas. The UK was slow to approve harbour porpoise sites; just before the UK voted to leave the EU, WWF took action at the EU level against the UK and sites were then announced. With coronavirus and the economic downturn of 2020, it remains to be seen how and when these newer sites will be created.

[1] https://www.protectedplanet.net/target-11-dashboard ; fully/ highly protected is 2.6% according to https://mpatlas.org (accessed 3.11.2020)
[2] https://www.gov.uk/government/news/uk-creates-global-alliance-to-help-protect-the-worlds-ocean

SACs for coastal bottlenose dolphins form an extensive network with varying protection measures implemented by each country. The problem with most SACs is that the protection awarded to the offshore, pelagic and deep sea marine environment is extremely limited (Hoyt, 2011). In addition, when the Habitats Directive was put in place in 1992, little was known about many cetacean species so, except for bottlenose dolphins and harbour porpoises, they were not included on Annex II. The Habitats Directive and Annex II need to be updated with current knowledge about known habitats for Risso's dolphins (*Grampus griseus*), Atlantic white-sided (*Lagenorhynchus acutus*) and white-beaked dolphins (*Lagenorhynchus albirostris*), minke whales (*Balaenoptera acutorostrata*), fin whales, sperm whales and Cuvier's beaked whales (*Ziphius cavirostris*), among others, some of which carry a threatened status.

Germany, by comparison to the UK, France, Spain and Portugal, has only a small marine estate. In the Baltic, Germany has taken an active role in identifying and declaring SACs for harbour porpoise, the only cetacean species regularly present. In addition, Germany has made a substantial contribution to work toward high seas protection, including work leading to the current effort to forge a high seas agreement. The Global Ocean Biodiversity Initiative – International Climate Initiative (GOBI-IKI) programme, a suite of international spatial projects funded by the German climate initiative, is providing substantial support (2016-2021) aimed at understanding and promoting marine conservation of marine mammals and birds in national waters and on the high seas (Johnson *et al.*, 2019).

In Scotland, the MPA process has proposed 30 new Scottish MPA sites but only a few involving cetaceans (Risso's dolphin and minke whale habitats). Hopkins *et al.* (2016) highlight several issues if the Scottish MPA network is to move beyond an administrative exercise toward a meaningful contribution to marine biodiversity protection for Europe: i) fully adopt best practice ecological principles, ii) ensure effective protection, and iii) explicitly consider climate change in the management, monitoring and future iterations of the network.

In France, Spain and Portugal, an online questionnaire was administered to MPA managers, focused on multiple processes inherent to each MPA, namely on the characteristics and suitability of planning, management, monitoring, governance and enforcement (Batista and Cabral, 2016). Responses were used to calculate the overall level of MPA management effectiveness. Only 9% of analysed MPAs are larger than 1000 km2 and they are unequally distributed in the study area. Overall, 46% of MPAs and 59% of the total area covered was established during the last five years, while only 3 of the 35 no-take areas (22% in area) were implemented during this period. MPA effectiveness (i.e., the extent to which an MPA is protecting values and achieving its goals and objectives) was related to high levels of stakeholder support, with suitable goals, management and enforcement. Results highlighted the need to improve MPA coverage taking into account other existing MPAs to increase coherence and representativeness of networks, that new no-take areas should be implemented in key conservation sites and that management strategies (e.g. enforcement and monitoring) should be strengthened (Batista and Cabral, 2016). Also in EU waters, Dureuil *et al.* (2018) found widespread industrial exploitation of MPAs; of 727 MPAs designated, 59% of them were commercially trawled with the trawling intensity being 1.4 times higher within the MPAs compared to outside areas.

Non-EU countries have been slower to implement conservation measures. Iceland has the most diverse and accessible cetacean fauna in Europe including endangered big baleen whales and diverse toothed whales and dolphins. Researchers and groups have identified prime whale habitats for possible future protection including Faxaflói (also used by whalers for hunting minke whales) and Skjálfandi Bay, but the idea of cetacean MPAs has yet to gain government support (Hoyt, 2011). In Norway, including Svalbard, some areas have been protected that include cetacean habitats but Norway's whaling policy has not encouraged the idea of protecting cetacean habitat.

MPAs covering both national and high seas European waters

The North East Atlantic is unique in the world in terms of a group of nations working together to identify and implement MPAs on the high seas. The work is carried out through the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention). For each of the OSPAR High Seas MPAs created, a background document has been produced that covers the scientific rationale including the presence of marine mammals (OSPAR list species). The OSPAR MPAs are slowly gathering acceptance and the usefulness of the model has been oft mentioned in discussions of marine biodiversity in areas beyond national jurisdiction (BBNJ) at the United

Nations (UN) that hopefully will lead to a global legally binding agreement for protecting biodiversity on the high seas (D. Johnson, pers. comm. 2020).

Besides OSPAR, European waters are covered by two CMS regional conventions; the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) and the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS). Both treaties overlap OSPAR to a small extent, and ACCOBAMS in the Mediterranean includes high seas, although that will disappear as national claims extend further when Mediterranean Exclusive Economic Zone (EEZ) boundaries are agreed. Unlike OSPAR, ASCOBANS and ACCOBAMS are specifically focussed on cetaceans, although ASCOBANS only on small cetaceans.

In addition to the above, a key agreement for global marine conservation, including the high seas, was created within the CBD with its ecologically or biologically significant areas (EBSAs) which aim to identify "high seas critical habitats". These include habitat uniqueness or rarity, species or habitat fragility or vulnerability, importance for threatened or declining species or habitats, high biological productivity, high biological diversity, importance for life history stages, and naturalness. EBSA workshops have covered the Mediterranean basin, the Baltic Sea, the Black Sea and the North East Atlantic Ocean. EBSAs are not MPAs, but it would be valuable to look at the areas identified with cetaceans as candidates for MPAs and other spatial protection measures.

Similarly, the important marine mammal area (IMMA) tool—closely aligned to the EBSA and the BirdLife important bird and biodiversity area (IBA) tools—is specifically designed for the identification of marine mammal habitat from nearshore waters to the high seas (Notarbartolo di Sciara and Hoyt, 2020). IMMAs, which are not MPAs, can also provide leads for needed spatial protection measures including MPAs[3]. To date, the IMMAs have covered the Mediterranean and a small portion of the North Atlantic off Africa, but will expand further into the North Atlantic and Baltic Sea in the future.

Europe is already well disposed to work on the high seas, even without a UN BBNJ agreement. Therefore, much more progress could be made even before the agreement has been put in place. The obstacles to progress in the region appear to have more to do with gaining agreements between countries and regulating industry, and then acting upon the recommendations of scientific and country member bodies to implement MPAs with management plans, management bodies and substantial funding to make MPAs effective. It is time for governments to step up and pay attention to sustaining marine biodiversity and that means focussed efforts with appropriate budgets.

Conclusion: What is needed for MPA and spatial protection

MPAs and other spatial tools are valuable for conservation. Still, they were never going to address all the problems, threats and challenges of ensuring that highly mobile cetacean populations can recover and flourish (Hoyt, 2011). Spatial approaches need to be employed, along with threat reduction. As the CBD has pointed out, it's not just a matter of creating MPAs but ensuring that the goal is conferring sustainability upon the whole ocean. That is a tall order. MPAs have a long way to go to become the kind of tool for cetacean and marine habitat conservation, such that the whales, dolphins and porpoises themselves notice the difference.

Recommended actions

Policy

- Countries should be encouraged to go for, not just 10%, but at least 30% protection of their national waters, and similar levels for international waters once BBNJ legislation comes in.
- Governments should extend the OSPAR approach to creating high seas MPAs to more actively consider cetaceans, in anticipation of the BBNJ legislation.

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[3] marinemammalhabitat.org

- Regarding Brexit, the UK must keep its SACs and high levels of protection and implement and extend proposed MPAs for Risso's dolphins and other cetaceans in UK waters.
- The EU cannot be allowed to lose the focus on habitat conservation and needs to enhance and extend the Habitats Directive, or other legislation, to other cetacean species besides harbour porpoises and bottlenose dolphins.
- Although MPAs are the most popular and well-known spatial protection tool, the emphasis should be on creating MPAs, or modifying existing MPAs, to make highly protected IUCN Category I reserves. Other spatial tools which may be useful for cetacean protection should not be forgotten including International Maritime Organization (IMO) Particularly Sensitive Sea Areas (PSSAs) and other directives which could help to reduce noise or the risk of ship strike.
- Marine spatial planning exercises need to take into account various uses and give space to cetaceans through IMMAs, to seabirds through marine-IBAs, as well as actively promoting protection of biodiversity.

Management measures

- Managers should monitor and improve effectiveness of MPAs against their stated goals. Every MPA requires a management regime with both a management body and a plan that includes provisions for enforcement, public education, monitoring, research and periodic review and adaptive management.
- As a large, highly visible MPA for the region, the Pelagos Sanctuary requires an effective management body, implemented plan and budget, and the political will to achieve the goals of conserving cetaceans.
- Interim management measures could also be extended to IMMAs: consider adjusting or extending MPA boundaries or implementing other spatial habitat measures (IMO directives, etc.) to IMMAs newly created in the Mediterranean.
- Regarding CMS and its impact in Europe (as well as setting an example for the rest of the world), it would be valuable to put more teeth into the directives for protection adopted by ACCOBAMS and ASCOBANS parties by empowering a special citizen/stakeholder/civil society group to put in place the recommendations and adopted resolutions.

Private sector

- Authorities should regulate industrial activities in cetacean areas.
- All stakeholders should be encouraged to support MPAs by becoming part of community groups.
- Stakeholders should encourage private sector business to help with funding MPAs.

Science

- Authorities and managers should support established and novel approaches to identifying and quantifying cetacean biodiversity in national waters and on the high seas, including aerial surveys (within EEZs), shipboard transect surveys, and the latest satellite identification techniques.

Public

- Authorities and managers should establish education programmes to improve knowledge and caring about whales and the sea.
- The public should be encouraged to participate in MPA stakeholder groups.

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Cetacean Strandings, Diseases and Mortalities in European Waters

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"Cetaceans are being affected by many factors in our increasingly busy seas and it has never been more important than now to monitor their health. Working together to build functional stranding networks would help us to monitor both cetacean and ocean health."
Sandro Mazzariol

Introduction to stranding numbers and trends

Any marine mammals found dead or still alive stranded on the beach, floating near the shoreline, or being transported by sea currents are defined as stranded. Strandings are categorized as single events, involving an individual cetacean or a mother-calf pair. Mass strandings are those cases when two or more individuals are beached on the same stretch of coast over a narrow timespan. Mass strandings are considered atypical when they involve different species over a lengthy stretch of coastline and over a long timeframe.

These events are monitored and reported by stranding networks established in many countries worldwide, including many European countries. Unfortunately, different national organization, legal frameworks and funding mean that data collection is not carried out systematically. It is, therefore, difficult to extrapolate and compare stranding trends worldwide or on a continental level. However, individual, well-organized countries can report any anomalies in their stranding numbers. In Europe two major Agreements (i.e. ASCOBANS[1] and ACCOBAMS[2]) have both recommended the establishment of fully-functional stranding networks as well as the use of regional databases through which individual nations can voluntarily enter their stranding reports. Despite technical and economic limitations, some information can be extrapolated.

ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas)

The 16th ASCOBANS Advisory Committee in 2009 recommended a review of trend analyses of stranding and other data available regarding small cetaceans in the Agreement area. In 2010, an overview of trends in status, distribution and impacts on small cetaceans was presented (Evans, 2011). Systematic stranding reporting varies greatly in its coverage between countries: the UK, Netherlands, Belgium, Germany and France have the longest running and most comprehensive schemes with the Baltic States being less interested due to the very few cetaceans occurring in the region. The same pattern can be found for systematic postmortem examinations aimed at investigating the possible cause of death through a common protocol applied since 1990.

Sample sizes are greatest for harbour porpoises (*Phocoena phocoena*) and short-beaked common dolphins (*Delphinus delphis*), and so the knowledge of major causes of mortality is best for these two species. The most common causes of death for stranded harbour porpoises are bycatch, infectious disease and attacks by bottlenose dolphins (*Tursiops truncatus*) (in areas where the two species are sympatric). Trends in bycatch showed declines in the British Isles but possible increases in Belgium and the Netherlands. These trends were considered a possible combination of reduced fishing effort in the case of the UK, and geographical shifts in porpoises possibly interacting with increased fishing effort in the case of the southernmost North Sea. For common dolphins, the most common cause of death has been bycatch, followed by live stranding, although proportions of bycatch amongst postmortem examinations have generally declined. In the ASCOBANS report it is underlined that it is much easier to establish bycatch as cause of death than many other activities, such as prey depletion, pollution, noise disturbance and ship strikes.

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

In the Mediterranean regions, Black Sea and adjacent waters there is no similar ongoing initiative due to the lower presence of well-established stranding schemes and political and economical difficulties. ACCOBAMS has established a common stranding database, named MEDACES (Mediterranean Database of Cetacean Strandings), which gives details on stranding numbers and trends[3]. Unfortunately, even though almost 20,000 stranded cetaceans are reported, this database is not able to cover the entire basin since data are not provided consistently from all countries. For instance, between 2001-2008 Italy only reported 1,348 strandings in MEDACES out of the 5,500 animals reported in the Italian Stranding Database[4]. Merging these two major databases established in the Mediterranean Sea, more than 24,000

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[1] https://www.ascobans.org
[2] https://accobams.org
[3] http://medaces.uv.es
[4] http://mammiferimarini.unipv.it/index_en.php

cetacean strandings were reported between 1998 and 2018 (Figure 1) with a prevalence of striped dolphins (*Stenella coeruleoalba*) (29%), bottlenose dolphins (15%), common dolphins (15%) and harbour porpoises (9%) and a large percentage of stranded specimens remaining unidentified (21%) (Figure 2).

Causes of strandings are difficult to assess in this area due to poor body condition of the stranded cetaceans (74.7% were not well preserved according to MEDACES) and due to diagnostic difficulties in spite of a well-structured network involving veterinary laboratories established in Spain, Italy and, to a lesser extent, in France and Croatia.

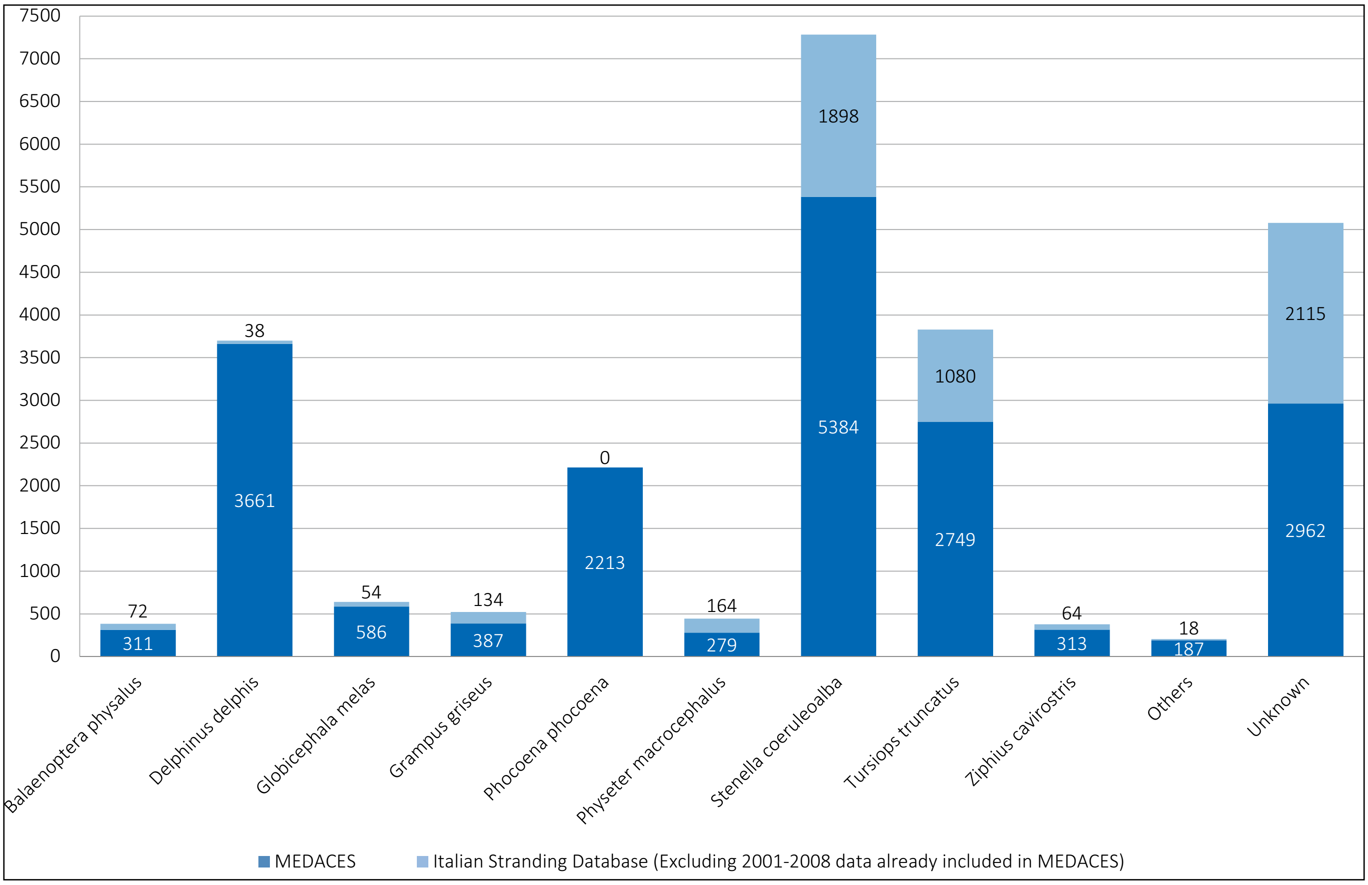

Figure 1: Total number of cetacean strandings in the Mediterranean Sea merging data from MEDACES and Italian Strandings Databases (1998 – 2018).

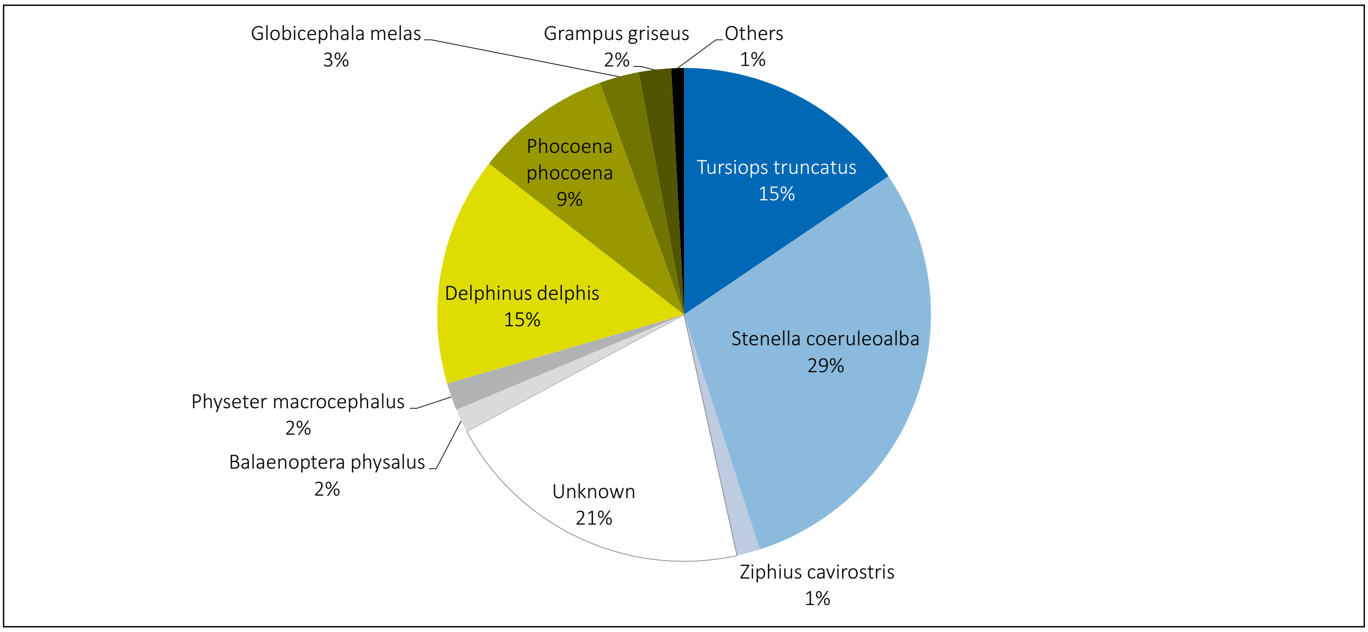

Figure 2: Percentage of each cetacean species stranded in the Mediterranean Sea (1998 – 2018).

Mortalities related to spontaneous diseases

Cetacean strandings are an important source of information for cetacean population health status, allowing not only the causes of mortality to be determined, but also the threats that affect these populations, including anthropogenic and natural risks (Peltier *et al*., 2014). Global contamination has become a great concern, especially for cetaceans, because they are one of the populations receiving high concentrations of persistent organic pollutants (POPs) arising out of an alarming anthropogenic pressure (Tanabe, 2002). Although the majority of these toxic chemicals are currently banned, significant levels still persist in the environment, accumulate in lipid-rich tissue and build up along trophic levels, thereby affecting cetacean populations all over the world. After the 1990-1992 morbillivirus epizootic occurred in striped dolphins in the Mediterranean Sea (Domingo *et al*., 1992), many publications stressed the role of contaminant levels in facilitating infectious diseases (Ross, 2002). Although direct effects of POPs are difficult to assess, many studies have related pollutant load with adverse health effects, such as immune suppression, endocrine disruption, reproductive impairment and carcinogenic effects (Martineau *et al*., 1994; De Swart *et al*., 1995; Lahvis *et al*., 1995; Schwacke *et al*., 2002; Wells *et al*., 2005; Schwacke *et al*., 2012; Yap *et al*., 2012). However, the influence of pollution in the development of diseases is not clearly evident during postmortem investigations. Emerging and re-emerging viral, bacterial, protozoal, and fungal diseases are being increasingly described in cetaceans. The most significant cetacean pathogens are reviewed here, namely *Morbillivirus, Herpesvirus, Brucella ceti* and *Toxoplasma gondii* infections, along with several additional pathogens which have gained progressive importance in recent years in European waters.

Morbillivirus

Cetacean morbillivirus (CeMV) is recognized as a biological disease agent of great concern for free-ranging cetaceans and is responsible for several outbreaks in marine mammals worldwide in the last 25-30 years (Van Bressem *et al*., 2014). Focusing on cetacean species, the most dramatic episodes affected bottlenose dolphins along the Atlantic coast of the United States in 1987-88 and in 2013-2015 (Lipscomb *et al*., 1994; Schulman *et al*., 1997; NOAA, 2019) and striped dolphins in the Mediterranean Sea between 1990 and 1992 (Domingo *et al*., 1990, 1992) and in 2007-2008 (Raga *et al*., 2008). Interestingly, before this latter event, at the end of 2006, a morbilliviral epidemic was also reported in long-finned pilot whales (*Globicephala melas*) around the Strait of Gibraltar (Fernández *et al*., 2008). In the following months, it was reported in striped dolphins and pilot whales along the Spanish Mediterranean coast as well as a pilot whale and a bottlenose dolphin found stranded on the French Mediterranean coast (Keck *et al*., 2010) and in striped dolphins in Italy (Di Guardo *et al*., 2013). In the following years other smaller episodes were reported mainly in Italian waters (Casalone *et al*., 2014; Pautasso *et al*., 2019) affecting not only small odontocetes but also larger ones (Mazzariol *et al*., 2017; Centelleghe *et al*., 2017) and mysticetes (Mazzariol *et al*., 2016).

Mortalities related to CeMV were also reported in the Black Sea involving common dolphins and harbour porpoises (Mazzariol, personal communication). In specific conditions this strain also infected other species such as pinnipeds, as in the case of a monk seal (*Monachus monachus*) mortality episode in 2000 (Van de Bildt *et al*., 2000) and in a single captive harbour seal (*Phoca vitulina*) (Mazzariol *et al*., 2013), and river otters (*Lutra lutra*) (Padalino *et al*., 2019). These peculiar epidemiological trends (small outbreaks, cross-species infections) suggest an endemic circulation among cetaceans of the Mediterranean Sea with two different lineages (Rubio-Guerri *et al*., 2018; Pautasso *et al*., 2019) infecting cetaceans living in this basin and in adjacent waters of the Atlantic Sea (Bento *et al*., 2016; Sierra *et al*., 2016). Sporadically, CeMV has been reported in the North Sea in multiple species such as white-beaked dolphins (*Lagenorhynchus albirostris*) (van Elk *et al*., 2014) and fin whales (*Balaenoptera physalus*) (Jo *et al*., 2017), after the morbilliviral epidemics affecting harbour porpoises in the late 1980s (Visser *et al*., 1993; Van Bressem *et al*., 2014). CeMV causes a systemic infection, characterized by broncho-interstitial pneumonia, lymphoid depletion with germinal centre necrosis and non-suppurative encephalitis (Domingo *et al*., 1992; Duignan *et al*., 1992; Raga *et al*., 2008; Soto *et al*., 2011). In case of recovery, as with other morbilliviral species, the immune function of the affected animal is impaired and the capability to face other diseases is consequently reduced, so these animals could also die from subsequent complications (Van Bressem *et al*. 2014).

Herpesvirus

Herpesvirus causes disease of varying severity in many species, including cetaceans. However, little is known about the distribution and the pathogenic effects of these viral agents on dolphins and whales living in the Mediterranean Sea and nearby Atlantic waters (Arbelo *et al*., 2012; Lecis *et al*., 2014; Melero *et al*., 2015).

Infections induced by herpesviruses (Esperón *et al*., 2008), have been reported in bottlenose dolphins (Blanchard *et al*., 2001), as have proliferative dermatitis lesions (Manire *et al*., 2006). Similar infections have also been described in beaked whales, namely in Cuvier's beaked whale (*Ziphius cavirostris*) (Arbelo *et al*., 2010) and in a Blainville's beaked whale (*Mesoplodon densirostris*) (Arbelo *et al*., 2012). Reports of primary herpesviral infection in free-ranging cetaceans include cases of non-suppurative encephalitis in bottlenose dolphins (Esperón *et al*., 2008) as well as in harbour porpoises living in the North Sea and Northern Atlantic waters (Kennedy *et al*., 1992; van Elk *et al*., 2016). The relationship between herpesviruses and immunocompromised hosts has been described, including the presence of systemic herpesviral lesions in a striped dolphin, probably secondary to immunosuppression caused by morbillivirus co-infection (Soto *et al*., 2012) and in common dolphins (Bento *et al*., 2019).

Brucella and other bacteria

Cetaceans living close to coastal areas, such as bottlenose dolphin populations, can be exposed to pathogens normally associated with humans or domestic animals, especially in urbanized areas. Bacteria such as *Salmonella* spp., *Escherichia coli* and *Listeria monocytogenes* have been found in some stranded animals (Davison *et al*., 2010; Grattarola *et al*., 2016). Methicillin-resistant *Staphylococcus aureus* (MRSA), a bacterial species responsible for several nosocomial infections both in human beings and in farm animals, has been isolated in free-ranging cetaceans close to the shores of Florida in the USA but also in dolphins under human care (Mazzariol *et al*., 2018b). These findings, even if they are generally detected in single animals, support the idea of a telluric biological pollution with these bacteria being carried by sewage waters or flooding from land facilities to the marine environment, with these latter events increasing due to extreme events related to climate change.

In the Mediterranean Sea, these strandings seem to be clustered closest to the shorelines of the Ligurian and Adriatic Seas where rivers or floods are able to carry bacterial pathogens from terrestrial sources. Among these bacteria, *Brucella* spp. and *Erysipelothrix rusiopathiae* are considered among the most worrying. *Brucella* spp. have been isolated from free-living cetaceans in Northern European and Mediterranean waters. While these infections are probably not fatal, they can lead to several chronic disease conditions which make animals more susceptible to other pathogens, or prevent them from feeding in an effective manner. *Brucella* spp. infections have been described in different marine mammals worldwide (Nymo *et al*., 2011). Since the first reference in these species in 1994 (Ewalt *et al*., 1994; Ross *et al*., 1994), they have been related to placentitis, abortion (Miller *et al*., 1999), and non-suppurative meningo-encephalitis (González *et al*., 2002; Davison *et al*., 2009). Based on their biological and molecular characteristics, the isolates obtained from cetaceans were distinguished into *B. delphini* and *B. phocoenae* (Bourg *et al*., 2007). Several cases of Brucella infection in bottlenose dolphins have been previously described with a wide range of induced lesions, such as pulmonary abscesses (Cassle *et al*., 2013), vertebral osteomyelitis (Goertz *et al*., 2011), and abortion and placentitis (Miller *et al*., 1999).

Initially Brucella infections were reported mainly in Northern European waters, however, in recent years, an increasing number of cases have been reported in striped dolphins and bottlenose dolphins living in the Mediterranean Sea (Alba *et al*., 2013; Garofolo *et al*., 2014; Isidoro-Ayza *et al*., 2014; Cvetnić *et al*., 2016). *Erysipelothrix rhusiopathiae* is ubiquitous and can persist for long periods in the environment, including in the marine environment (Wang *et al*., 2010). *E. rhusiopathiae* is the causative agent of erysipelas, a disease of many mammalian and avian species, mainly swine and turkeys (Kinsel *et al*., 1997). In humans, it is considered an occupational zoonosis caused by contact with contaminated animals (especially handling fish), their products and their waste (Wang *et al*., 2010). The dermatologic and acute septicemic forms of this disease have been reported in several cetacean species, including free-ranging bottlenose dolphins (Melero *et al*., 2011).

Toxoplasma gondii

Toxoplasma gondii, an apicomplexan protozoan parasite, infects a range of hosts worldwide, including several marine mammal species, in which it may cause abortion, lethal systemic disease (Dubey *et al*., 2003), and non-suppurative encephalitis (Resendes *et al*., 2002; Dubey *et al*., 2009; Di Guardo *et al*., 2010, 2011). Free-ranging bottlenose dolphins rank among *T. gondii*–susceptible hosts inhabiting the Mediterranean Sea and many other marine ecosystems worldwide. *T. gondii* is believed to be a pathogen of concern for this and other cetacean species, with a documented potential to affect their already threatened health and conservation status, as clearly highlighted by the prominent subacute-to-chronic, non-suppurative meningoencephalitis lesions reported in several striped dolphins found stranded between 2007 and 2008 along the coast of the Ligurian Sea in Italy (Di Guardo *et al*., 2010). The presence of parasitic bodies and zoites was documented in earlier studies as associated with encephalic abnormalities with the simultaneous finding of a mild inflammatory reaction, lung and lymph node levels, in the latter site a moderate to serious necrotizing lymphadenitis was also apparent. This protozoan has also been documented in large pelagic species such as the sperm whale (*Physeter macrocephalus*) and the fin whale (Mazzariol *et al*., 2011, 2012), generally as the consequence of either virus- or pollutant-induced/related immunosuppression, or cachexia/starvation. The number and the nature of infections caused by *T. gondii* underlines how this agent has spread in coastline waters likely affected by anthropogenic pressure and by coastline changes, along with the prolonged resistance of protozoan oocysts even in sea water.

Unusual Mortality Events (UMEs) in Europe

When unexpected events involve a significant die-off within a cetacean population which requires an immediate response, it is defined as an Unusual Mortality Event (UME). Large cetacean mortalities are often believed to be caused by human activities either by the media or the general public. However, according to the US National Oceanic and Atmospheric Administration (NOAA), between 1991 and 2019, only 6% of UMEs involving marine mammals were related to human activities while 14% were associated with infectious diseases, 19% with biotoxins and 13% were caused by ecological factors, while 48% had unknown causes.[5] In Europe, the lack of a centralized and systematic stranding reporting system prevents a similar data collection and response to UMEs. Despite these difficulties, it is possible to report some large mortalities involving specific causes. As mentioned previously, morbilliviral outbreaks have been responsible for many mortality outbreaks in the Mediterranean Sea since the 1990s. Recently, CeMV has also been deemed a possible co-factor in a mass stranding of sperm whales in Italy (Mazzariol *et al*., 2017) (Figure 3).

Figure 3: A mass stranding of sperm whales occurred in the Adriatic in 2014. *Cetacean morbillivirus was deemed as a co-factor in this "follow-me" stranding. © Sandro Mazzariol.*

[5] https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-unusual-mortality-events

Tragic events involving pods of this species usually occur in well-defined geographical areas such as the Adriatic and the North Seas with social, bathymetric and/or marine factors being proposed as possible causes. In most cases, human activity has been excluded as a reason for the stranding even if marine debris has been found during postmortem investigations and ocean noise sources have been considered among the possible factors (Mazzariol *et al*., 2011, 2018a; IJsseldijk *et al*., 2018).

Large mass strandings involving hundreds of common dolphins on the French coast in recent years are likely related to bycatch activities, in particular to trawling in the North Atlantic. Peltier and colleagues (2014) estimated a total of 4,000 dead animals at sea by using a drift prediction model applied to 800 stranded animals in 2015.

A similar predictive model based on drifting of carcasses helped to support postmortem investigations carried out by several countries during an UME that occurred in 2018 in the North Atlantic involving beaked whales. More than 70 beaked whales were reported dead stranded on the UK and Irish Atlantic coasts during August and September 2018, with similar stranding reports also in Iceland and Norway. Infectious or toxic diseases were unclear from pathological data, but unlikely based on epidemiological analysis with strandings incidence not consistent with infectious or toxic aetiology. Based on ocean and wind models, as well as simulations with carcass conditions and buoyancy, Brownlow (2018) hypothesized a sudden ocean noise source as the likely cause of stranding. Impulsive ocean noise sources have been spatially and temporally linked to other UMEs, mainly involving Cuvier's beaked whales in the Mediterranean and adjacent Atlantic waters. A recent report summarized all these events with more than 61 atypical stranding events involving this species in the Northern Hemisphere, spatially and temporally associated with military exercises using naval mid-frequency active sonar. The most recent events occurred in the Canary Islands (2002/2004), Almeria, Spain (2006/2011) and Greece (2011/2014) (Bernaldo de Quiros *et al*., 2019). The ban of military exercises using anti-submarine sonars in waters around the Canary Islands coincides with the absence of further beaked whale atypical mass strandings (Fernandez *et al*., 2013).

Conclusion

Strandings offer a valuable source of information regarding infectious and toxic diseases and it is essential that stranding networks are adequately funded and organized and that strandings databases are kept up to date with all available information. A number of pathogens affect cetaceans in European waters and are of particular concern when they combine with other threats affecting animal immune systems such as chemical pollution (see Chapter 9).

Recommended actions

Policy

- A functional and fully-funded stranding network is needed in each country and this should be twinned with centralized European coordination in order to obtained standardized and harmonized data which can be used for conservation purposes.
- Common procedures and national protocols should be implemented; reference laboratories should be identified with fully trained veterinarians performing necropsies.

Management measures

- Stranding networks should be linked to a centralized authority.
- Each stranded animal in appropriate condition should be collected and delivered to an appropriate veterinary laboratory.

Science

- Postmortem examinations should be carried out by trained personnel using common procedures aimed at understanding the cause(s) of death and investigating every case according to a forensic approach.

- Examination should not only aim at finding evidence of human interactions, but should be undertaken with an open mind and without expectations.
- Data should be exchanged through common databases through which information can be easily found for management and/or policy.

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Whaling in Europe: An Ongoing Welfare and Conservation Concern

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“Tens of thousands of cetaceans have been deliberately killed over the last decade in the North Atlantic, in stark contrast to the high level of protection the European Union affords them.”
Mark P. Simmonds

Introduction

Early European human settlements by the sea would have welcomed the occasional whale that stranded for its meat and other products, and ancient remains in Scotland suggest this opportunistic use of whales may have occurred as early as the Mesolithic or middle Stone Age (8500-4000 BC) (Simmonds, 2011). It is more difficult to say when organised whale hunting began but organised, and perhaps even commercial, whaling was probably initiated by the Vikings and, whilst the Basque whalers are better known, the Vikings were probably earnestly pursuing whales some centuries before them (Roman, 2005). The value of whales was formally recognised in England in 1324 when the English sovereign claimed all stranded or captured cetaceans and many British monarchs are known to have consumed cetacean flesh, including Henry VIII (Simmonds, 2011).

Early cetacean hunting in Europe would have been opportunistic and basic. Once whales had been sighted, small boats would set off to try and drive them ashore in a fashion similar to the drive hunting still used in the Faroe Islands. More organised, widespread and efficient killing followed and the Basque whalers, for example, removed some 40,000 North Atlantic right whales (*Eubalaena glacialis*) between 1530 and 1610 and the species remains critically endangered to this day (Simmonds, 2011). The efficiency of the Basques may also help explain the extinction of the gray whale (*Eschrichtius robustus*) in the Atlantic long before industrialised whaling arrived.

Whales were valued in 19th century Europe for the oil they provided, which lubricated the machines of the industrial revolution and lit the factories and streets. Industrial whaling – characterised by modern whaling techniques – began in the early 1900s and its products included whalebone, fertiliser, bone meal and meat. London, along with many other European cities, became a major whaling port. Shore-based whaling, with landing stations, overlapped for a while with far-seas whaling, which eventually took over as populations of large whales near to Europe were so diminished that they became uneconomic to hunt. Leading whaling nations, including Norway (which had a proud history of innovation in whaling techniques and exploitation) and the United Kingdom (UK), eventually sent their whaling fleets to the Southern Ocean, where the last large populations of great whales remained (Tønnessen and Johnsen, 1982). Similarly, the German Nazi-regime in the 1930s tried developing its own independent whaling fleet, which joined the hunts in Antarctica in the 1936/37 whaling season (Kersten and Entrup, 2000). Further plans to continue expanding the whaling fleet did not materialise due to the Second World War.

Soon even the remote whale populations dwindled under the onslaught of industrialised whaling. In fact, during the 20th century, more than two million whales were killed in the Southern Hemisphere alone (Clapham and Ivashchenko, 2009). More than half of this total was made up of catches of the two largest species: 350,000 blue whales (*Balaenoptera musculus*) and three quarters of a million fin whales (*Balaenoptera physalus*) – slaughtered for meat, oil, pharmaceuticals, margarine and other commercial products. Other takes included 160,000 humpback whales (*Megaptera novaeangliae*), 380,000 sperm whales (*Physeter macrocephalus*), 180,000 sei whales (*Balaenoptera borealis*), and around 160,000 others. Combined with the Northern Hemisphere takes, this adds up to the greatest removal of animals- in terms of sheer biomass- in the whole history of human hunting.

Concerns about dividing up the remaining 'stocks' between nations led to the inception of the International Convention for the Regulation of Whaling (ICRW) in 1946, which established the International Whaling Commission (IWC). In due course, these same concerns led to the moratorium on commercial whaling[1] agreed by the IWC member nations in 1982. Like many other international treaties, the ICRW allows member nations to take out reservations (or objections) to its decisions and this means nations holding reservations are not bound by what has been agreed. Many whaling nations did this in 1982, including the Russian Federation, but only Norway has made use of, and maintained its reservation through the decades until now. Hence, this Nordic country can say that its whaling is legal, even if it defies the moratorium. Iceland did not make a similar reservation at the time but some years later left the IWC. When it re-joined in 2002, its 'articles of adherence' included a reservation to the moratorium. This was, at first, refused by a majority vote of the IWC member nations but was then accepted on a second attempt at a subsequent meeting,

[1] The moratorium is implemented by ICRW Schedule paragraph 10(e) (IWC, 2018).

thereby setting a much-discussed precedent[2]. Iceland has also sometimes described its whaling as being for research, something that is allowed by Article VIII of the Convention. Not surprisingly, Iceland's claims that its whaling is legal have been robustly challenged (see for example Saxer, 2003).

Whaling in Europe in the 21st century

Coming right up to date, whaling in Europe is still conducted by several countries and territories (see Table 1) while one of Iceland's two whaling companies announced in 2020 that it would stop whaling for good[3]. The takes by Norway and Iceland of common minke whales (*Balaenoptera acutorostrata*) and, in the case of Iceland, also fin whales (which are still classified as 'vulnerable' by the International Union for Conservation of Nature (IUCN)), are clearly 'commercial.'

Species		**Country**			
Common name	**Scientific name**	**Faroe Islands**	**Green-land**	**Iceland**	**Norway (mainland and Svalbard)**
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	H	H	P	P
Beluga	*Delphinapterus leucas*	P~	HQ	P~	P
Blue whale	*Balaenoptera musculus*	P	P	P	P
Bowhead whale	*Balaena mysticetus*	P~	HQ	P	P
Common bottlenose dolphin	*Tursiops truncatus*	H	P~	P	P
Common minke whale	*Balaenoptera acutorostrata*	P	HQ	HQ	HQ
Fin whale	*Balaenoptera physalus*	P	HQ	HQ	P
Harbour porpoise	*Phocoena phocoena*	H	H	P	P
Humpback whale	*Megaptera novaeangliae*	P	HQ	P	P
Killer whale	*Orcinus orca*	P	H	P	P
Long-finned pilot whale	*Globicephala melas*	HR	H	P	P
Narwhal	*Monodon monoceros*	P~	HQ	P~	P
Northern bottlenose whale	*Hyperoodon ampullatus*	P	H	P	P
Sei whale	*Balaenoptera borealis*	P	P	P	P
Sperm whale	*Physeter macrocephalus*	P	P	P	P
White-beaked dolphin	*Lagenorhynchus albirostris*	H	H	P	P
H=Hunted without Quota, HQ = Hunted with Quota, HR = No quota but hunting restrictions (seasonal or needs-based), P = Protected, P~ = Protected but not usually present in the area					

Table 1: Status of hunting of cetaceans in the Faroe Islands, Greenland, Iceland and Norway *(Adapted from NAMMCO website[6]).*

[2] Excerpt from ICRW Schedule, Article III. "Iceland's instrument of adherence to the International Convention for the Regulation of Whaling and the Protocol to the Convention deposited on 10 October 2002 states that Iceland 'adheres to the aforesaid Convention and Protocol with a reservation with respect to paragraph 10(e) of the Schedule attached to the Convention'. The instrument further states the following: 'Notwithstanding this, the Government of Iceland will not authorise whaling for commercial purposes by Icelandic vessels before 2006 and, thereafter, will not authorise such whaling while progress is being made in negotiations within the IWC on the RMS. This does not apply, however, in case of the so-called moratorium on whaling for commercial purposes, contained in paragraph 10(e) of the Schedule not being lifted within a reasonable time after the completion of the RMS. Under no circumstances will whaling for commercial purposes be authorised without a sound scientific basis and an effective management and enforcement scheme.' The Governments of Argentina, Australia, Brazil, Chile, Finland, France, Germany, Italy, Mexico, Monaco, the Netherlands, New Zealand, Peru, San Marino, Spain, Sweden, UK and the USA have lodged objections to Iceland's reservation to paragraph 10(e)".

[3] https://www.nationalgeographic.com/science/2020/04/commercial-whaling-may-be-over-iceland/

Whales are usually pursued far out at sea in mechanised vessels using modern techniques (see Figure 1), and meat (the only major product) is sold for profit. Both in Iceland and Norway, local demand for whale meat is low. Almost all of the fin whale catch in Iceland is exported to Japan (AWI *et al*., 2014). For the rest of the fin whale meat, other uses for whale products are being invented such as dietary supplements[4]. Much of the minke whale catch in Iceland is served in restaurants to tourists, falsely claiming that these are 'traditional' local dishes[5]. Amid decreasing demand, minke whale meat in Norway is also served to tourists on cruise ships, in restaurants and at festivals, used for feed at fur farms or is exported to Japan (Altherr *et al*., 2016). Norway funds a range of projects aimed at boosting whale product sales in the country, such as the development of dietary supplements, alternative drugs or cosmetics from whale oil. Associated research is a by-product and not the primary purpose. Norway and Iceland decide upon their own quotas, they are not approved in any way by the IWC (Table 2).

Whaling (which we define here to include takes of all cetaceans) in Greenland and the Faroe Islands (both independent territories of the Danish Kingdom) is generally viewed in a different light to the hunting conducted in Iceland and Norway. The takes of larger whales by Greenland are treated by the IWC under its category of 'Aboriginal Subsistence Whaling' (ASW), which has been allowed to continue whilst the moratorium on commercial whaling has been in place and is intended to meet the 'needs' of Indigenous peoples. Greenland also harvests significant numbers of other cetaceans (see section below 'The case of Greenland').

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Figure 1: Hauling a dead minke whale onto a Norwegian whaling ship.

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[4] https://icelandmonitor.mbl.is/news/politics_and_society/2018/04/17/whaling_in_iceland_recommences_and_byproducts_used_/

[5] https://icelandmag.is/article/whaling-not-icelandic-tradition

[6] https://nammco.no/topics/hunting/

		Year										
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Iceland												
Fin whale	**Catch**	**148**	**0**	**0**	**134**	**137**	**155**	**0**	**0**	**146**	**0**	**0**
	Quota	150	154	154	154	154	171	146	175	161	161	161
Common minke whale	**Catch**	**60**	**58**	**52**	**35**	**24**	**29**	**46**	**17**	**6**	**0**	**0**
	Quota	200	216	229	229	229	275	264	269	217	217	217
Norway												
Common minke whale	**Catch**	**468**	**533**	**464**	**594**	**736**	**660**	**591**	**432**	**454**	**429**	**505**
	Quota	1,286	1,286	1,286	1,286	1,286	1,286	880	999	1,278	1,108	1,278

***Table 2: Iceland and Norway cetacean catch data and quotas 2010 – 2020**[7] (Adapted from: NAMMCO, 2020 and IWC, 2021; Ministry of Trade, Industry and Fisheries website, Norwegian Government[8]; Government of Iceland website[9]).*

Legal frameworks

Chapter 2 provides an overview of the various legal protections afforded to cetaceans, which are a mixture of domestic and international provisions (recently made more complicated by the UK leaving the European Union (EU) and moving away from being bound by the key provisions of EU law). With the IWC being the key internationally-recognised body to regulate the directed takes of whales, disagreement among Members of the IWC remain about whether its mandate covers all cetacean species, or only those listed exclusively within the Schedule of the ICRW. Indeed, the IWC has never attempted to establish quotas for small cetaceans[10], but this is, arguably, because the pro-whaling nations have campaigned successfully against this. Nonetheless, the IWC, notably via its Scientific Committee, has repeatedly highlighted cases when it believes removals of cetaceans are likely to be unsustainable, including where there are no appropriate population assessments.

There are also other international and regional agreements and treaties that relate to cetaceans in this region, such as the Convention on the Conservation of Migratory Species of Wild Animals (CMS), which prohibits the take of species listed on its Annex I. Its two regional cetacean daughter agreements have similar provisions: the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS), specifically forbids the killing of cetaceans; and the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS), in its conservation and management plan, stresses "Parties shall endeavour to establish (a) the prohibition under national law, of the intentional taking and killing of small cetaceans where such regulations are not already in force". The EU Habitats Directive[11] affords all cetaceans its highest level of protection. EU Council Regulation (EC) No 338/97, which implements the provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in the EU, is also important and bans the introduction of cetaceans into the Union for primarily commercial purposes and this is complimented by Council Regulation (EEC) No 348/81, which only allows imports of certain products listed in its Annex if they are not to be used for commercial purposes.

Countries with an interest in continuing the intentional killing of cetaceans, including the Faroe Islands, Greenland, Iceland, and Norway, developed an additional regional body – the North Atlantic Marine Mammal Commission or NAMMCO – to underpin their policies. It was established in 1992[12].

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7 Quotas are not reported to the IWC. Countries may allow unspent quotas to be carried over from one year to the next. Attempts have been made to present the most up to date and accurate data.
8 https://www.regjeringen.no/en/topics/food-fisheries-and-agriculture/fishing-and-aquaculture/whaling-and-seal-hunting/principles-on-whaling/id2505089/
9 https://www.government.is/topics/business-and-industry/sustainable-whaling-/
10 Small cetaceans are all the species not recognised as 'Great Whales' (a term used to refer to all the baleen species and the sperm whale) by the IWC.
11 EU Habitats Directive: Annex IV of Council Directive 92/43/EEC: The Directive also prohibits the keeping, transport and sale or exchange, and offering for sale or exchange, of specimens taken from the wild.
12 https://nammco.no/topics/nammco-agreement/

Ongoing hunts of small cetaceans

Faroe Islands

The Faroe Islands are situated some 200 miles to the west of Scotland and hunts of long-finned pilot whales (*Globicephala melas*) and other small cetaceans have been conducted there since at least 1584 (Parsons and Monaghan-Brown, 2017). Nowadays, the animals are still driven in their schools into bays and then to the shore where they are killed in the shallows. These hunts are similar to the 'drive hunts' of antiquity conducted here and elsewhere, except that the whales are now driven using motorboats and the hunt is managed with the aid of mobile phones and radios. From 1709 until the present day, over 250,000 pilot whales have been killed with an average of 1,200 per year (Parsons and Monaghan-Brown, 2017). This hunting technique depends on the special social cohesion of the animals concerned. Out in the open ocean, individuals cooperate to protect themselves from predators or other threats and so stick together even when driven into the danger of shallow waters. The intelligence and highly social nature of these animals raises significant welfare concerns in the context of hunting, including drive hunts. As Butterworth *et al*. (2017) put it '...despite profound differences in their body form, dolphins like our closest relatives, the great apes, are sentient, highly social mammals that exhibit complex cognitive abilities... possess self-awareness... and demonstrate epimeletic (helping and caregiving) behaviours'. They conclude that this means these animals should be protected against the 'suffering and distress' caused by drive hunts.

As well as long-finned pilot whales, dolphins and northern bottlenose whales (*Hyperoodon ampullatus*) are also occasionally taken (see Table 3). Although these takes are less widely recognised, the numbers of animals taken are not insignificant (for example 1,204 Atlantic white-sided dolphins *Lagenorhynchus acutus* have been killed since 2010).

Species		Year										
Common Name	**Scientific name**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Long-finned pilot whale	*Globicephala melas*	1,107	726	713	1,104	48	501	295	1,203	624	682	530
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	14	0	0	430	0	0	0	488	256	8	8
Northern bottlenose whale	*Hyperoodon ampullatus*	0	0	2	0	5	2	2	0	5	0	0
Risso's dolphin	*Grampus griseus*	21	0	0	0	0	0	0	0	0	0	0
Common bottlenose dolphin	*Tursiops truncatus*	0	0	0	0	0	0	0	0	0	0	0
Harbour porpoise	*Phocoena phocoena*	n/a*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 3: Faroe Islands cetacean catch data 2010 – 2020 *(Adapted from NAMMCO, 2020).* ** n/a = not applicable*

The Faroese people call their small cetacean hunts the 'grind', and there is no doubt that these hunts were once an important source of sustenance in the islands and are bound into their traditions and culture[13].

[13] Faroese writers, Kjørsvik Schei and Moberg (1991), provide this description 'And a slaughter it is: terrifying and cathartic. When the grind are close to the shore, the animals at the back are harassed, the noise increases brutally, the pressure mounts until the pilot [lead animal] of the grind dashes ahead to be stranded high up on the shore. The others follow blindly and loyally in one rapid black flow. The climax is mercifully swift, eight minutes was all it took to kill 136 whales at the grindadráp [hunt] at Leynar in Streymoy. The men leaping from their boats or waiting on the beach to draw their beautifully worked grindaknivar [whaling knives] across the heavy necks of the grind sever the main blood vessels so that the animals die within seconds.... the agility of the bullfighter is required of the grindamaour, as he stands unprotected up to his waist in bloodied water. No wonder that for a while he turns wild.'

Any modern assessment of the cruelty of the Faroese hunt must start when the drive starts and we can assume that the animals become highly stressed as loud noise is used to drive them into the alien and life threatening situation of shallow water. They are also no doubt aware of what is happening to the other school and family members as they are killed around them.

The bloody and cruel nature of the hunts has raised concerns all over the world. In 1986, the Technical Committee of the IWC, in an effort to reduce the cruelty of the pilot whale hunt, called on the Faroese government to minimise the use of the gaff or whaling hook, restrict the use of the hook from boats, and reduce the number of official 'whaling' bays used in the hunts. The Faroese government enacted these recommendations only in part, but a new blunt-ended hook was developed, although its use is not without welfare concerns (Lonsdale, 2004). Such efforts show a willingness to try to make the hunts more humane.

Whilst the claims of a long-standing tradition are clearly strong, claims that whale meat is 'good for the health of the people' (Kjørsvik Schei and Moberg, 1991) have been challenged by a series of papers that have shown, firstly, remarkably high levels of contaminants in the bodies of the whales and then, more recently, associated human health effects leading to advice to limit consumption (Weihe *et al*., 1996; Weihe and Joensen, 2008, 2012; Altherr and Lüber, 2012; NAMMCO, 2016).

Black Sea and Mediterranean

The three species of small cetaceans found in the Black Sea (Black Sea bottlenose dolphin, *Tursiops truncatus ponticus*, Black Sea common dolphin, *Delphinus delphis ponticus* and Black Sea harbour porpoise, *Phocoena phocoena relicta*) were remorselessly hunted from 1870 to 1983 when Turkey, the last nation hunting, ceased this activity (Mulvaney, 1996). One of the primary reasons for this hunting was that it was believed the dolphins were competing with fishermen for fish. The scale of takes was huge with reported catches for all three species by the Union of Soviet Socialist Republics (USSR) reaching a maximum of 135,000-140,000 in 1938. The exact number of animals killed in the Black Sea in the 20th century is unknown, but kills by the USSR exceeded 1.5 million and other range states probably killed over 4 million (Birkun *et al*., 1992). Commercial dolphin hunting was banned in 1966 by the former Soviet Union, Georgia, Bulgaria and Romania, and by Turkey in 1983. Whether there is any ongoing hunting in the Black Sea is now unclear although, in 1996, Mulvaney suggested that some hunting had resumed in Turkey.

There are also occasional anecdotal reports of dolphin killing from elsewhere, including in the Mediterranean. Together with habitat degradation, dolphin hunts in the Adriatic Sea are most likely responsible for dramatic changes in dolphin abundance in this region, with short-beaked common dolphins (*Delphinus delphis*) disappearing from the northern part of the Adriatic. Systematic dolphin culling campaigns took place in particular between the second half of the 18th century and the 1960s, although cases of directed hunts are also recorded afterwards (Bearzi *et al*., 2004). These incidents may relate to retaliation against animals because of a perceived threat to fish production activities or they may just be wanton acts of violence against animals when their curiosity or desire to bow-ride drew them close to vessels, as seen elsewhere in the world (see Vail, 2016).

The case of Greenland

The people of Greenland hunt a wide range of cetaceans (Table 4). For example, in 2018 they killed a total of 131 large whales (118 common minke whales, 7 fin whales and 6 humpbacks) and, for decades, these takes were made under IWC-approved ASW quotas. In 2012, Denmark- on behalf of its territory, Greenland- sought an increase in the existing ASW quota. In response, many countries raised concerns about the extensive commercial use of whale meat intended for subsistence purposes in Greenland, including the widespread availability of whale meat in Greenland's tourist restaurants and hotels, and Greenland's poor compliance with IWC regulations (WDC, 2012, 2020). A study conducted earlier in 2012 revealed that whale meat is sold in 77% of tourist restaurants in Greenland[14]. Despite these concerns, Denmark/Greenland refused to compromise by reducing the number of whales sought. Consequently,

[14] https://awionline.org/sites/default/files/uploads/documents/GreenlandReportAvailabilityofWhaleMeat-072012.pdf

Greenland's entire request was voted down and, because its previous quota expired in 2012, it had no quota to whale in 2013. Greenland responded by self-allocating quotas and going ahead with its whaling, clearly a violation of international law.

Greenland argues that its whale meat can be sold to anyone, as long as it is sold locally, including to tourists and other visitors to the territory. However, this mixing of commercial takes and aboriginal subsistence takes remains a fraught issue. Harrop (2011), in his review of interactions between humans and cetaceans, commented that 'Greenland operates in a strange limbo of subsistence and commerce and at the one end are true traditions, still maintained although occasionally interrupted, which derive from hunting practices that date back to antiquity and were designed to keep small polar communities alive in harsh conditions.' The line between commercial whaling and subsistence takes is nowhere more finely drawn and this has certainly caused issues at the IWC in recent years.

Another concern in Greenland is the scale of takes of other cetaceans as illustrated in Table 4 and Figure 2. From 2010 to 2020, Greenland took at least 36,332 small cetaceans (NAMMCO, 2020). Not all data for 2020 was available at the time of writing, so this figure is likely an underestimate. The science underpinning any notional sustainability of some takes is lacking as many do not even have quotas established for them (see Table 1). This deserves further independent scrutiny.

Species	Year										
Common Name	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Cetaceans hunted with quotas											
Narwhal	218	296	361	350	415	312	401	426	507	536	281
Beluga	149	151	211	305	271	127	203	196	213	263	189
Common minke whale	196	189	152	181	157	139	163	143	118	171	182
Fin whale	6	5	5	9	12	12	10	8	7	8	3
Humpback whale	9	8	10	8	7	6	5	2	6	4	1
Bowhead whale	3	1	0	0	0	1	0	0	0	0	0
Cetaceans hunted without quotas											
Harbour porpoise	2,093	2,828	2,385	2,646	2,558	2,009	2,380	2,435	2,836	2,569	–
Long-finned pilot whale	338	274	432	316	433	283	195	388	388	285	–
Atlantic white-sided dolphin / White-beaked dolphin	261	237	180	146	137	96	126	103	119	126	–
Killer whale	15	39	44	38	16	23	14	17	21	31	–
Northern bottlenose whale	11	20	14	5	11	3	3	16	0	8	–

Table 4: Greenland cetacean catch 2010 – 2020 *(Adapted from NAMMCO, 2020 and IWC, 2021. Note that data for 2020 for species hunted without quotas was not available at the time of writing).*

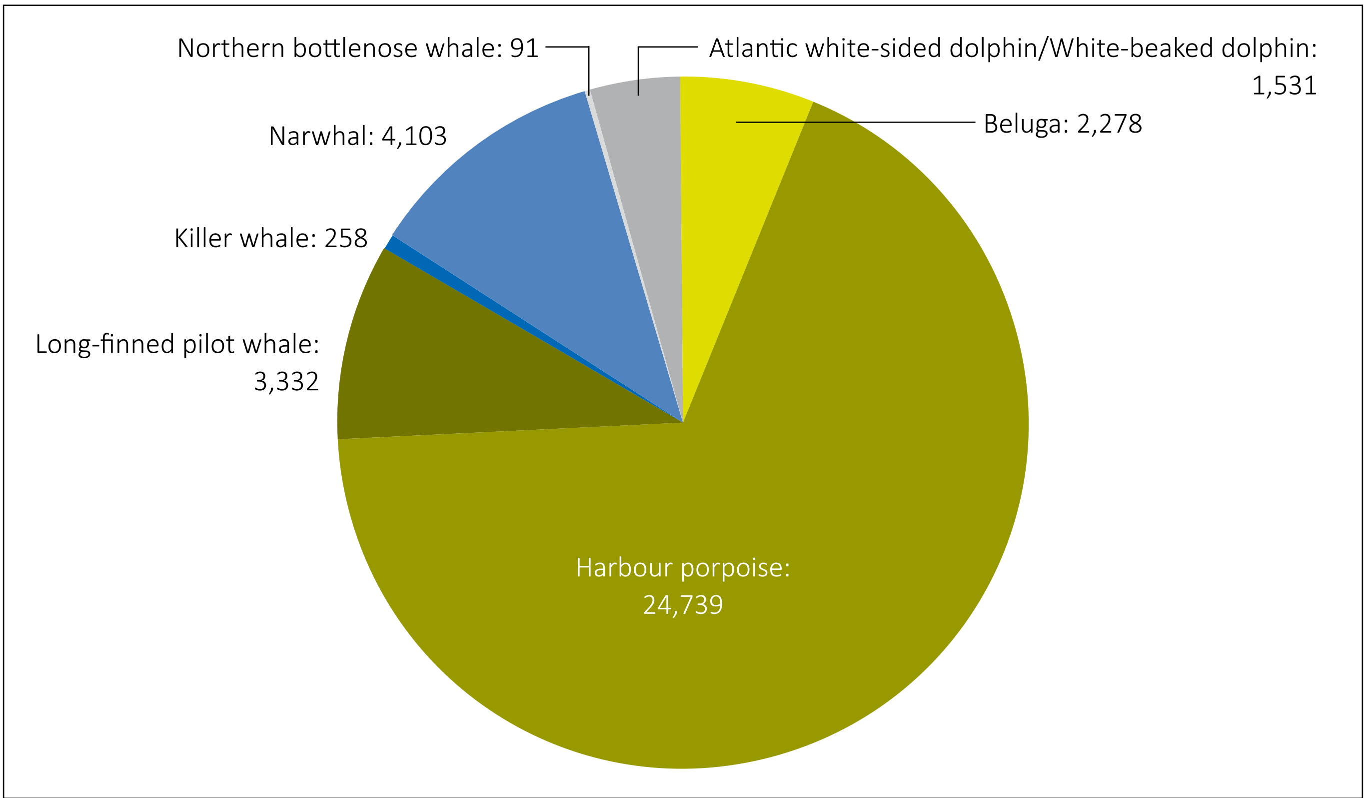

Figure 2: Small cetaceans killed in Greenland 2010-2020 (Total = at least 36,332) *(Adapted from NAMMCO, 2020. Note that not all data for 2020 was available at the time of writing).*

Clearly some small cetacean species are being heavily targeted by countries hunting in the North Atlantic. Figure 3 shows the takes of long-finned pilot whales in Greenland and the Faroe Islands and Figure 4 illustrates takes of white-sided and white-beaked dolphins in the same territories. Note that in the Faroes all takes are recorded as Atlantic white-sided dolphins but in Greenland there is no differentiation between the two species and numbers are recorded together.

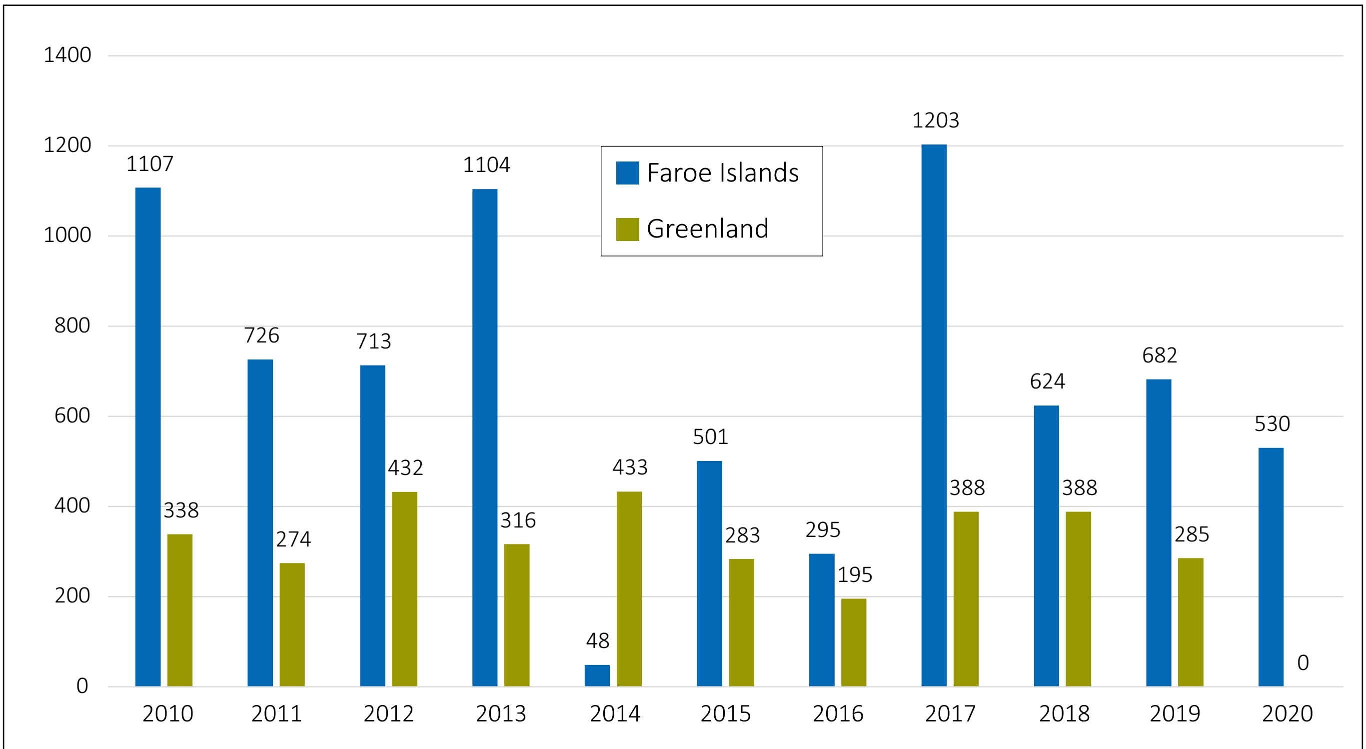

Figure 3: Long-finned pilot whales killed 2010-2020 (Total = 10,865) *(Adapted from NAMMCO, 2020. Note that data for Greenland's catch in 2020 was not available at the time of writing).*

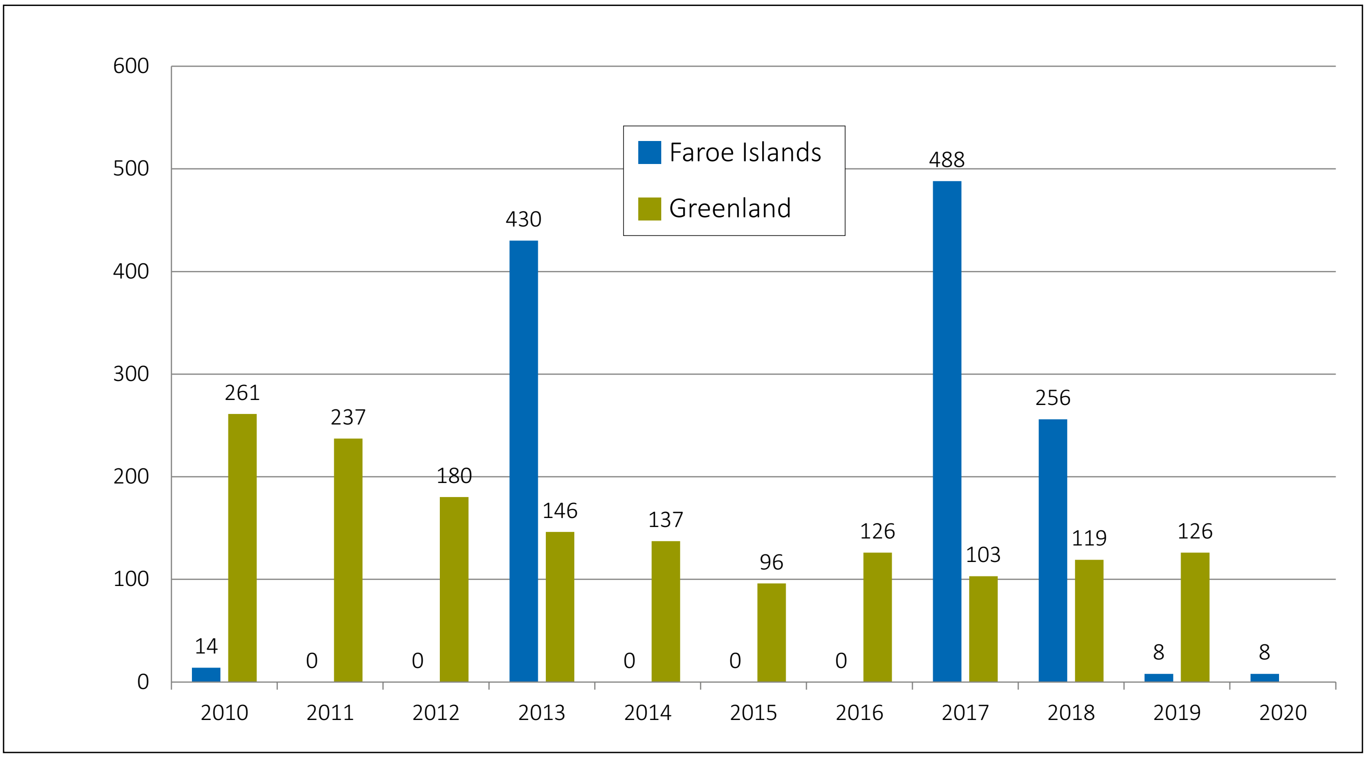

Figure 4: White-beaked and Atlantic white-sided dolphins killed 2010-2020 (Total = at least 2,735) *(Adapted from NAMMCO, 2020. Note that data for Greenland's catch in 2020 was not available at the time of writing).*

Ecological impacts of the hunts

The recent history of the organised killing of whales has revolved around the belief that there is a sustainable removal rate that can be safely achieved and many scientists have focused their efforts around calculating such numbers. Similar techniques are used to try to manage fisheries, but what needs to be remembered in the case of cetaceans is that they are long-lived social animals with relatively low reproductive rates. They are inherently unsuitable to attempts at sustainable use and this notion is reinforced by the whole history of whaling.

After the moratorium was put in place, the IWC Scientific Committee went to work on a mechanism to allow a 'safe' approach to the development of whaling quotas. This approach is known as the Revised Management Strategy (the RMS). This has never been agreed and work on it ceased in 2007, when the Commission recognised that it had reached an impasse (IWC, 2020a). One component of the RMS was the Revised Management Procedure (RMP) which allowed quotas to be calculated based on certain information including, but not limited to, population statistics. The IWC agreed to a version of the RMP in 1994 (IWC, 2020b). Norway, in its whaling rhetoric, often indicates that it is using this process in determining its takes, however it appears that they are using a revised version which provides bigger quotas and they are certainly not applying this in the context of the RMS which was how it was intended to be deployed.

As explained elsewhere in this report, whales and other cetaceans now face a range of significant threats other than being hunted and, hence, hunting needs to be viewed against these threats and the notion that quotas (where they have been calculated) are sustainable should at least take other removals and cumulative and synergistic impacts into account.

Equally importantly, and coming increasingly into public and policy focus, is the concept that whales and other cetaceans play an important role in the maintenance of healthy marine ecosystems. Before the advent of industrial whaling: as consumers of fish and invertebrates; as prey to other large-bodied predators; as reservoirs and vertical and horizontal vectors for nutrients; and as detrital sources of energy and habitat in the deep sea, the great whales would have strongly influenced marine ecosystems (Roman *et al*., 2014). The decline in great whale numbers, estimated to be at least 66% and perhaps as high as 90%, has therefore likely altered the structure and function of the oceans. Whales facilitate the transfer of nutrients by releasing faecal plumes near the surface after feeding at depth and by moving nutrients from highly productive, high-latitude feeding areas to low-latitude calving areas. Whale carcasses sequester carbon to the deep sea, where they provide habitat and food for many endemic invertebrates and the continued recovery of great whales may help to buffer marine ecosystems from destabilising stresses and could lead to higher rates of productivity in locations where whales aggregate to feed and give birth. A recent estimate puts the lifetime value of the average great whale at more than US$2 million, based on the animal's ecological services plus economic contributions such as towards tourism and fisheries, arguing that decision makers should reflect on the ecological contributions of cetaceans as a public good (Chami *et al*., 2019).

Cetacean culture and other ethical considerations

Over the past two decades, new scientific findings about the social complexity and intelligence of cetacean species, including social learning, knowledge transfer and communication, have helped to develop the scientific concept of "culture" in whales and dolphins, and also other species (Brakes *et al*., 2019). Cetaceans are now appreciated to have distinct personalities, a strong sense of self, can think about the future, and have some language skills (Simmonds, 2006). Their communities have their own culture and social structures that can only come from a sophisticated understanding of each other (Marino *et al*., 2007; Marino, 2013; Whitehead *et al*., 2004; Rendell and Whitehead, 2001). This growing body of science has led to a programme of work by the CMS on conserving animal cultures, including those of cetaceans[15].

Wildlife has always deserved our respect. Now that we understand that many species possess intelligence and culture, as well as the capacity to suffer, there is an increased moral duty on us to protect their individual liberty and protect them from hunting.

Conclusion

Between 2010 and 2020:

- Greenland, Iceland and Norway took 7,984 common minke whales;
- Greenland and Iceland took 805 fin whales;
- Greenland and the Faroes took at least 10,865 long-finned pilot whales;
- Greenland and the Faroes took at least 2,735 Atlantic white-sided and white-beaked dolphins;
- Greenland took at least 24,739 harbour porpoises.

In total, Greenland, Iceland, Norway and the Faroes took at least 53,966 cetaceans (common minke whales, fin whales, long-finned pilot whales, Atlantic white-sided, white-beaked and Risso's dolphins, harbour porpoises, narwhals, belugas, bowhead, humpback and northern bottlenose whales and orcas) from 2010 to 2020.

Whales, porpoises and dolphins are not restricted in their distributions by the lines that we draw in the sea to define our territories and a fin whale killed in Iceland would otherwise have been a whale seen elsewhere in Europe on migration or in its breeding grounds; perhaps it would have been enjoyed by whale watchers. Similarly, the minke whale killed on the border of Norwegian-UK waters is no more the property of Norway than it would have been that of the UK had it escaped southwards. So, the actions of those countries that continue to kill whales for profit undermines the conservation efforts and legislative provisions that the EU, the UK and other European countries have in place for these populations.

It is also clear that whaling in its various forms presents significant welfare concerns. At best, a whale may be killed outright (or be made fully insensible) when struck by a harpoon but this is not the situation for all the whales and other cetaceans being hunted. Deliberate killing is also the threat that is easiest resolved through political will, whereas other forms of threats, such as climate change and pollution, are much more difficult to address.

[15] See UNEP/CMS/COP13/Doc.26.4.1/Rev.1. https://www.cms.int/sites/default/files/document/cms_cop13_doc.26.4.1_rev.1_conservation-implications-of-animal-culture-and-social-complexity_e.pdf

Recommended actions

Policy

- The IWC moratorium should continue undiminished and there should be sanctions for any violations.
- There should be strict implementation of objectives of relevant Conventions and legislation.
- There should be increasing collaboration and partnerships by the IWC with other Multilateral Environmental Agreements (MEAs) in order to facilitate work to address threats of mutual concern and conservation actions addressing cetaceans.

Management measures

- There should be strict application of the EU Habitats Directive by all EU Member States.
- There should be strict application of national legislation by non-EU Member States which at least equates to EU legislation.

Private sector

- International supermarket chains should stop the sale of whale meat.
- Travel agents and cruise ships should educate tourists about the issue of whale meat consumption and also encourage them to avoid purchasing souvenirs made from whale products.

Science

- IWC Scientific Committee and/or Conservation Committee should undertake a global review about the current status of direct takes of small cetaceans and report back to the Commission (in line with IWC Resolutions 1990-3 and 1991-5).
- The IWC should continue its work on whale welfare and develop an expert panel to facilitate this.

Public

- Well-managed whale watching industries should be supported in whaling countries.
- Tourists should avoid consumption of whale meat when visiting whaling nations (what may only be a 'mouthful' for one person is magnified into many mouthfuls and many dead whales when lots of visitors partake).

Acknowledgements

The authors thank the many colleagues with whom they have discussed whaling and other directed takes over the years. The views expressed in this brief review are exclusively those of the authors and not necessarily those of any institutions that they are or have been associated with.

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Bycatch: A Serious Threat for Cetaceans in Europe

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"Bycatch is definitely the most serious threat for some populations of cetaceans, such as Baltic and Black Sea harbour porpoises and Bay of Biscay common dolphins. Unless we take immediate action, we may not be able to see those cetaceans in the near future."
Ayaka Amaha Öztürk

Introduction

Because oceans have so much to offer, humans have come to exploit them in many ways. One of the most important, yet most harmful, being fisheries. As the world population is set to exceed 9 billion by the mid-21st century, an unprecedented demand for food is putting pressure on all kinds of resources, including marine life. Humans have been fishing at sea since ancient times, but never on the scale observed in the last few decades. Around the world, roughly 80 million tons of marine fish are caught annually while the production of aquaculture has also steadily increased (FAO, 2018). In European waters 4.1 million tons of marine fish were caught in 2019[1].

Marine living resources contribute to the food security of the growing world population. Fisheries are also one of the world's most important activities, both economically and socially, with more than 40 million people engaged in fisheries, either part-time or full-time, in 2016 (FAO, 2018). This demonstrates that it is an intensive practice which has resulted in the overexploitation of some 33% of fish stocks and is, therefore, well beyond the sustainable level (FAO, 2018).

Fisheries impact not only affects target species (e.g. fish and cephalopods) but many other species both directly (e.g. discards and bycatch) and indirectly (e.g. species at higher trophic levels relying on target catch). Bycatch or incidental catch of vulnerable species including sea turtles, seabirds, sharks, rays and cetaceans has become a central conservation and welfare concern for fishing industries, resource managers, conservation organizations and scientists worldwide, including in all European countries (Reeves, *et al*., 2013; Dolman *et al*., 2016; Read *et al*., 2017). Bycatch also poses an economic problem for fishers as their fishing gear can be damaged or lost, which results in loss of time and money (Leaper and Calderan, 2018).

A welfare and conservation issue

As mammals, cetaceans surface to breathe air. If caught in fishing gear they cannot do this and eventually suffocate and die. Some bycaught animals are released from nets alive, but the majority die, sometimes subsequently washing up on shore with missing flukes, tails and fins, because fishers have cut them off to minimize damage to their nets. Other bycaught cetaceans escape, burdened by entangled nets or lines for long periods which makes diving and feeding difficult or impossible, and eventually leads to animals starving to death or dying as a result of other effects (Lysiak *et al*., 2018). See Figure 1.

Due to the demographic characteristics of cetaceans, which include slow population growth and low fecundity, bycatch is a serious threat for populations. However, another important effect of bycatch is the impact on animal welfare to both the bycaught animal and to other conspecifics (Dolman and Brakes, 2018). For example, when a nursing mother is bycaught and then unable to nurture her calf who will subsequently experience negative welfare before starving to death, or when an entire social structure is altered by the loss of individuals. The long, slow deaths of larger whales towing nets is also a severe welfare concern (Lysiak *et al*., 2018).

Figure 1: A sperm whale entangled with a driftnet in the Mediterranean. *© A. Dede*

[1] https://ec.europa.eu/eurostat/web/products-eurostat-news/-/EDN-20201016-3

A complex problem

Bycatch of cetaceans is a worldwide problem involving many kinds of fishing activities, varying in scale, fleet size and gears used, as well as many different target and bycaught species (Read *et al*., 2006; Reeves *et al*., 2013). Research on bycatch has increased over the last two decades, but accurate assessment at the current population level is lacking (Soykan *et al*., 2008) which makes it more challenging to determine the true scale of the problem.

In Europe, five types of fishing gears are particularly identified as having a cetacean bycatch associated with them. These are mid-water or pelagic trawls that are towed along either by one or a pair of vessels, static fishing gear (e.g. bottom-set gillnets), driftnets, seine nets and pot lines (Evans, 2020).

In the Mediterranean Sea, driftnets that target large pelagic fish, such as swordfish and tuna, have been instrumental in catching large numbers of cetaceans, as well as sea turtles and seabirds (Öztürk, 2015). To reduce the rate of mortality, driftnets of any length were banned across the entire basin from 2002. However, illegal use of driftnets continues, resulting in the bycatch of cetaceans such as common dolphins (*Delphinus delphis*), striped dolphins (*Stenella coeruleoalba*), Risso's dolphins (*Grampus griseus*) and sperm whales (*Physeter macrocephalus*) (Baulch *et al*., 2014). Bycatch across small-scale fisheries also poses a risk to various coastal species, however this problem has not been studied in detail.

Figure 2: A bycaught harbour porpoise in a turbot net in the Black Sea. *© A. M. Tonay*

Figure 3: A stranded bottlenose dolphin with a piece of rope tangled around its tail. *© A. M. Tonay*

In the Black Sea intensive dolphin fisheries were finally banned in 1983, but cetacean populations have been slow to recover and this is particularly true for Black Sea harbour porpoises (*Phocoena phocoena relicta*) which are victims of bycatch in turbot (*Scophthalmus maximus*) bottom set nets (Birkun and Frantzis, 2008). See Figure 2. In 2014, a survey funded by the Directorate-General for Maritime Affairs and Fisheries (DG MARE) in the western part of the Black Sea (the waters off Bulgaria, Romania and a part of Ukraine) estimated the abundance of harbour porpoises in that area as roughly 30,000 animals, while bycatch estimates reached over 4,500 (Birkun *et al*., 2014). This represents 15% of the population, which is highly unsustainable, though the scale of bycatch may have been overestimated due to inappropriate sampling. Illegal, unreported and unregulated (IUU) fishing also prevails in the basin, especially for turbot, for which no reliable data are available. Marine animals remain under threat from ghost nets: nets that fishers abandon during bad weather or to escape from relevant authorities (see Box below).

Bottom set nets, used widely along the coasts by small-scale vessels which comprise more than 80% of the Mediterranean and Black Sea fishing fleets (FAO, 2020), represent the main source of interactions between cetaceans and fishing gear. Existing data indicates low mortality of coastal species, with the possible exception of the Black Sea. However, the high number of small boats working across many ports, represents a high number of set nets deployed each day. The lack of solid data determining the abundance, population structure and threats to Black Sea dolphins and porpoises, combined with a lack of monitoring, makes it difficult to measure past and current impacts on coastal cetaceans.

In the North East Atlantic, even though the bycatch of several species, such as harbour porpoises (*Phocoena phocoena*), has been monitored and mitigation measures have been tested, major knowledge gaps exist regarding cetacean bycatch throughout the region (ICES, 2018ab). In the UK, where monitoring and mitigation measures for gillnet fisheries are implemented (Read *et al*., 2017), the estimate of bycatch for harbour porpoises reached 1,250 for vessels over 12m using pingers (see below), and 1,482 for those without pingers (Northridge *et al*., 2017). The bycatch risk assessment for the North Sea and Celtic Sea ecoregion indicated 1.1- 2.4% of the abundance estimate of 57,491 porpoises based on data from the SCANS III survey in 2016 (ICES, 2018b). This high bycatch level, despite the mitigation measures implemented, raises a significant conservation concern.

In the Bay of Biscay and the English Channel, thousands of cetaceans, primarily common dolphins, strand ashore every year (Peltier *et al*., 2016). In the first three months of 2017 and 2019, 865 and 1,100 stranded dolphins were found, respectively, on the coasts of the Bay of Biscay, of which roughly 90% were common dolphins (see Figure 4). A high proportion of these animals exhibited typical bycatch marks[2]. It is assumed that most of this bycatch takes place in pelagic sea bass (*Dicentrarchus labrax*) and albacore tuna (*Thunnus alalunga*) fisheries, but other fisheries working in the area may also be involved and monitoring is clearly insufficient. Relevant authorities need to address adverse cetacean/fisheries interactions and to take immediate action to mitigate mass bycatch. The International Council for the Exploration of the Sea (ICES), which acts as an adviser to the European Union (EU) in matters related to the Marine Strategy Framework Directive (MSFD)[3] and the Birds[4] and Habitats[5] Directives, has recently stated that to reduce common dolphin bycatch in the Bay of Biscay there should be temporal closures and that when fishing is taking place, pair trawlers should use pingers (ICES, 2020).

Figure 4: A common dolphin with net mark, stranded on the French coast of the Bay of Biscay. *© H. Peltier/Observatoire PELAGIS.*

Legislation for cetacean bycatch

There are several legal frameworks in Europe that tackle the issue of bycatch as informed by scientific evidence (Dolman *et al*., 2016). The EU Common Fisheries Policy aims to ensure fishing and aquaculture remain environmentally, economically and socially sustainable. The Habitats Directive and MSFD are in force to protect cetaceans, requiring all member states to monitor and mitigate bycatch in European waters. European Council Regulation (EC) No. 812/2004 consisted of two main components to help address this issue; monitoring (from at least 10% of vessels with an overall length of 15m or over as defined in Annex III) and mitigation (those vessels of 12m or more with acoustic deterrent devices (ADDs) or 'pingers' as identified in Annex I). Many countries worked hard to comply with this regulation while some had not necessarily taken the same steps. Compliance by EU member states in northern Europe varied (Read *et al*., 2017) and had not been fully achieved before the Regulation was repealed in 2019. Cetacean bycatch is now addressed by Regulation (EU) 2019/1241 on the conservation of fisheries resources and the protection of marine ecosystems through technical measures (European Parliament, 2019).

The Code of Conduct for Sustainable Fisheries has set guidelines under the UN Food and Agriculture Organization to address massive fish consumption and aims to ensure economically, socially and environmentally sustainable use of marine living resources globally (FAO, 2015). Several international and intergovernmental organizations, such

[2] https://www.observatoire-pelagis.cnrs.fr/actualites-240/actualites/article/les-mortalites-de-petits-cetaces?lang=fr
[3] https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm
[4] https://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm
[5] https://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm

as ICES, International Whaling Commission (IWC), as well as agreements and conventions such as the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS), the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) (under the Convention on the Conservation of Migratory Species [CMS] umbrella), and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) have established specific articles, resolutions and guidelines that acknowledge the seriousness of bycatch and aim to reduce its effect as high priority (e.g. ACCOBAMS, 2004; ASCOBANS 2015a).

Even if all member states comply with the regulations and adopt coherent and coordinated measures, IUU fishing activities will regrettably continue in European waters (Baulch *et al*., 2014; Öztürk, 2015). With limited data available to determine how IUU fishing impacts cetaceans and other protected marine species in terms of bycatch, it is urgent to halt the practice.

The endangered Baltic harbour porpoise is also threatened by bycatch, resulting in a new agreed conservation action to urgently address its situation and also that of the Iberian harbour porpoise at the last Conference of Parties to the CMS (CMS, 2020). ICES (2020) advises that a combination of spatial-temporal closures and the use of pingers in static nets fisheries should be implemented to reduce harbour porpoise bycatch in the Baltic Proper. ICES also advises that all fisheries of concern should be closed.

Monitoring and mitigation measures

Regulation (EU) 2019/1241 aims to ensure that incidental catches of marine mammals, marine reptiles, seabirds and other non-commercially exploited species do not exceed levels provided for in EU legislation and international agreements that are binding on the EU. Member states are required to put in place technical measures in support of this and mitigation measures to minimize and, where possible, eliminate the catching of such species by fishing gear.

Recently, countries including Canada, the United States of America, Australia, New Zealand, Denmark, the United Kingdom, the Netherlands and Germany, and regional fisheries management organizations have started using Remote Electronic Monitoring systems (REMs). REM includes integrated on-board systems of cameras, gear sensors, video storage and GPS to record images of fishing activities with associated sensors and exact positions. Although developed to monitor various parameters of fishing activities, REM can be used for monitoring bycatch of protected species, such as cetaceans (ASCOBANS, 2015b). Because this system is costly for fishers to deploy, it needs the joint support of fishers, industries and managing authorities to achieve better management.

Strandings of cetaceans exhibiting signs of bycatch are indicative of bycatch levels (Peltier *et al*., 2016) and sound the alert to a larger problem. However, it is important to note that stranding data regularly underestimates incidences of bycatch mortality. To mitigate or reduce cetacean bycatch, it is effective to incorporate fishery schemes including temporal and spatial closures of relevant fisheries, reducing soak time, changing the deployment depth of the nets, and reducing the number of boats in hotspot areas. However, these measures are not appealing for fishers, because they often represent a potential economic loss.

Gear modification including the use of ADDs, which were compulsory for a limited number of vessels under Regulation (EC) No. 812/2004 and are required in certain cases under Regulation (EU) 2019/1241 as well, can be deployed on fishing nets to emit sounds that alert cetaceans to the presence of nets. These small battery-operated devices are placed 200-500m apart on the nets, necessitating a sufficient quantity of pingers to function effectively. Although individual pingers are inexpensive, larger quantities are costly to deploy and replace. They have been tested for harbour porpoises but are not necessarily effective against other species such as bottlenose dolphins (*Tursiops truncatus*) (Dawson *et al*., 2013).

Collaboration with fishers and fishing communities needs to be encouraged through awareness raising campaigns, education and outreach, and coordinated policy at a local, national and international level. These concerted actions are essential among EU and neighbouring non-EU countries which share the same marine resources.

Conclusion

Although monitoring efforts and mitigation measures have increased in recent years, bycatch remains a major concern for cetacean conservation and animal welfare in European waters. The absence of data of both sufficient quantity and quality hinders the definition of clear management targets. Fisheries in European waters are highly diverse and limited studies make strategic decisions difficult. Therefore, it is recommended that a risk-based regional approach in all aspects of fisheries is adopted to achieve effective monitoring and mitigation of cetacean bycatch. While no magic solution exists for such a complex issue, the responsibility of cetacean conservation falls upon the European states who need to seek solutions through collaboration with all stakeholders – fisheries, industries and scientists, including those of neighbouring non-EU countries.

Ghost nets

'Ghost nets' are fishing gear abandoned in seas. Fishing gear can be lost accidentally during rough weather, but it can also be abandoned deliberately. The main impacts of abandoned or lost fishing gear are: continued catches of fish and other animals such as marine mammals (including cetaceans), sea turtles and seabirds which are trapped and die; alterations of the sea-floor environment; navigation hazards which can cause accidents and damage boats. Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG) makes up around 10% (640,000 tonnes) of all marine litter (Macfadyen *et al.*, 2009). There have been some efforts to retrieve these nets, but much more effort is needed.

Recommended actions

Policy

- Conservation needs should be coordinated at a local, national and international level especially where neighbouring EU and non-EU countries share marine resources.
- Measures need to be brought in to stop all IUU fishing.

Management measures

- There should be effective monitoring of fisheries with bycatch.
- Ghost gear recovery programmes should be elaborated and implemented.
- Collaboration should be encouraged between all stakeholders in order to find solutions.
- Emergency measures, such as temporal and spatial closures for fishing, should be taken when mass bycatch is detected.

Science

- Effective bycatch mitigation measures should be developed urgently.
- Improved data gathering regarding the scale of the problem particularly for the common dolphin in the Bay of Biscay, the Baltic Proper harbour porpoise and the Black Sea harbour porpoise. This requires accurate abundance estimates as well as bycatch data.

Public

- Ask fish retailers to question their providers to try to ensure that sources are sustainable and do not pose a risk to cetaceans.

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Whale and Dolphin Watching in Europe

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"What was once seen as a completely benign industry now has the potential to be a threat to individual whales or whale populations if not properly conducted and managed."
Erich Hoyt

Introduction

Whale watching refers to the commercial activity of viewing any of the 90 species of whales, dolphins and porpoises in their natural habitat (Hoyt, 2001; IFAW *et al*., 1995; see also[1]). The wide variety of whale watching activities includes tours lasting from 1 hour to 2 weeks, using platforms ranging from kayaks to cruise ships, from land points including cliffs and beaches, from sea planes and helicopters, as well as swimming and diving activities in which the whale watcher enters the water with cetaceans. Whale watching grew out of the traditions of bird watching and, to a lesser extent, other forms of land-based wildlife watching. To this day, the better whale and dolphin trips include sightings of seabirds, seals, turtles, and other marine fauna to appeal to more people as well as to give a well-rounded ecological interpretation (Hoyt, 2012).

The first commercial whale watching tours occurred in southern California in 1955, with a fisherman charging $1 USD for a short trip to view gray whales (*Eschrichtius robustus)*. People were already coming in the thousands to see the whales from the cliffs and near lighthouses during their winter and late spring migrations. By 1959, Ray Gilmore, a US Fish and Wildlife Service biologist, had begun acting as a naturalist on whale watching trips out of San Diego (Hoyt, 2001).

The global growth of whale watching

Whale watching became big business soon after it started up in Provincetown, Massachusetts, in 1975, with multiple operators in at least seven communities taking approximately 1 million people a year to see whales (Hoyt, 2001). These were largely the reliable humpback whales (*Megaptera novaeangliae*), with occasional sightings of fin whales (*Balaenoptera physalus*), minke whales (*Balaenoptera acutorostrata*), North Atlantic right whales (*Eubalaena glacialis*) and Atlantic white-sided dolphins (*Lagenorhynchus acutus*).

The continuing success of Massachusetts whale watching is generally explained by the proximity to large population centres (Boston to New York); the high quality of the narration, with scientists informing people about the individual whales they are studying; the reliability of good sightings featuring the acrobatics of humpback whales; the accessibility, including proximity to shore; and the rapid development of the industry from the use of fishing boats to the second stage of special purpose whale watching boats with large flat, comfortable platforms for photography and rain/sun cover. These larger ships could accommodate at least 150 people. They were faster but also quieter and two or three separate trips could be done per day in peak season.

By the late 1980s, whale watching was spreading around the world, even to the whaling countries of Japan and Norway. *Whale Watching 2001*, a comprehensive report on whale watching worldwide, revealed a growing industry in established countries, expanding to new countries. The growth rate through the 1990s (12%) was 3-4 times the rate of overall tourism (3-4%) (Hoyt, 2001). When whale watching was next measured in 2008, the average annual growth rate had slowed to approximately the same rate as overall tourism (Table 1) (O'Connor *et al*., 2009). But the rapid increase over the previous decade had created problems in many areas. For the most part, these were management problems similar to other tourism businesses. But what was once seen as a completely benign industry, especially compared to whaling, was now being viewed, in a few areas, as a potential threat to individual whales or whale populations if it was not properly conducted and managed.

Much is made of the commercial aspects of whale watching, but it is also useful to consider the educational, scientific, conservation and recreational aspects. These aspects explain some of the broad success of whale watching and show its value in a wider sense than commerce alone. Five international workshops on whale watching in the 1990s and early 2000s productively considered these other aspects, and helped to build the argument that whale watching at its best could be a sustainable industry offering positive impacts not only for business, but for local communities, tourists, students, and the whales themselves (IFAW *et al*., 1995, 1997; IFAW, 1999; Hoyt, 2001, 2005, 2018; O'Connor *et al*., 2009, etc.).

[1] https://wwhandbook.iwc.int/en/

Tourism Year	No. of whale watchers worldwide	Average Annual Growth Rate (%)	Direct Expenditure (millions $ USD) (a)	Total Expenditure (millions $ USD) (b)	Countries worldwide with whale watching	No. of whale watchers in Europe (c)
1981	400,000	—	$4.1	$14.0	c8	<1,000
1988	1,500,000	20.8	$11.0-16.0	$38.5-56.0	c25	<10,000
1991	4,046,957	39.2	$77.0	$317.9	c45	199,000
1994	5,425,506	10.3	$122.4	$504.3	65	605,000
1998	9,020,196	13.6	$299.5	$1,049.0	87	1,418,000
2008	12,977,218	3.7	$872.7	$2,113.1	119	1,439,000
2018	na	na	na	na	125+	est 1,800,000

(a) Direct expenditure = Cost of whale watching tour (ticket price).
(b) Total expenditure = The amount spent by tourists going whale watching from point of decision, including transport, food, accommodation, and souvenirs, as well as ticket price, but not including international air fares.
(c) Estimated numbers include Iceland, Canary Islands, Azores and Madeira
na not available

Table 1. Estimated Worldwide Growth of Whale Watching. *Sources: Hoyt (2001) and O'Connor et al. (2009).*

Whale watching in Europe

The first commercial whale watching in Europe can be dated to 1980 with dolphin-focussed tourism in Gibraltar. This was followed in the mid-1980s by dolphin tourism in the UK, Ireland and France. Various resident bottlenose dolphin (*Tursiops truncatus*) populations were easily accessible by boat and, indeed, could often be seen from shore. In the case of Ireland, the tourism was focused on a single dolphin called Fungie who lived in the harbour at Dingle, Ireland from the early 1980s until October 2020 (Hoyt, 2011).

In the late 1980s, the non-profit Tethys Research Institute began offering educational and scientific tours to see dolphins with the possibility of fin whales and sperm whales (*Physeter macrocephalus*) in the waters of the Ligurian Sea (what would later become the Pelagos Sanctuary) as well as in the Ionian Sea off Greece. Many apprentice cetacean researchers and conservationists took these tours and learned photo-ID, survey and acoustic recording methods. They are still offered today.

In 1988 tours opened up in northern Norway to see sperm whales in summer, and, a few years later, killer whales (*Orcinus orca*) in winter. Tours in Spain and the Canary Islands, as well as in the Azores and Madeira started around the same time (Hoyt, 2011). Whale watching in Iceland was embraced in the mid 1990s and soon became the fastest growing whale watching in Europe. In 2017, one out of every five visitors to the country went whale watching — 368,032 whale watchers per year[2].

In all, whale watching occurs in 22 European countries and overseas territories (O'Connor *et al*., 2009) (Table 2). It generally occurs outside of populated cities or centres and tends to be a feature of more remote ports with easy access to an area with a reliable presence of whales on a seasonal basis. In most European countries and overseas territories, it is necessary to choose carefully the best season and then to travel to one or more ports. Thus, whale watching often provides an additional tourist attraction and seasonal income for a rural locale.

[2] https://icewhale.is

Country / territory	Year started whale watching	2008 number of whale watchers except as noted	Main cetaceans watched
Gibraltar (UK)	1980	35,371	Dolphins: bottlenose, common, striped
Ireland	1986	117,000	Dolphins: bottlenose, common; porpoises: harbour; whales: minke
England	1989	91,600	Dolphins: bottlenose, common; porpoises: harbour; whales: minke
Scotland	1989	223,941	Dolphins: bottlenose, common, Risso's, white-beaked, Atlantic white-sided; whales: minke
Wales	1989	33,349	Dolphins: bottlenose; porpoises: harbour; whales: minke
Iceland	1991	368,032 (2017)	Dolphins: white-beaked, Atlantic white-sided; whales: humpback, minke, blue, killer
Norway	1988	35,400	Whales: sperm, killer, humpback, minke
Denmark	mid-1990s	100	Porpoises: harbour; dolphins: white-beaked
Germany	early 1990s	Minimal	Porpoises: harbour
France	1983	5,535	Dolphins: bottlenose, common, striped, Risso's; porpoises: harbour; whales: fin, minke, sperm, Cuvier's beaked, pilot
Portugal	early 1980s	58,400	Dolphins: bottlenose, common, striped; whales: fin, killer, pilot
Madeira	1998	59,731	Dolphins: bottlenose, short-beaked common, Risso's, striped, pantropical spotted; whales: false killer, short-finned pilot
Azores	1989	40,180	Dolphins: bottlenose, spotted, common, Risso's, striped; whales: blue, sperm, pilot, various beaked
Spain	late 1980s	74,600	Dolphins: bottlenose, striped, common, Risso's; whales: fin, minke, sperm, long-finned pilot, killer, Cuvier's beaked
Canary Islands	late 1980s	611,000	Dolphins: bottlenose, common, spotted, rough-toothed; whales: pilot, sperm, Bryde's, Cuvier's beaked
Malta	early 2000s	minimal	Dolphins: bottlenose
Monaco	early 1990s	minimal	Dolphins: bottlenose, common, striped; whales: fin, minke, sperm, Cuvier's beaked, pilot
Italy	1988	14,400	Dolphins: bottlenose, common, striped, Risso's; whales: fin, minke, sperm, Cuvier's beaked, pilot
Croatia	1991	24	Dolphins: bottlenose
Cyprus	late 1990s	100	Dolphins: bottlenose, common, striped
Greece	late 1980s	3,283	Dolphins: bottlenose, common, striped; whales: sperm
Slovenia	early 2000s	21	Dolphins: bottlenose

Table 2. European countries and territories with whale watching. *Sources: Hoyt (2001) and O'Connor et al. (2009).*

Problems and successes with whale watching

The explosive growth in whale watching has put a spotlight on management. In areas with multiple operators offering two-three times daily tours, and especially in confined geographical areas, typical scenarios include: too many boats on the water in a confined area due to the size or location of cetacean critical habitat; too many close approaches; strain on the infrastructure of a community and the environment of cetaceans from too many visitors; disputes and a competitive atmosphere among tourism companies; ineffective guidelines, regulations and enforcement; and poor compliance to existing rules (Higham *et al*., 2014; Hoyt, 2018).

The problem of vessel crowding first appeared in European waters, off South Tenerife, in the Canary Islands in the late 1980s and early 1990s (Hoyt and Parsons, 2014). A local population of pilot whales (*Globicephala melas*) and bottlenose dolphins became the subject of unregulated watching and swimming tours with nearly 100 boats on the water. Many were visiting, unlicensed yachts whose skippers offered cheap trips using beluga (*Delphinapterus leucas*) and other generic photos to advertise. Many of these tours were drinking cruises with loud music, no guides and a casual atmosphere toward safety (Hoyt, 2012). In the late 1990s, the Canaries government ran operator workshops and, with the advice of NGOs, took action, removing unlicensed boats, offering further training programmes, and using a government boat to enforce regulations.

By contrast, South Africa and New Zealand avoided some whale watching problems by establishing permit systems before the industry developed and offering a limited precautionary number of permits (Hoyt, 2018). Both countries have whale watching opportunities spread out along extensive coastlines which means there is a generally lower potential for boat congestion (Hoyt, 2012). This has also been true in Iceland with at least five separate areas of the country from which different kinds of whale watching have developed, thus avoiding, or at least postponing, the problem of too many boats in a given area.

Whale watching problems may also develop with only a few boats in a confined area. In Doubtful Sound, New Zealand, the local bottlenose dolphins were displaced (Lusseau, 2003, 2006). When the population or species is endangered or vulnerable for various reasons aside from whale watching, such as with southern resident killer whales in the US-Canadian west coast, or various river dolphins in South America and Asia, the respective confined areas can present problems for management, and whale watching boat traffic may need to be restricted by distance or time regulations, as well as by limiting the number of boats.

Recent worldwide research has found short-term behavioural responses of whales and dolphins to whale watching boats. Responses range from cetaceans avoiding or approaching boats; suddenly changing speed or direction; staying down longer; reducing the time spent resting, socializing or foraging; altering vocalization patterns or other natural behaviour (Higham *et al*., 2014; New *et al*., 2015). Some of these studies have focussed on European populations of whales and dolphins, showing cetacean reactions to various kinds of boats including avoidance of traffic lanes (e.g., Papale *et al*., 2012; Campana *et al*., 2015, 2017). Individuals, populations and species vary considerably in their reactions to the same stimulus; the whales' reactions to boats may vary depending on the behaviour they are engaged in (feeding, breeding, resting). Certain individuals may appear not to react at all (New *et al*., 2015). Behavioural responses can also differ according to vessel type, number of vessels and closeness of the approach. The "masking" effects of vessel noise may pose a problem for whale species in a situation where they are dependent on sound to communicate, navigate, forage or breed (Erbe, 2002; Foote *et al*., 2004; Sousa-Lima and Clark, 2008). But what is the impact of these short-term behavioural responses? In most cases, it remains to be seen, but a precautionary approach is advisable. Long-term negative impacts can be demonstrated in several cases such as the dolphins in Shark Bay, Australia whose reproductive success declined following interactions with humans who watched and fed them (Bejder *et al*., 2006a, b; Foote *et al*., 2004; Higham *et al*., 2014; Lundquist, 2014; Report of the Workshop on the Science for Sustainable Whalewatching, 2004; Williams *et al*., 2002, 2006, 2009).

Photo-ID research in many parts of the world has revealed the surprising extent to which cetaceans have been struck by various boats and ships. It may seem more prevalent in areas such as off Hawaii and New England in the USA but that is partly due to more detailed studies and higher whale watching numbers (Lammers *et. al.*, 2013). Hill *et al*. (2017) noted that 15% of humpback whales carried scars from ship strikes. These are the whales who survived the interaction. Most of these strikes are not caused by whale watching boats, which are more aware of whale presence and behaviour, and are normally careful when close to the whales. Still there are accidents. More detailed photo-ID and other monitoring studies in European waters will, no doubt, turn up more cases; better reporting is needed.

In a few cases in Mexico, Dominican Republic, New Zealand and western Canada, there have been deaths of whale watchers during whale watching. Mostly these are boat accidents but a few incidents are the result of whales breaching and accidentally landing on boats. The number of boats in an area and the degree of congestion are both factors in such accidents, but safety provisions (or the lack thereof) also play a part.

With the lower volume of whale watching in Europe, fatal interactions between whales and humans are far less likely, although the threat is always there. An important issue in European waters is that whale watching often takes place in very busy waterways with whales and dolphins which are recognised as having a vulnerable or endangered status. As such, the industry should not be earmarked for substantial growth or development, but should seek to consolidate and improve what already exists through a framework of guidelines, regulations, monitoring, scientific research, and strong focus on educational engagement with customers and through the enhancement of the role of naturalists or guides.

Toward high quality whale watching

Well-managed whale watching tourism requires a government policy protective of cetaceans and their habitats, featuring a competitive permit system, and a regulatory and enforcement regime to control the number of operators engaged in marine tourism, the number of boats on the water and the rules to limit the closeness of their approach as well as the amount of time spent with the cetaceans (Higham *et al*., 2009, 2014; Hoyt, 2012, 2018; IFAW *et al*., 1995). A practical, precautionary plan would keep one-third of every cetacean tourism area and one-third of daylight hours free from any tourism activity (Hoyt, 2012, 2018; Tyne *et al*., 2014). Such restrictions on areas and times would also prove useful for researchers needing controls for comparative studies (Williams *et al*., 2002, 2006). Management of this industry should also be actively engaged in the education of whale watching tourism operators, passengers, and recreational vessel operators who use the same waters as whale watching boats. Central to education, especially on tour boats, is the role of the naturalists who are the public face of whale watching tours as well as marine protected areas (MPAs) (IFAW *et al*., 1997; Hoyt, 2012). Tourist surveys and expert workshops have led to the formulation of effective interpretation programmes to achieve greater tourist satisfaction (IFAW *et al*., 1997; Orams, 1999). Naturalist guides can act as a bridge between the largely urban wildlife tourists and the ocean.

Still other strategies attempt to manage the development and practice of cetacean tourism to minimize the risk from adverse impacts. In some areas of the world, watching whales from a large, comparatively quiet ship may reduce the pressure exerted by numerous small boats with outboard engines. Whale watching tourism needs to adopt the principles of the best bird and land-based wildlife watching — unobtrusive watching stations, or blinds, the ethic of watching without disturbing natural behaviour and the idea of leaving the lightest possible footprint (Hoyt, 2012).

The sustainability of whale watching, mainly in European waters, has been examined in the Canary Islands, Scotland, and the Mediterranean as well as in Croatia and Spain in the Strait of Gibraltar (Woods-Ballard *et al*., 2003; Lambert *et al*., 2010; Pace *et al*., 2015). Hoyt (2005) offers a checklist toward sustainability with specific assessments at the intersection of whale watching and MPAs specifically in the Atlantic region.

Whale watching has much to offer for education, science, conservation as well as commercial benefit, but utilising a responsible, sustainable approach is the only way that it will have a long-term future in Europe.

Recommended actions

Policy

- Whale watching tours should be controlled by permits from government authorities with precautionary carrying capacity established for each area limiting numbers of boats/ operators.
- Permits from authorities must only be awarded contingent on contributions to public education and science as priorities, and the provision of qualified naturalist guides on every trip.

Management measures

- Authorities and managers must monitor and improve effectiveness of whale watching against the guidelines devised by operators and communities. A compilation of worldwide regulations and guidelines is available from IWC (Carlson, 2014) (See also https://wwhandbook.iwc.int/en/).
- Naturalist guides should be mandated on every boat with certified training programmes for guides.
- Guidelines should be agreed by operators, researchers, managers and authorities or regulators working together, as well as legal regulations with teeth of enforcement.
- Guidelines and regulations must be individually tailored to a given area. There should be no 'one size fits all' approach to whale watching management because different species and populations with different sets of variables react differently around boats.
- Where possible, whale watching should be managed within the structure of an MPA with zoned no-go areas and times. Recommended guideline would be one-third of time and space to be free of whale watching boats (Hoyt, 2012; Tyne *et al*., 2014).

Private sector

- Whale watching operators should change their emphasis on encounters and getting close to whales; they can assist with training of good naturalist guides.
- Whale watching operators must be encouraged by authorities to provide a more educational experience and to offer their boats as scientific platforms for research, as well as to seek improved integration with local coastal communities.

Science

- Scientists should be engaged and lead the way to ask for more science (photo-ID, acoustics) to be done from whale watching vessels, with provisions for free use of whale watching platforms.
- Independent studies should also be encouraged to monitor the effects of whale watching on whales and dolphins, and on the ocean environment.

Public

- Managers and operators should devise and implement extensive education programmes to improve knowledge and caring about whales and the sea.
- Managers should provide specific education programmes for boaters to help modify whale interactions with private vessels.
- Managers and operators should engage the public in fun events that have commercial and educational value such as whale watching festivals (popular in Mexico, California, South Africa).

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The Threat Posed by Ocean Noise Pollution to Europe's Cetaceans

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"Whales and dolphins live in an acoustic world, which they primarily perceive by listening. But we are filling their homes with noise pollution. It is important to their health and survival that we significantly reduce noise in the ocean."
Nicolas Entrup

Introduction

The oceans are an acoustic world: marine mammals live in a medium through which sound propagates extremely well. This explains the dependence of many marine animals on acoustics for navigation, hunting, reproduction and communication. Cetaceans are highly adapted physiologically and behaviourally to use sound (Tyack and Miller, 2002). As humans increasingly use sound underwater in our attempts to efficiently navigate, explore and exploit the seas, ocean noise pollution has become recognised as an issue of major significance and concern and a primary focus of marine mammal research over the last two decades (Simmonds *et al*., 2014). This has resulted in some relevant legislation, regional and international policy decisions, and associated guidance. Most current mitigation efforts are directed at reducing the risk of injury from exposure to intense noise, although the effectiveness of such mitigation measures in terms of risk reduction has rarely been quantified. Longer-term chronic impacts of noise, including disturbance or masking of sounds critical for feeding and reproduction, have received substantially less attention.

Several substantive reviews have considered ocean noise pollution in recent years (for example, Richardson *et al*., 1995; Simmonds *et al*., 2004; Hildebrand, 2005; Jasny, 2005; Weilgart, 2007; and Simmonds *et al*., 2014). The available evidence shows how noise can have a variety of deleterious effects on cetaceans, including:

- reducing communication ranges and obscuring sounds of interest (a process known as masking);
- disrupting reproductive behaviours;
- adversely affecting energetic budgets through interference with foraging and increased travel;
- excluding animals from certain important habitats;
- inducing chronic stress responses;
- causing temporary or permanent loss of hearing sensitivity;
- inducement of physical injury; and,
- in certain instances, causing mortality.

Research on beaked whales has demonstrated that intense noise events can have impacts at the population level (Weilgart, 2007), and noise pollution is also now appreciated to be creating widespread effects impacting many different marine species (Weilgart, 2018). Whilst many marine animals have evolved to cope with and, indeed, use sound, including the many natural sounds in the marine environment, human activities are now a major source of noise throughout many parts of the world's oceans increasing direct impacts as well as cumulative effects.

Ocean noise sources generated by human activities can be divided into two main categories: ambient, continuous noise and intense, impulsive noise (Hildebrand, 2005; Simmonds *et al*., 2014). Ambient and continuous noise mainly relates to vessel traffic, including commercial shipping and passenger ferries as well as leisure boats. Continuous noise can also be produced from drilling in oil and gas operations or some construction. Intense impulsive noise includes seismic airgun arrays for oil and gas exploration, military, research, fisheries and civil powered sonars; industrial and construction noise (notably from pile-driving for offshore wind farms); acoustic deterrent and harassment devices (used predominantly to deter marine mammal predators from fisheries and aquaculture facilities); and loud noises used in some scientific experiments. The impact of different noise sources may vary according to marine habitat. Coastal areas with heavy shipping and/or industrial activities may be most heavily affected by chronic noise pollution. However, the distinctions between continuous and impulsive noise are not necessarily perfect, as some impulsive noise can become continuous over larger distances and in certain conditions. Chronic noise can cause chronic impacts, such as masking, but also acute impacts such as hearing damage. Powerful noise sources can cause acute impacts, for example the loud noise made by seismic surveys or military sonars, but the impacts can be long-lasting, even up to a year or more after the noise has ceased, at least in invertebrates (Day *et al*., 2017; Fitzgibbon *et al*., 2017; Day *et al*., 2019).

Chronic noise

Commercial shipping is of great economic importance, providing an efficient means of transporting large quantities of goods and materials, and it is also the principal source of low frequency (5–500 Hz) background noise in the world's oceans. Studies undertaken relating the output from large ships to the characteristics of the vessel, and using measurements from more than 1,500 ships, found a linear relationship between source level and speed of most ship classes, with sound levels increasing by around 1 dB per knot of speed (Veirs *et al*., 2016). Container ships had the highest source levels. The dataset also showed that the loudest 15% of ships contribute the majority of the sound energy from shipping (Veirs *et al*., 2018). Leaper and Renilson (2012) estimated that the noisiest 10% of vessels (those that are 6.8 dB or more over the average) contribute to 48-88% of the total acoustic footprint (the sea area over which the ship noise increases the background noise over a certain level). Shipping traffic is not uniformly distributed, and this affects chronic noise pollution. The major commercial shipping lanes follow particular routes to minimise the distance travelled. Dozens of major ports and "mega-ports" handle the majority of the traffic, but hundreds of small harbours and ports host smaller volumes of traffic. There is also a related issue of collisions between shipping and cetaceans, which is causing growing concern (see box on ship strikes below).

Acute noise

Seismic exploration uses high-intensity sound to examine the Earth's crust, mainly in pursuit of fossil fuel deposits. To a lesser extent, it is also used by researchers to gather other geological information. Arrays of airguns are deployed and fired with precise timing to produce a coherent pulse of sound (Hildebrand, 2005). Oil industry airgun arrays typically involve twelve to forty-eight individual guns, towed about 200m behind a vessel, and produce source levels as high as 260 dB peak re 1 µPa at 1 m output[1] (Hildebrand, 2009). Except for nuclear and chemical explosions, this is probably the loudest human-caused underwater noise. Noise from a single seismic airgun survey, used to locate oil and gas deposits under the sea floor, can blanket an area of over 300,000 km^2, raising background noise levels 100-fold (20 dB), continuously for weeks or months (IWC, 2005, 2007). In 2015, Nowacek *et al*., highlighted the fact that technological improvements and economic market forces in petroleum and natural gas exploration had extended the spatial and temporal reach of seismic surveys, notably into higher latitudes and deeper waters, during most months of the year. They emphasised that this may have acute, cumulative, and chronic effects on marine organisms and noted that this expansion also raised issues about overlapping jurisdictions and governance. They gave the Mediterranean and north-eastern North Atlantic as examples and suggested the creation of an international regulatory instrument to try and better manage seismic surveys. However, as far as we are aware, this idea has not been further developed.

Sonar systems use acoustic energy to probe the ocean itself "looking" at objects within the water column, at the sea bottom, or within the underlying sediment. Active sonar emits high-intensity acoustic energy and receives reflected and/or scattered energy. A wide range of sonar systems are in use by civilian and military interests. Sonar systems are described as low-frequency (100 Hz - 1 kHz), mid-frequency (1–20 kHz), and high-frequency (>20 kHz) (Hildebrand, 2005). Military sonars generally cover a broader frequency range with higher source levels than civilian sonars and are operated during both training exercises and combat. Low-frequency active (LFA) sonars are used for submarine tracking over scales of many hundreds to thousands of kilometres. Mid-frequency tactical antisubmarine warfare (ASW) sonars are designed to detect submarines over several tens of kilometres.

Offshore industries can produce both acute noise, for example pile-driving during construction, and chronic noise, for example sounds produced by machinery on off-shore platforms and the noise produced by vessels or helicopters servicing offshore activities. Simmonds and Brown (2010) looked at the offshore marine renewables industry (wind farms, submerged turbines and other energy generating devices) in UK waters. They noted its rapid expansion and a lack of understanding of possible impacts on cetaceans, emphasising the desirability of countries coordinating their construction activities to try and limit noise pollution.

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[1] Loudness (also called sound pressure level, or SPL) is measured in logarithmic units called decibels (dB). The intensity of a sound wave with a pressure of 1 microPascal (µPa) is the reference intensity for underwater sound. The logarithmic nature of the decibel scale means that each 10 dB increase is a ten-fold increase in intensity. A 20-dB increase is a 100-fold increase in intensity, and a 30-dB increase is a 1000-fold increase in intensity.

International engagement with noise pollution

Growing awareness led to efforts to engage with this issue starting in the 1990s to 2000s (Simmonds *et al*., 2014). One of the first, and perhaps the most widely recognised, signs that loud noise was causing problems for marine life came from a number of very unusual live strandings of beaked whales (in some cases, different species stranding at the same time). For example, there was a spate of these in the Spanish Canary Islands between 1982 and 1989. These were linked to military exercises offshore (Simmonds and Lopez-Jurado, 1991). Other similar stranding events followed, as did considerable investigation (e.g. Jepson *et al*., 2003; Fernández *et al*., 2005). The International Whaling Commission's (IWC) Scientific Committee commented that "there is now compelling evidence implicating military sonar as a direct impact on beaked whales in particular" (IWC, 2004)[2]. The Spanish government imposed a moratorium on naval exercises in the waters of the Canary Islands in 2004 and these stranding events have not reoccurred there since (Fernández *et al*., 2013), pointing to a significant conservation success following this precautionary action.

Further to the association between strandings and loud noise sources becoming widely recognised alongside other lines of evidence, the significance of ocean noise pollution has been increasingly acknowledged by several international and regional conventions. Examples include the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) and the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS). Both have considered the threat posed by ocean noise in some detail and passed relevant resolutions, including the 2007 ACCOBAMS "Guidelines to address the impact of anthropogenic noise on marine mammals in the ACCOBAMS area"[3].

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) has also been highly proactive on this issue (CMS, 2020). Among other things, Cuvier's beaked whales (*Ziphius cavirostris*) in the Mediterranean Sea were added to Appendix I of CMS in 2014, and this was, in part, as a reaction to concerns about the impacts of noise on their relatively small and isolated populations[4]. (ACCOBAMS had passed a Resolution calling for strict protection of this species in the Mediterranean the year before[5].) In 2017, CMS also agreed to the "CMS Family Guidelines on Environmental Impact Assessment for Marine Noise Generating Activities" (CMS, 2017).

Likewise, in 2008, the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) added "noise from commercial shipping and its adverse impacts on marine life" to its work. Subsequently, in 2014, "Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life" were approved by the MEPC[6]. OSPAR (the Convention for the Protection of the Marine Environment of the North-East Atlantic) and CBD (the Convention on Biological Diversity) have also reviewed the issue in recent years (Simmonds *et al*., 2014).

The European Union's (EU) Marine Strategy Framework Directive (MSFD) (2008/56/EC)[7] explicitly requires consideration of underwater noise in the determination of Good Environmental Status (GES) by its member states, and two noise-related indicators have been defined in the Directive: one for intense sounds of short duration such as sonar, seismic surveys and pile driving (including as used to establish the foundations of wind farms), and one for chronic, low-frequency noise associated primarily with shipping.

In addition, various guidelines to help address noise impacts have been proposed. The most well-known of these have probably been the guidelines proposed by Southall *et al*. (2007). Their guidance is focused on Temporary Threshold

[2] In the years that followed, efforts were made to elucidate the mechanisms that were leading to strandings and death and, at the time of writing, it seems most likely that in many instances deeper diving cetaceans become incapacitated when exposure to loud noise causes them to change their dive pattern and develop decompression sickness, as in the case of divers with the 'bends', when bubbles of gas form in their tissues (see e.g. Jepson *et al*., 2003; Fernandez *et al*. 2005).

[3] https://www.accobams.org/wp-content/uploads/2016/06/ACCOBAMS_MOP3_Res.3.10.pdf

[4] The proposal for the inclusion of this population on Appendix 1 can be found here: https://www.cms.int/sites/default/files/document/Doc_24_1_1_Prop_I_1_Ziphius_cavirostris_%28Cuvier%27s_Beaked_Whale%29_EU.pdf

[5] Resolution 5.13 Conservation of Cuvier's beaked whales in the Mediterranean. Available here: https://www.accobams.org/wp-content/uploads/2016/06/ACCOBAMS_MOP5_Res.5.13.pdf

[6] MEPC.1/Circ.8337. April 2014

[7] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056

Shift (temporary hearing loss) and Permanent Threshold Shift (permanent hearing loss) which are physical impacts. They did not extend to behavioural responses, which are more difficult to understand and mitigate against.

Based on the outputs of the relevant international fora, we believe that the following general principles are widely agreed:

1. Measures should be taken to avoid, minimise and mitigate adverse impacts of anthropogenic underwater noise on marine and coastal biodiversity;
2. Environmental Impact Assessments (EIAs) that take underwater noise into consideration should be conducted;
3. Consideration should be given to noise pollution in management plans for marine protected areas and other critical habitat areas;
4. Further research to help better understand impacts and the effectiveness of mitigation should be conducted; and
5. Best Available Techniques (BAT) and Best Environmental Practice (BEP) should be further developed and applied. Weilgart (2019) gives some guidance on this for three noise sources (shipping, seismic airguns, and pile driving).

The Mediterranean Sea – 'A Special Study'

Thanks to the support of ACCOBAMS, a special report on noise hotspots in the Mediterranean Sea was published in 2016 (Maglio *et al.*, 2016). The Mediterranean is the largest and deepest semi-enclosed basin in the world and a major reservoir of marine and coastal biodiversity, including eleven cetacean species. The report considered the area between the Strait of Gibraltar and the Bosphorus: in other words, the whole of the Mediterranean but not the adjacent waters. It considered the position of 1,446 harbours, 228 drilling platforms, 52 wind farm projects, 830 seismic exploration areas, a number of military areas, and 7 million vessel positions. The authors found an average of around 1,500 vessels present in the area at any time, with areas of heaviest traffic levels mainly in the northern and western part of the basin and in Greek waters. The dataset also demonstrated a significant increase in seismic exploration activities, some of the loudest noise sources in the marine environment, during the period considered. The area covered by seismic surveys increased from 3.8% to 27% of the Mediterranean between 2005 and 2013.

The authors found that certain areas were exposed to multiple noise-producing human activities: the Italian part of the Adriatic Sea, the Strait of Sicily, the French Mediterranean from the Côte d'Azur to the Gulf of Fos, the Gulf of Valencia, the north-eastern part of Corsica, the higher Ionian Sea, and the coast of Campania. They compared these hot spots with key cetacean habitat areas and identified potential areas of conflict in the Ligurian Sea, the Strait of Sicily and the northern part of the Hellenic Trench. Whilst the authors stressed that their report should be seen as a "first rough review" of the real situation in the Mediterranean Sea, this kind of compilation of information serves to illustrate where noise is concentrated and may be a particular problem for cetaceans. It would be good to see this work extended and other areas in Europe similarly considered.

Specific noise issues in European waters

Shipping

International shipping transports more than 80% of global trade around the world[8] and this is set to increase[9]. European waters are exposed to intense shipping traffic, attracted by large ports, such as Rotterdam, Antwerp and Hamburg (Figure 1). The Mediterranean Sea connects the Atlantic and the Indian Oceans, as well as providing entry to the Black Sea, making the Strait of Gibraltar and the Suez Canal areas of particularly heavy shipping. The intensity of cargo and tanker shipping in the Mediterranean is shown in Figure 2.

[8] http://www.imo.org/en/About/Pages/Default.aspx
[9] https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=2563

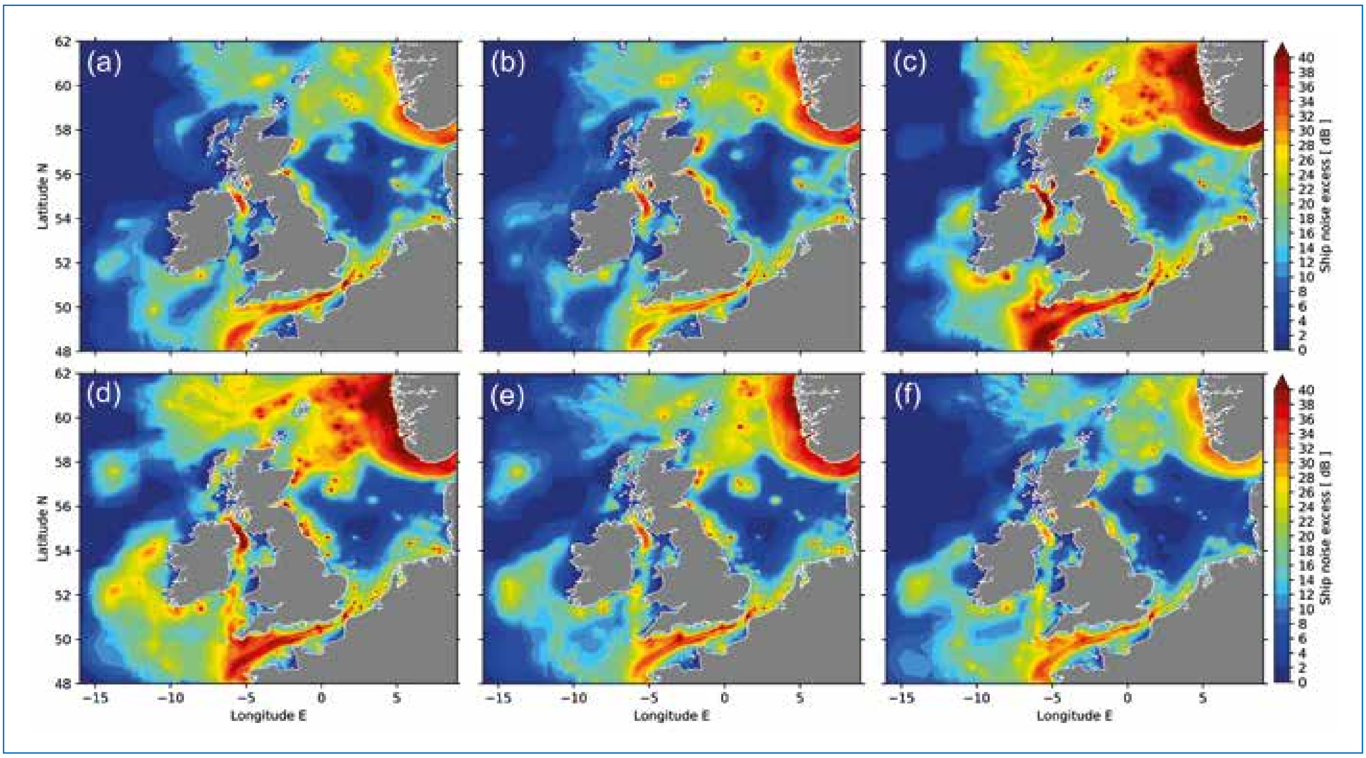

Figure 1. Median broadband ship noise excess (ship noise levels above wind) for selected months in 2017. *(a) January (b) March (c) May (d) July (e) September (f) November (From Farcas et al., 2020).*

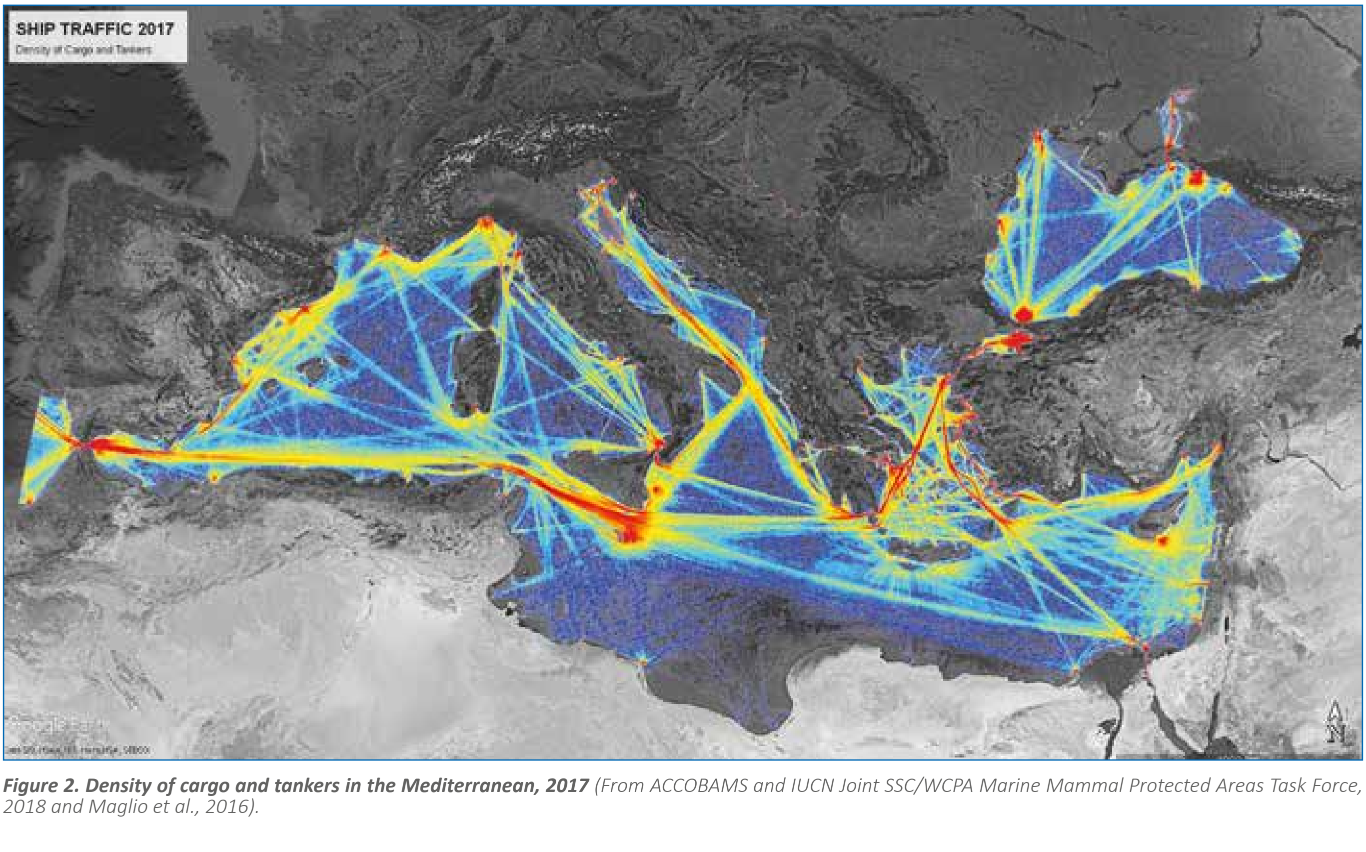

Figure 2. Density of cargo and tankers in the Mediterranean, 2017 *(From ACCOBAMS and IUCN Joint SSC/WCPA Marine Mammal Protected Areas Task Force, 2018 and Maglio et al., 2016).*

In addition to introducing significant noise into the marine environment, major impacts of maritime transport also include:

i. operational, accidental or intentional pollution, including the release of oil, litter, and hazardous and noxious substances, including toxic gases and particulates such as sulphur oxides (SOx) and nitrogen oxides (NOx), as well as greenhouse gas emissions; and
ii. the introduction of non-indigenous species through ballast waters.

As noted above, noise emissions generated by shipping are mainly produced by larger vessels, and there is also a relationship between noise level and speed. The IMO approved Guidelines in 2014 designed to reduce noise emissions[10].

Additionally, Leaper (2019) recently explored the links between ship speed, ship strikes, greenhouse gas emissions and noise. His modelling shows that a modest 10% speed reduction across the global fleet, estimated to reduce overall greenhouse gas emissions by around 13% could also reduce the total sound energy from shipping by around 40% and could potentially reduce overall ship strike risk by around 50%. A 20% reduction in speed could lead to a reduction of noise emissions from shipping by around 67%.

Vancouver Fraser Port – A model to be replicated

The Vancouver Fraser Port Authority, British Columbia, Canada, has developed the Enhancing Cetacean Habitat and Observation (ECHO) Program to develop mitigation measures that will lead to a quantifiable reduction in threats to whales because of shipping activities[11]. This programme includes research on changes in the underwater noise emitted as a result of voluntary ship slowdown measures and avoidance of cetacean habitat. For instance, comparisons are made between the loudest and quietest ships to determine the causes of these differences based on vessel design characteristics.

In 2019, 82% of large commercial ships participated in the slowdown and reduced underwater noise intensity by half[12]. Vehicle carriers, cruise ships and container vessels slowed to 14.5 kts or less through the water; and bulkers, tankers, ferries and government vessels to 11.5 kts or less. In 2018, the slowdown was to 15 kts and 12.5 kts for the same vessel categories. The participation rate was 87% vs. 61% in 2017. The slowdowns produced a 15% reduction in affected whale foraging time in 2018 and a 22% reduction in 2017. In 2017, mean speed reductions were 2.1 kts for bulk/general cargo ships and as high as 7.7 kts for container ships. This produced a 44% reduction in noise intensity.

The Port's EcoAction Program, launched in 2007, offers discounts on harbour dues to vessels that voluntarily reduce their noise emissions. Depending on how quiet ships are, they can earn up to 47% off the basic harbour due rate. The number of qualifying vessels has steadily increased over the years, to reach 986 in 2019. Shore power installations for cruise and container ships have also cut down noise and air emissions. The Prince Rupert Port Authority has a similar programme to financially reward quieter ships[13].

Such port strategies could be replicated in European ports both for cetaceans and their prey (fish and invertebrates) which is also largely noise-sensitive.

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[10] https://www.imo.org/en/MediaCentre/HotTopics/Pages/Noise.aspx
[11] https://www.portvancouver.com/environmental-protection-at-the-port-of-vancouver/maintaining-healthy-ecosystems-throughout-our-jurisdiction/echo-program/
[12] https://www.portvancouver.com/wp-content/uploads/2020/08/ECHO-Program-2019-voluntary-vessel-slowdown-in-Haro-Strait-and-Boundary-Pass-final-report.pdf
[13] https://www.portvancouver.com/environment/air-energy-climate-action/marine/

Military noise

Noise produced by military activities is a sensitive issue because it relates to matters of national security. Nonetheless, in 2004, the European Parliament adopted a Resolution calling on Member States to adopt a "Moratorium on the deployment of high-intensity active naval sonars until a global assessment of their cumulative environment impact on marine mammals, fish and other marine life has been completed"[14]. However, apart from the Spanish ban on activities around the Canary Islands, no other government, as far as we are aware, has taken action. Perhaps understandably, there is little information publicly available about the extent of military noise. Maglio *et al.* (2016) for example, reported that data on the spatial extent of military areas were only available for four Mediterranean countries (Spain, France, Italy and Greece) and this covered almost 18.2% of sea surface in the Mediterranean Sea.

There is also debate about how to interpret EU law in this matter. Article 2.2 of the EU's MSFD states that "This Directive shall not apply to activities the sole purpose of which is defence or national security"[15]. It also adds "Member States shall, however, endeavour to ensure that such activities are conducted in a manner that is compatible, so far as reasonable and practicable, with the objectives of this Directive."

In 2010, the Parties to ACCOBAMS, adopted Resolution 4.17[16] agreeing to "Guidelines to address the impact of anthropogenic noise on cetaceans in the ACCOBAMS area". These Guidelines include specific recommendations for "military high power sonar", including that "*Sonar surveys should be planned so as to avoid key cetacean habitat and areas of cetacean density, so that entire habitats or migration paths are not blocked, so that cumulative sonar sound is limited within any particular area, and so that multiple vessels operating in the same or nearby areas at the same time are prohibited.*"

In 2018, further to an atypical mass stranding of beaked whales that occurred between the 31st of March and 10th of April 2014 on Crete, the ACCOBAMS Follow-Up Committee (an independent tool of the Agreement which is used to review compliance by Parties) concluded that "it is likely that the atypical mass stranding of beaked whales … was the result of the military exercises taking place from 31 March to 10 April 2014, in which Greece was also involved"[17]. It invited Greece "to provide information to the ACCOBAMS Secretariat about how the Guidelines annexed to the Resolution 4.17 have been implemented after 2014 till now". This conclusion was endorsed by the 7th Meeting of the ACCOBAMS Parties in 2019.

Searching for oil and gas

In December 2015, the Paris Agreement, the first-ever universal and legally binding global climate change agreement, was adopted. Its objective was to limit global warming to well below 2°C and to pursue efforts to limit it to 1.5°C compared to pre-industrial levels. We believe that all European countries have ratified the Agreement, except Turkey. Meeting the objectives of the Agreement requires a transition away from burning fossil fuels, but the continued search for new hydrocarbon resources in European waters stands in stark contrast to this objective. To date, France is one of the few European countries that has clearly banned exploration for new hydrocarbon resources in its waters.

The threat from loud noise to cetaceans is now widely recognised, as outlined above, yet hydrocarbon exploration continues in European waters, including very deep areas, some of which are likely of critical importance to sensitive whale species, such as beaked whales (Bernaldo de Quirós *et al.*, 2019), sperm whales (*Physeter macrocephalus*) and others. There is also no comprehensive overview of previously undertaken and planned seismic activities in European waters. Instead, the approach is rather fragmented.

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[14] European Parliament resolution on the environmental effects of high-intensity active naval sonars; 28 October 2004 – Strasbourg. https://www.europarl.europa.eu/sides/getDoc.do?reference=B6-2004-0089&type=MOTION&language=EN&redirect

[15] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056

[16] This resolution was updated in 2019 by Resolution 7.13

[17] Report of the Second Meeting of the ACCOBAMS follow up committee. Monaco, 5-6 March 2018. ACCOBAMS-FC2/2018/Doc 14

For the Northeast Atlantic, an analysis reviewing impulsive noise-generating activities between 2015 and 2017 summarised that seismic airgun surveys have been the dominant noise source (67%- 83% of annual impulsive noise activity) in the region, although a decline of 38% was reported during this period. Pile driving, as well as explosions and employing active sonar devices, were reported to increase. The authors interpret the documented decline in seismic surveys to be due to an "exceptional strategic survey conducted in UK waters in 2015/16", as well as "due to the low oil price over this period" (Merchant *et al*., 2020).

Maglio *et al*. (2016) reviewed a dataset of 830 seismic activities in the Mediterranean Sea, demonstrating a significant increase of seismic exploration activities. These covered 3.8% of the Mediterranean's surface in 2005 and 27% in 2013. These are likely to be minimum figures, as no datasets were available for some states. Additionally, there are "more than two hundred offshore oil and gas platforms […] active in the Mediterranean. With new discoveries of large fossil fuel reserves and explorations in the region, this figure is set to increase".[18] Hydrocarbon exploration and exploitation in the Hellenic Trench has been especially controversial in recent years and, in 2019, dozens of scientists and conservation organisations called on the Greek government for immediate and effective protection of this region[19]. ACCOBAMS has also been calling for protection of this area.[20]

Continued seismic activities in the Mediterranean are unlikely to be in line with the Noise Guidelines adopted by Parties to ACCOBAMS concerning the protection of whale species in the Mediterranean and Black Seas, which require that, in principle, intense noise-generating activities shall "avoid cetaceans' key habitats and marine protected areas, define appropriate buffer zones around them and consider the possible impact of long-range propagation"[21]. The Guidelines include a specific section for seismic surveys and airgun uses which states "seismic surveys should be planned so as to avoid key cetacean habitat and areas of cetacean density, so that entire habitats or migration paths are not blocked". Most European waters range states have also supported the adoption of the 2017 CMS Family Guidelines to undertake Environmental Impact Assessments prior to noise-generating activities, but exploration and exploitation activities for hydrocarbon resources continue in most jurisdictions.

Exceptions to such hydrocarbon activities are France and, also, Spain where, in recent years, many applications for permits to undertake seismic surveys have been withdrawn by the applicant or rejected by authorities due to concerns over the impact on marine biodiversity.

In the 2019 'Reduce the Noise' report[22], four conservation organisations reviewed at least 13 Programmes of Measures by EU Member States to reach GES within their waters, as required by the MSFD, and concluded that for reducing underwater noise levels this binding objective will not be met. This appears to be little different for Non-EU-Member European States.

Conclusions

The chronic and acute impacts of anthropogenic noise on cetaceans in European waters is of concern and, as with other forms of pollution, reducing input at source will be the most effective way of reducing impacts. Impacts on sensitive species can also be reduced by temporal or spatial separation. Marine spatial planning, following a science-based protected area approach, including the definition of buffer-zones, can be used to provide guidance towards noise exclusion zones and quieting regions.

Given the many sources of noise, consideration also needs to be given to their cumulative and synergistic effects and to managing them collectively. Underwater noise is also a transboundary issue, and international cooperation

[18] https://wedocs.unep.org/bitstream/handle/20.500.11822/28627/19wg468_21_eng.pdf?sequence=1&isAllowed=y
[19] https://www.wwf.gr/images/pdfs/Resolution_text_ENG.pdf
[20] (Resolution 3.22. Marine Protected Areas for Cetaceans; Area of Special Importance for the Sperm Whale; (16) southwest Crete and the Hellenic Trench; Resolution 4.15. MPAs of Importance for Cetacean Conservation; Resolution 6.24. New Areas of Conservation of Cetacean Habitats)
[21] RESOLUTION 4.17 GUIDELINES TO ADDRESS THE IMPACT OF ANTHROPOGENIC NOISE ON CETACEANS IN THE ACCOBAMS AREA. Available here: https://www.accobams.org/wp-content/uploads/2016/06/ACCOBAMS_MOP4_Res.4.17.pdf
[22] https://www.oceancare.org/wp-content/uploads/2019/01/Report_Reduce-the-Noise_190124.pdf

and coordination are required to address it. Reducing habitat degradation arising from noise pollution will also give species and populations more resilience to face the myriad of other non-acoustic threats that they now face.

The international community needs to meet the United Nations' (UN) Sustainable Development Goals (SDGs) – of particular relevance here are SDG13 to combat climate change, and SDG14 which focuses on the health of oceans. These are central to marine conservation efforts in the face of ocean noise pollution. SDG1 (related to human livelihoods) and SDG2 (related to food security) are also highly relevant because noise pollution in the seas also threatens these aspects. Additionally, in Europe, there are the objectives set under the Paris Agreement, as well as by the EU to achieve GES for its waters. All of these objectives mean that it would make sense for decision-makers to phase out exploration activities (i.e. seismic airgun surveys) for new hydrocarbon sources, one of the loudest human-made noises.

By reducing speed, the shipping sector can contribute most cost-effectively to reducing the environmental impact of shipping, including ocean noise and ship strikes. Furthermore, port policies will play a major role in creating incentives towards speed reduction schemes. Ocean noise-generating activities should also be subject to robust and transparent EIAs, as agreed by the Parties to CMS. Military activities, in particular manoeuvres and activities in peacetime, should follow the environmental and species conservation provisions recognised nationally, regionally and internationally.

Ship strikes

An issue closely related to ocean noise is ship strikes, meaning collisions between cetaceans and ship propellers or any other part of a vessel. In resolution 7.12 SHIP STRIKES, ACCOBAMS recently reiterated its concerns about the effects of ship strikes on large whales, such as fin (*Balaenoptera physalus*) and sperm whales. It noted that the only effective mitigations to avoid serious injury and death of cetaceans from ship strikes at present are (a) avoidance by ships of areas or times with a high density of whales, including the establishment of shipping lanes or non-shipping zones, and (b) speed reductions in such areas or times, slowing ships down to speeds below 10-12 knots. The resolution also identified some high risk areas including the Hellenic Trench, the Strait of Gibraltar, the Pelagos Sanctuary, the area south west of the island of Crete, around the Balearic Islands, between Almeria and Nador, at the eastern side of the Alborán Sea, and the Strait of Sicily.

Recommended actions

Policy

- An immediate ban on the search for new oil and gas deposits in the seabed in European waters;
- Mandatory application of the CMS Guidelines on EIAs prior to noise-generating activities;
- The development of best-available quieting technologies and legislation covering the use of these technologies;
- Europe should take a leading role in devising a global strategy that seeks to reverse the trend of rising ocean noise levels and supports the incorporation of measures to manage ocean noise in international agreements and in the negotiations leading up to such agreements within the UN system;
- Agreement should be reached on a European-wide shipping and port policy for the reduction of ocean noise, including incentive programmes (e.g. reducing port fees) for quieter ships and the promotion of operational noise-reducing measures, such as speed reductions, within the IMO. These actions also have other environmental health benefits (e.g. the reduction of greenhouse gases);
- The assessment of cumulative impacts of all activities in the ocean, including climate change, through multi-sectoral strategies for countries' energy, environmental and blue economy policies;
- The removal of subsidies for the oil and gas industry and the use of public money in line with the objectives of the 2015 Paris Agreement on Climate Change; and
- Research into the socioeconomic effects of ocean noise on marine life.

Management measures

- Time-area closures to minimise contact with cetaceans and other marine life, especially during sensitive seasons;
- The identification of and establishment of noise exclusion zones and alternative shipping routes, including the designation of noise buffer zones around sensitive habitats, using science-based protected area approaches as guidance, as well as the establishment of 'quiet zones' in Important Marine Mammal Areas (IMMAs), Natura 2000 protected areas and Ecologically or Biologically Significant Marine Areas (EBSAs);
- Application of the precautionary approach, including by carefully assessing all future ocean noise-generating activities and ensuring the use of BAT and BEP for any approved activities. Regulators must require operators to demonstrate that they are not using sources that are more powerful than necessary and at unnecessary frequencies; and
- Compilation of a list of past, present and future impulsive noise-generating activities through a registry in order to share data amongst stakeholders for the ultimate purpose of establishing noise budgets and limits for regions.

Private sector

- Work towards the development and application of quieting technologies by various noise-generating industries;
- The shipping sector should reduce speed as a measure to reduce noise emissions, whilst also, by this action, contributing to the achievement of climate goals;
- There should be a general commitment to imposing quieting measures and to the SDGs, in particular Goal 14, on the conservation and sustainable use of the oceans, seas and marine resources, which seeks to prevent and significantly reduce marine pollution.

Science

- Whilst further research is clearly needed to better understand the details and mechanisms of the impacts of noise on marine life, this research should not delay mitigation and remedial action to curb underwater noise pollution;
- Provision of scientifically sound and independent advice that guides the establishment of 'quiet zones' and assists with the prioritisation of efforts;
- Assistance in the compilation of a list of past, present and future impulsive noise-generating activities through a registry, sharing data amongst stakeholders for the ultimate purpose of establishing noise budgets and limits for a region;
- Assistance in assessing the appropriateness of BAT and BEP as well as their effectiveness in mitigating noise;
- Acoustics experts should take part in and lead research on the temporal and spatial distribution of sensitive species, as well as the spatial distribution of their suitable habitats for better planning and mitigation; and
- Studies should be extended to include consideration of the impacts of ocean noise on fish, invertebrates, and catch rates and the overall ecosystem, as well as associated socioeconomic effects.

Public

- Whilst there is a growing awareness by the general public of noise pollution, a wider appreciation of the sensitivity of cetaceans to noise should also be generated by appropriate educational initiatives;
- Everyone using echo sounders/fish finders/sonar and motor-driven vessels should recognise that they are introducing noise pollution into the seas and oceans that may affect the ability of cetaceans to perceive their environment and communicate with each other. Sonar should only be used when necessary:
- Great care should be taken when sailing or motoring around these animals, they should not be chased and whale and dolphin watching guidelines should be followed; and
- Local communities should be encouraged to work towards preventing and significantly reducing ocean noise.

Acknowledgements

The authors thank the many colleagues they have discussed this complex and still little recognised issue with over the years, including but not limited to Michael Jasny and Russell Leaper.

The views expressed here are our own and do not necessarily reflect those of any institution that we are or have been associated with.

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The Impacts of Chemical Pollutants on Cetaceans in Europe

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"I think cetaceans are often remarkably resilient. Any single human activity may not appear as having a huge impact on them. But when you put these various threats together, their cumulative effects may become significant. Chemical pollutants, in particular, are invisible stressors that are very likely to act synergistically with other threats. We should strive to reduce all of them."

Tilen Genov

Introduction

In modern times, human activities have introduced over 200,000 synthetic chemicals into the environment and have profoundly altered the levels of naturally occurring elements (Reijnders *et al*., 1999). Many of these chemicals are not easily degradable and have been shown to have substantial impacts on various species and ecosystems, including cetaceans. Organochlorine contaminants such as polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) are particularly worrisome, because they are persistent in the environment, highly lipophilic, bioaccumulate in individuals over time, and accumulate in top predators through trophic transfer (Green and Larson, 2016). This chapter briefly reviews the main chemical pollutants affecting cetaceans in European waters, focusing predominantly on those likely to represent the greatest threat, historically or currently. Due to space limitations, this review is not meant to be comprehensive.

Effects of chemical pollution on cetaceans

Effects of chemical pollutants can be direct or indirect, and can be manifested at the molecular, individual or community level (Reijnders *et al*., 1999). Some contaminants, particularly organochlorines, have been shown to cause a number of effects in marine mammals, including anaemia (Schwacke *et al*. 2012), immunosuppression (Tanabe *et al*., 1994) and the subsequent increased vulnerability to infectious disease (Aguilar and Borrell, 1994; Jepson *et al*., 2005; Randhawa *et al*., 2015), endocrine disruption (Tanabe *et al*., 1994; Vos *et al*., 2003; Schwacke *et al*., 2012), reproductive impairment (Schwacke *et al*., 2002) and developmental abnormalities (Tanabe *et al*. 1994; Vos *et al*., 2003). These compounds are likely directly impacting abundance via reduced reproduction or survival (Hall *et al*., 2006; Hall *et al*., 2017), with potentially dire consequences (Desforges *et al*., 2018). Some compounds may lead to cancer induction and mutagenic effects, and may even have behavioural effects (Reijnders *et al*., 1999). Indirect effects include impacts on the abundance or quality of cetacean prey. However, establishing clear relationships between concentrations of chemical pollutants in animals or their environment and their impacts on individuals or populations is extremely challenging, particularly so in cetaceans.

Cetaceans as indicators

Cetaceans and other marine mammals, typically being top predators in their ecosystems, having long life spans and carrying extensive fat stores, bioaccumulate a range of such chemicals (Vos *et al*., 2003) and are thus often regarded as ecosystem sentinels (Ross, 2000; Wells *et al*., 2004; Moore 2008). Generally speaking, toothed whales (Odontocetes) are at greater risk than baleen whales (Mysticetes), due to their diet and the associated higher position in the trophic web, as well as due to typically being present in coastal areas. Moreover, within Odontocetes, species occuring closer to the coast and/or feeding on prey found at higher trophic levels tend to be more exposed to toxicity from various chemical compounds. However, there is also substantial intra-specific variability, which can be dependent on sex, age and other factors.

In European waters, the common bottlenose dolphin (*Tursiops truncatus*) is one of the most widely distributed and commonly occurring cetaceans, particularly in coastal areas, with populations in the North Sea, Atlantic European waters, Mediterranean Sea, and Black Sea. In many parts of the world, including European waters, it is essentially "coastal" and mainly found nearshore (Bearzi *et al*., 2009). This makes it particularly susceptible to a range of anthropogenic impacts, including the exposure to organochlorine contaminants (Marsili *et al*., 2018). Due to its coastal nature, widespread distribution in European waters, and being studied in detail in many locations, it is probably a particularly good candidate species for establishing levels of chemical pollution, the impacts of pollutants on cetaceans, and for monitoring trends.

Figure 1: Common bottlenose dolphin (Tursiops truncatus) in a port in the northern Adriatic Sea. *Chemical pollutants such as polychlorinated biphenyls (PCBs) pose a serious threat to marine top predators, particularly coastal small cetaceans. © Tilen Genov, Morigenos*

Current pollutant levels in European cetaceans

A number of chemical pollutants have been analysed in tissues of several cetacean species in Europe. For several compounds and in several species, toxicological risks to these animals have been identified. Generally speaking, killer whales (*Orcinus orca*) and common bottlenose dolphins appear to have the highest levels of pollutants, with PCBs representing the main concern (Jepson *et al*., 2016).

PCBs and DDTs

In most of Europe, the use of PCBs and OCPs such as dichlorodiphenyltrichloroethane (DDT) was prohibited in the 1970s-1980s, due to concerns about their toxicity to humans and other organisms, and their environmental persistence. Following the ban, these compounds declined in several European cetaceans (Law *et al*., 2012), including in the Mediterranean Sea (Aguilar and Borrell, 2005; Borrell and Aguilar, 2007). However, they remain far from phased out, as they continue to be found at high levels in several cetaceans species in Europe (Jepson *et al*., 2016). PCBs in particular, have declined at a slower pace than DDTs (Aguilar and Borrell, 2005) and have subsequently reached a plateau in harbour porpoises (*Phocoena phocoena*) around the United Kingdom (Law *et al*., 2012) and in striped dolphins (*Stenella coeruleoalba*) in the western Mediterranean Sea (Jepson *et al*., 2016).

Among chemical pollutants, PCBs currently represent the main source of concern, as high concentrations have been found in several species, often exceeding known toxicological thresholds at which physiological effects or even reproductive impairment are known to occur (Jepson *et al*., 2016; Desforges *et al*., 2018; Genov *et al*., 2019). High PCB levels have been linked to small populations, range contraction, or population declines in some striped dolphin, common bottlenose dolphin and killer whale populations (Jepson *et al*., 2016). Killer whales, particularly populations feeding on high trophic level prey such as marine mammals or the Atlantic bluefin tuna (*Thunnus thynnus*), are especially at risk, with the highest PCB levels ever recorded, and strong evidence of population suppression across multiple populations (Jepson *et al*., 2016; Desforges *et al*., 2018). Levels are also very high in European common bottlenose dolphins (Jepson *et al*., 2016). Within the Mediterranean Sea, concentrations found in these animals generally tend to decline from west to east, and from north to south (Genov *et al*., 2019), while in the European Atlantic and North Sea waters, they are particularly high in animals living around the Iberian peninsula and around the United Kingdom (Jepson *et al*., 2016).

DDT levels in the western Mediterranean Sea and around the United Kingdom (Aguilar and Borrell, 2005; Borrell and Aguilar, 2007; Law *et al*., 2012) are much lower than those of PCBs, while in the Eastern Mediterranean Sea, they are higher than those of PCBs (Shoham-Frider *et al*., 2009; Gonzalvo *et al*., 2016).

Hexachlorobenzene (HCB)

HCB levels are generally extremely low in European waters (Law *et al*., 2012; Gonzalvo *et al*., 2016; Genov *et al*., 2019) and the current environmental input of this compound is likely negligible (Borrell and Aguilar, 2007).

Polybrominated diphenyl ethers (PBDEs)

PBDEs have been widely used as flame retardants, but were largely banned in Europe in the 2000s. Concentrations in UK harbour porpoises reached a peak in 1998, with a subsequent 67.6% reduction by 2008 (Law *et al*., 2010).

Hexabromocyclododecane (HBCD)

HBCD is a flame retardant, with levels in harbour porpoises around the UK significantly increasing after 2001, but then significantly decreasing after 2003 (Law *et al*., 2012)

Polycyclic aromatic hydrocarbons (PAHs)

PAHs are petroleum-derivate compounds. Few studies have addressed these compounds in cetaceans. A study from the Canary Islands showed that these compounds are present in common bottlenose dolphins, but their impact on populations remains poorly known (García-Álvarez *et al*., 2014). PAHs have been associated with severe lung disease in common bottlenose dolphins in the Gulf of Mexico, following the Deepwater Horizon oil spill (Schwacke *et al*., 2014), showing that chemical pollution related to oil spills has the capacity to drastically impact cetacean health.

Heavy metals

Among metals, mercury (Hg) is one of the pollutants of most concern due to its persistence, high toxicity and accumulation in top predators (Vos *et al*., 2003). Small cetaceans have the highest recorded levels of mercury among any organisms (Bowles, 1999). Among European seas, the Mediterranean Sea may be especially vulnerable, due to its semi-enclosed nature, as well as the relatively high presence of this metal, from both natural and anthropogenic sources (Andre *et al*., 1991). However, following concerns about the toxic effects of mercury on biota and human health, levels have decreased substantially since the 1980s and 1990s, due to efforts to reduce emissions from industries, power plants and mining (a useful summary can be found in Borrell *et al*., 2014).

Unlike compounds such as PCBs and DDTs, which are man-made substances and therefore an "evolutionary novelty" to which cetaceans have no adaptation, heavy metals have been present in the marine environment for millenia. As a consequence, a number of storage and detoxifying mechanisms that may alleviate the effects of high concentrations have evolved in many cetacean species (Bowles, 1999). Cetaceans are able to metabolize the toxic organic methylmercury into a less toxic inorganic mercury (Palmisano *et al*., 1995; Nigro and Leonzio, 1996). Therefore, while metals may represent a toxicological risk to cetaceans, high concentrations alone do not necessarily imply toxicity (Bowles, 1999). However, this does not mean that metals do not pose a threat. Once levels exceed the storage and binding capacity, toxicological risk increases. Contamination by mercury still persists, with levels in Mediterranean striped dolphins reaching threshold levels of tolerance for mammalian hepatic tissue, above which hepatic damage can occur (Borrell *et al*., 2014). In addition, synergistic effects with environmental factors such as deficiency in levels of iron and zinc, as well as water temperature and salinity (Bowles, 1999), or with concentrations of organochlorine pollutants (Lahaye *et al*., 2007) may elevate the toxicological risk of certain metals. In common bottlenose dolphins, animals from the Mediterranean Sea have substantially higher concentrations of mercury than those found in the Atlantic and the North Sea (García-Alvarez *et al*., 2015).

Novel emerging compounds

Following bans of certain compounds, new ones have appeared on the market, with their effects on biodiversity still poorly understood, but several have already been detected in marine mammals (Covaci *et al*., 2011). Recently, pyrethroid pesticides were analysed in the livers of striped dolphins from the Spanish Mediterranean Sea (Aznar-Alemany *et al*., 2017). These compounds are used for household, commercial, farming and medical applications. They became popular as a substitute for other banned pesticides, because they were presumed not to be persistent in the environment, and were believed not to accumulate in mammals, but they may nevertheless represent a health risk to European cetaceans (Aznar-Alemany *et al*., 2017).

Even more recently, a study showed the first evidence of the accumulation of organophosphorus flame retardants (OPFRs, a class of flame retardants, which are also used as plasticizers, antifoaming agents and as performance additives in consumer products) in marine mammals, in common dolphins (*Delphinus delphis*) from Spanish Mediterranean waters (Sala *et al*., 2019). It is possible that new chemicals will be added to the list of pollutants likely to impact cetaceans in the future.

Conclusion

Studies have shown that different chemical pollutants impact different cetacean species (as well as age and sex classes within species) in different ways. While some pollutants in Europe have significantly declined or are declining, PCB levels are high in several species and remain a cause of concern. Their effects should not only be considered on their own, but especially in relation to other impacts and stressors. Even in cases when population declines may be linked to other causes, the influence of PCBs on reproductive ability may supress population recovery following potential catastrophic events related to other causes. The risk of chemical pollutants should therefore be integrated in cumulative risk assessments.

Recommended actions

Policy

- The presence of pollutants in tissues of marine biota is already included as Descriptor 8 of the Marine Strategy Framework Directive (MSFD), while marine mammals are one of the indicators of "Good Environmental Status" under Descriptor 1 of MSFD.
- At the European policy level, PCB levels in relation to established toxicity thresholds should be used to assess "Favourable Conservation Status" of marine mammals under the EU Habitats Directive (Jepson and Law, 2016).
- Consideration of chemical pollutants should be included in risk analyses and impact assessments of other activities likely to impact cetaceans, due to cumulative and synergistic effects.

Management measures

- In Europe, greater compliance with the Stockholm Convention is needed by EU member states in order to significantly reduce PCB contamination of the marine and terrestrial environment by 2028 (Jepson *et al*., 2016; Jepson and Law, 2016; Stuart-Smith and Jepson, 2017).
- Measures include the safe disposal or destruction of large stocks of PCBs and PCB-containing equipment, limiting the dredging of PCB-laden rivers and estuaries, reducing PCB leakage from old landfills, limiting PCB mobilization in marine sediments, and regulating the demolition of PCB-containing precast buildings such as tower blocks built in the 1950s–1980s (Jepson *et al*., 2016; Jepson and Law, 2016; Stuart-Smith and Jepson, 2017).

Private sector

- See "management measures" above.
- The private sector should work closely with governmental bodies to comply with the provisions of the Stockholm Convention.

Science

- Cetaceans are long-lived predators that integrate contaminant concentrations over time and are, therefore, useful model species to monitor contaminant concentrations and their trends. Being highly mobile, they are likely good regional (rather than local) indicators (Genov *et al*., 2019) and, as top predators, they are likely representative of the ecosystem as a whole (Borrell and Aguilar, 2007).

Public

- Generally, greater awareness is needed of the risks posed by chemical pollutants to wildlife and, in particular, to cetaceans at the top of marine food webs. This will, hopefully, lead to more responsible consumer habits and individual behaviour related to life choices.

Acknowledgements

Many thanks to Paul D. Jepson for the careful review of the early draft, the words of encouragement and for largely being the one who mentored me on the topic of chemical pollutants in cetaceans.

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Marine Plastic Pollution – Sources, Sinks, and Impacts on Cetaceans

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“I am seriously worried that not enough action is being taken to prevent plastic pollution from entering the oceans and having a negative impact on cetaceans.”
Silvia Frey

Introduction

Plastic has become almost indispensable in our daily life. However, this dependency and the associated vast amounts of produced and casually discarded plastics combine to create a pervasive occurrence of these persistent synthetic polymers in the marine environment, where they account for up to 80% of all marine litter (Derraik, 2002). Today, plastic debris affects every ocean and coastline in the world, from the Antarctic to the Arctic, from the water surface to the deep sea, and poses a serious threat to marine life (Galgani *et al.*, 2015; Law, 2017; Barboza *et al*., 2019).

The first scientific evidence about marine plastic pollution was published more than 40 years ago with a significant increase of more systematic and in-depth studies occurring in recent years (Ryan, 2015; Law, 2017). During the last decade, media attention on the topic has also increased considerably, whereas the need for measures to address marine debris has been recognised at various levels for some time (Law, 2017; Barboza *et al.*, 2019). For example, at the international and regional level relevant initiatives have been undertaken by the International Convention for the Prevention of Pollution from Ships (MARPOL)[1], the Honolulu Strategy (UNEP and NOAA, 2016), the International Whaling Commission (IWC) (IWC, 2014), the United Nations Environment Assembly (UNEA-2) (UNEP, 2016), the Mediterranean Regional Plan on Marine Litter[2], and the European Union (EU) Marine Strategy Framework Directive (2008/56/EC)[3] besides national legal actions (Xanthos and Walker, 2017).

The impacts of plastic debris on cetaceans include ingestion of plastic (e.g. direct ingestion or via trophic transfer through their prey) and entanglement (Kühn *et al.*, 2015). It has been reported that over 60% of all cetacean species worldwide are adversely affected by marine plastic pollution (Fossi *et al.*, 2018a; Kühn and Franeker, 2020).

Today, the main paths pursued to solve the so-called plastic crisis focus on technological solutions, the banning or taxing of certain single-use plastic items and the promotion of plastic substitutes. Those measures are certainly helping to lighten the burden of plastic debris in the environment. Yet it is argued that more profound changes (i.e. systemic change) at the behavioural, economic, and political level are needed to address the main cause of plastic pollution which is over-production and over-consumption, in particular of single-use plastic products (World Economic Forum, 2016). It has also been suggested that non-recyclable or non-reusable plastics which are made of potentially toxic chemicals should be classified as hazardous. This could lead to a dramatic reduction of plastic waste. These hazardous items should be replaced by ones made from reusable and non-toxic materials (Rochman *et al*., 2013).

This chapter briefly illustrates the challenges of production, waste management, input sources and the fate of plastic in the oceans. It further seeks to highlight the impact of plastic debris on cetaceans. This is a high-level overview rather than a comprehensive one, due to space limitations.

A definition of plastic

"Plastics are a class of synthetic organic polymers composed of long, chain-like molecules with a high average molecular weight. Many common classes of plastics are composed of hydrocarbons that are typically, but not always, derived from fossil fuel feedstocks (Am. Chem. Counc., 2015). During the conversion from resin to product, a wide variety of additives—including fillers, plasticizers, flame retardants, UV and thermal stabilizers, and antimicrobial and coloring agents—may be added to the resin to enhance the plastic's performance and appearance." (Law, 2017)

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1 IMO (International Maritime Organization), International Convention for the Prevention of Pollution from Ships (MARPOL), Annex V. Available at: https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx

2 https://web.unep.org/unepmap/regional-plan-marine-litter-management-mediterranean-prevent-and-eliminate-pollution-enters-force

3 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32008L0056&from=EN

Plastic production and waste management

Since the mid-twentieth century when commercial plastic production took off with around 2 million tonnes produced per year, plastic manufacturing has increased almost exponentially to 360 million tonnes in 2018 (Geyer *et al.*, 2017; PlasticsEurope, 2019a). Worldwide plastic production is expected to further increase dramatically during the next three decades (see Figure 1; World Economic Forum, 2016). In 2018, 17% of worldwide plastic production was in Europe (PlasticsEurope, 2019a).

In Europe, three main production categories of plastics can be observed: around 40% are single-use packaging designed for short-term usage, 20% are consumer applications with an intermediate lifespan (e.g. vehicles, electronic devices, household engineering), and 20% are long-term infrastructure (e.g. buildings, constructions) (PlasticsEurope, 2019a). The remaining 20% include other applications such as medical and mechanical engineering and agriculture.

Most types of plastics are produced from crude oil or gas (i.e. non-renewable natural resources) that undergo chemical processing. Today around 6-8% of the world's oil and gas production is used for the production of plastic with half of it being used as a basic raw material and half as an energy source for manufacturing the plastic (Hopewell *et al.*, 2009; World Economic Forum, 2016). It is estimated that by 2050 worldwide plastic production will account for 20% of total oil consumption and 15% of the global annual carbon budget (World Economic Forum, 2016).

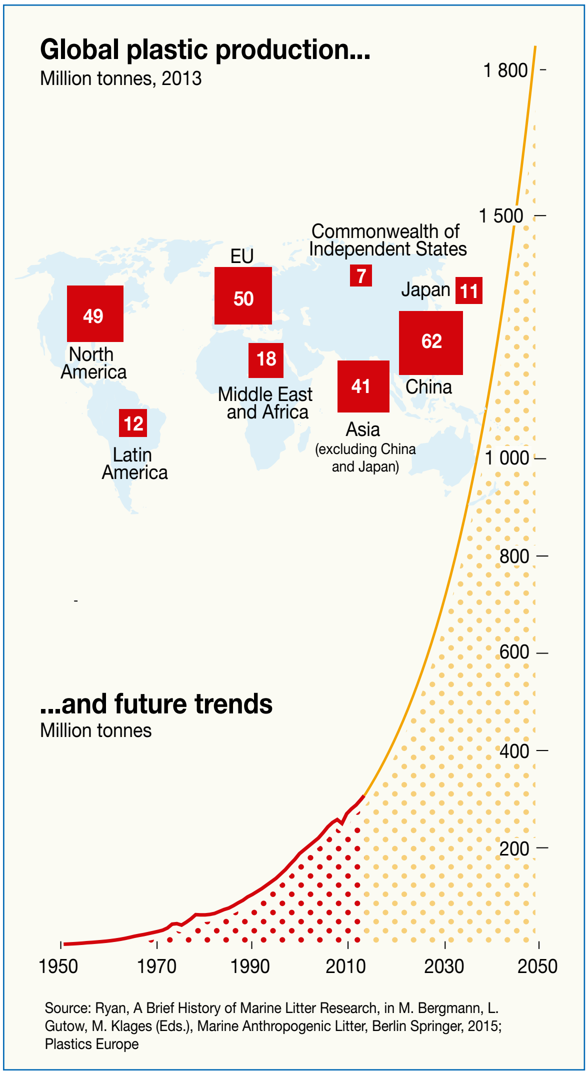


Figure 1: Global plastic production in the past and future trends (in million tonnes). *© Maphoto/Riccardo Pravettoni; http://www.grida.no/resources/6923*

According to a recent study, 8,300 million tonnes of plastic was manufactured worldwide between 1950 and 2015. In the same period, 6,300 million tonnes of plastic waste was generated of which 9% was recycled, 12% incinerated, and 79% was disposed of in landfills or in the natural environment. It is predicted that without countermeasures in production and waste management the amount of plastic waste discharged into landfills and into the natural environment will more than double in the next 35 years (i.e. amounting to 12,000 million tonnes) (Geyer *et al.*, 2017).

Sixty-one per cent of the plastic waste stream in Europe is comprised of packaging (PlasticsEurope, 2019b). In 2018, 24.9% of the total amount of collected plastic waste (= 29.1 million tonnes) ended up in landfills, 32.5% was recycled, and 42.6% was incinerated for energy recovery (PlasticsEurope, 2019a). It is noteworthy that, despite progress in recycling and energy recovery, plastic waste treatment differs quite remarkably between countries in Europe and landfills are still a first or second option in many European countries (PlasticsEurope, 2019a).

A major proportion of the plastic waste collected for recycling in Europe is exported to non-European countries for further processing. China had long been the most important recipient of non-domestic plastic waste worldwide until the country restricted plastic waste imports in 2017 (BIR, 2018). For instance, in 2012 EU Member States exported almost 50% of the plastic waste collected for recycling to China (Velis, 2014). Since 2017, some EU plastic waste export streams have shifted mainly to South East Asian countries (e.g. Malaysia, Taiwan, Indonesia, Vietnam). As these countries often have lower environmental standards when compared with European countries, concerns over the sustainability of local resource recovery practices arise (Velis, 2014).

Plastic inputs and the fate of plastic in the oceans

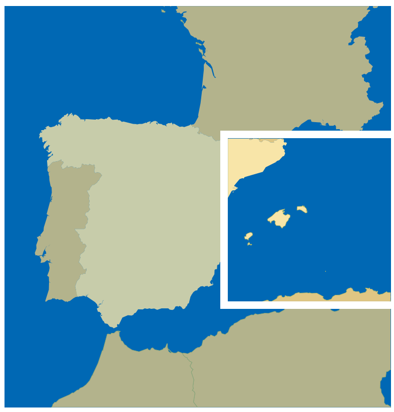
Most types of plastics do not biodegrade and therefore endure in the environment for decades, even centuries (Hopewell *et al.*, 2009). Plastic waste floats in the oceans, is carried by ocean currents, accumulates in ocean gyres, sinks to the ocean floor and can be found on beaches where it is washed up from the ocean or disposed of directly. There is still a considerably limited amount of data available on plastic waste flows to the ocean and on the respective amount of plastic contained in the various parts of the ocean. However, estimates are that currently over 150 million tonnes of plastics circulate in the oceans containing approximately 23 million tonnes of chemical additives of which some are persistent and toxic (World Economic Forum, 2016).

Eighty per cent of marine plastic debris comes from land-based sources finding its way, via untreated wastewater, the wind and rivers as well as directly from the beach, to the oceans (Ramirez-Llodra *et al.*, 2011). The remaining 20% of marine plastic debris originates from sea-based activities such as fisheries (vessels and aquacultures), shipping (merchant vessels, ferries, cruise ships, pleasure crafts, naval vessels), and offshore oil and gas platforms (UNEP, 2005). Abandoned, lost or otherwise discarded fishing gear (ALDFG), also known as ghost gear, is assumed to account for about 10% of marine debris in the oceans (Macfadyen *et al.*, 2009). It is estimated that marine plastic waste contamination from sea-based activities amounts to 1.75 million tonnes annually worldwide (Eunomia, 2016b).

Despite 80% and 20% being a common approximation of the contribution of land- and sea-based sources of marine plastic litter, the proportions of these sources may vary in marine regions and in distance from coastal development (Pham *et al.*, 2014; Eunomia, 2016b; Macfadyen *et al.*, 2009). For instance, in the German Bight ships have been identified as a main source of litter washed up on the shore (Vauk and Schrey, 1987). Furthermore, research in European waters has shown that fishing is the main source of plastic litter on the seafloor far away from coastlines, whereas close to shore, land-based sources of plastic litter are predominant (Pham *et al.*, 2014).

An estimated amount of 4.8-12.7 million tonnes of mismanaged plastic debris ends up in the oceans annually from coastal populations living within 50 km from the coastline (Jambeck *et al.*, 2015). Recent findings indicate that in addition to this, 0.79-1.52 million tonnes per year enter the oceans from inland sources via rivers (Lebreton *et al.*, 2017). For EU countries the estimated plastic waste emissions from the coast range from 54,000 to 145,000 tonnes per year, whereby the proportion from rivers is estimated to be between 1-14% of this (Eunomia, 2016b). It is noteworthy that the effluents of wastewater treatment plants into river systems may be a considerable source of microplastics even if the capture rates are high (Browne *et al.*, 2011; Leslie *et al.*, 2017).

A part of the plastic debris in the oceans floats. Recent research concludes that 233,500 tonnes of macro- and mesoplastic and 35,500 tonnes of microplastic debris float in the world's oceans (Eriksen *et al.*, 2014). Whilst macroplastic accounts for the highest amount of floating plastics by mass, microplastic is far more abundant in terms of plastic particle counts (Eriksen *et al.*, 2014; see Figure 2). The North Atlantic and Mediterranean Sea have been shown to account for roughly 21% and 9%, respectively, of the total mass of 269,000 tonnes of plastics afloat at sea worldwide (Eriksen *et al.*, 2014). Moreover, two major accumulation zones of floating plastics have been identified in Europe: the Mediterranean Sea due to high coastal human pressure and "trapping-like" hydrodynamic characteristics (Lebreton, 2012; Cózar *et al.*, 2015) and the North Atlantic (Greenland and Barents Seas) being the impasse of the oceanic large-scale surface circulation in the North Atlantic (Cózar *et al.*, 2017).



As well as the 5 great garbage patches that are recognised in the Pacific, Atlantic and Indian Oceans, the Mediterranean Sea could be considered the site of the world's 6th great garbage patch as there are comparable average densities of marine plastic litter, for example around the Balearic Islands.

There is growing scientific evidence, that the sea floor is a major sink for marine macroplastic and microplastic debris (Chiba *et al.*, 2018; Woodall *et al.*, 2014; Barnes *et al.*, 2009; Leslie *et al.*, 2017; Cózar *et al.*, 2014). Importantly, it has been reported that over 90% of macroplastics found in the deep seas are single-use products (Chiba *et al.*, 2018). Seafloor compartments in the North-East Atlantic Ocean, the southern Celtic Sea, and in the Mediterranean Sea as well as the estuarine sediments of the North Sea are highly contaminated with plastics (Galgani *et al.*, 2000; Pham *et al.*, 2014; Leslie *et al.*, 2017; Maes *et al.* 2018; Kane *et al.*, 2020). Although a major part of microplastic in the marine environment originates from the breakdown of larger plastic items (so-called secondary microplastic; see Figure 2), the emission of primary microplastic such as synthetic textile fibres, pellets, tyre abrasions, and microbeads from cosmetics is also a contributory factor (Boucher and Friot, 2017; Eunomia, 2016a). It has been assumed that 94% of plastic debris in the oceans is on the sea floor while the remaining mass is assumed to be located on beaches (5%) and floating on the sea surface (1%) (Eunomia, 2016a). However, according to current scientific knowledge the density of litter on beaches is estimated to be higher than on the sea floor (Pham *et al.*, 2014). A recent study has shown that Arctic sea ice is also an important, though temporal, sink of microplastics (Peeken *et al.*, 2018).

Megaplastic > 100 mm
Examples: Abandoned, lost or otherwise discarded fishing gear (ALDFG)

Macroplastic > 25 mm
Examples: Plastic bottles, packaging

Mesoplastic 5 – 25 mm
Examples: Fragments, bottle caps

Microplastics (MP) 0.0001 – 5mm
Examples: *Primary MP:* Industrially manufactured resin pellets; microbeads; synthetic textile fibres; tyre dust
Secondary MP: Plastic particles originating from the gradual breakdown of larger plastic items

Nanoplastic (NP) < 0.0001 mm
Examples: *Primary NP:* Industrially manufactured NPs used in electronics, biomedical products, paints
Secondary NP: Plastic particles originating from the gradual breakdown of microplastic

(Adapted from: Boucher and Friot, 2017; MSFD, 2013; Koelmans *et al.*, 2015)

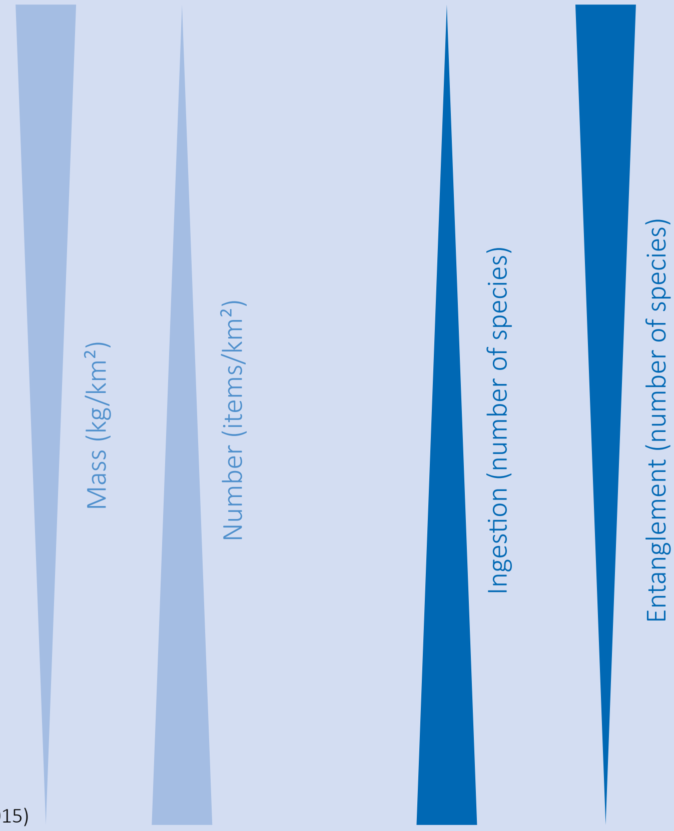


Figure 2: Selected size classes of marine plastic debris and related effects. *Depending on the size of the plastics, it is more abundant in the oceans by mass or by numbers. Likewise, size matters also with reference to the number of marine species being impacted by plastic ingestion or entanglement in plastic litter.*

Impact on cetaceans

Due to its persistence and ubiquitous occurrence in various sizes and forms, marine plastic impacts a wide range of marine invertebrate and vertebrate species (Deudero and Alomar, 2015; Kühn *et al.*, 2015; Kühn and Franeker, 2020). The impact of plastic on marine life is manifold and occurs throughout the food chain (Fossi *et al.*, 2018a; Law, 2017; Barboza *et al.*, 2019). Harmful encounters with marine debris have been described for over 800 species with plastic debris accounting for over 90% of ingestion and entanglement incidences (Fossi *et al.*, 2018b; Gall and Thompson, 2015; Schepis, 2016).

In European waters several studies document the adverse effects of plastic debris on cetaceans through entanglement and ingestion (see for instance Deudero and Alomar, 2015; Lusher *et al.*, 2015; Unger *et al.*, 2017a; Unger *et al.*, 2017b). For the Mediterranean Sea it has been shown that a major part of studied cetacean species have been impacted by marine plastic debris (Deudero and Alomar, 2015).

Macroplastic debris can act as a trap, leading to injuries as well as impeding animals' mobility and thus their ability to perform vital activities and, ultimately, causing death. Entanglements, mostly due to ALDFG, have been documented for 31% of all cetacean species worldwide (Fossi *et al.*, 2018a). Ingestion of marine debris, notably and most often plastic, has been reported for around 60% of all cetacean species (Kühn *et al.*, 2015; Kühn and Franeker, 2020; Baulch and Perry, 2014). Floating macroplastic can be mistaken as food and certain cetacean species are more likely to ingest plastic such as deep-diving toothed whales like the sperm whale (*Physeter macrocephalus*) and Cuvier's beaked whale (*Ziphius cavirostris*) due to their feeding habits (IWC, 2013). The ingestion of non-food items by sperm whales was already documented as early as the 1960s (Walker and Coe, 1990) and recent reports about the amounts of plastic debris found in stranded sperm whales in European waters is highly concerning (Unger *et al.*, 2017b; de Stephanis *et al.*, 2013; Mazzariol *et al.*, 2011; Notarbartolo di Sciara *et al.*, 2012). Once ingested, plastic debris can block and harm the digestive tract and lead to starvation and death (Laist, 1997). Apart from having direct lethal effects, ingested plastic items may lead to injury and compromise alimentation thereby decreasing overall fitness as well as increasing susceptibility to diseases (Fossi *et al.*, 2018a). To date, the ingestion of microplastics by cetaceans has been documented in just a few cases. Ingestion may occur directly from water during foraging or indirectly by ingestion of prey already contaminated with microplastics (IWC, 2013). Moreover, it is suggested that large filter feeders such as baleen whales are prone to large intakes of microplastics and therefore also of associated toxic chemicals (i.e. chemical additives contained in plastics and PBTs[4] adsorbed onto plastic particles) which may bioaccumulate in their tissues (Avio *et al.*, 2017; Fossi *et al.*, 2014).

Existing regulatory/governance frameworks

During the last decades important governance decisions and actions have been taken at global, regional, national, and local levels to reduce the emission and impact of marine plastic debris as a major form of environmental contamination. Due to space limitation, all the various initiatives and actions cannot be listed and described here. Instead, some selected examples are listed below. For further information on this subject, refer to the publications of Barboza *et al.* (2019), OceanCare (2017), and Xanthos and Walker (2017).

An important governance action at global level is the adoption of the UN Agenda 2030 with its action plan comprising different Sustainable Development Goals (SDGs) with different SDGs targeting the reduction of marine plastic debris by the UN General Assembly in 2015 (Barboza *et al.*, 2019). Further international approaches particularly relevant for cetacean conservation, include the establishment of the Code of Conduct for Responsible Fisheries which aims, among other targets, at reducing ALDFG by the Food and Agriculture Organization (FAO) and the establishment of a global whale disentanglement network by the IWC. Different European regional sea bodies adopted action plans on marine litter such as the Helsinki Convention for the Baltic Sea in 2015, the Barcelona Convention for the Mediterranean Sea in 2014, the OSPAR Convention for the North-East Atlantic in 2014, and the Black Sea Commission (action plan under development) (Barboza *et al.*, 2019).

At EU level, marine litter has been considered as Descriptor 10 within the European Marine Strategy Framework Directive (MSFD) (European Parliament and Council of the European Union, 2008). Monitoring guidance and standardized monitoring protocols for marine plastic debris have been elaborated by intergovernmental organizations and platforms as well as by expert committees such as the Joint Research Centre of the European Commission (JRC) (MSFD Technical Subgroup on Marine Litter, 2013), the International Council for the Exploration of the Sea (ICES) (ICES/IBTS, 2012), the Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans)[5], and the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) (GESAMP, 2019).

In the EU a major step in tackling environmental plastic pollution has been taken very recently through the adoption of the European Strategy for Plastics in a Circular Economy which aims to transform today's linear plastic economy into a more sustainable (circular) one in which the importance of reuse and recycling are respected.[6]

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[4] PBT = persistent, bioaccumulative and toxic chemicals
[5] http://www.jpi-oceans.eu/baseman/main-page
[6] http://europa.eu/rapid/press-release_IP-18-5_en.htm

Conclusion

Although our knowledge about the input of plastic debris into the oceans, its marine sinks and stocks as well as of the associated effects on marine life is still limited, existing field and model data show that the situation is alarming. In order to deal with this, various advances have been made in recent years to tackle marine plastic pollution. However, there is still a major need for further measures and actions at regulatory, economic, societal, and management levels in order to effectively reduce the amount of plastic waste produced as well as entering the oceans, with the aim of reducing the risks for cetaceans and other marine life posed by plastic debris.

Recommended actions

Policy

- Clear national and regional quantitative waste reduction targets should be implemented.
- An international agreement on marine plastic pollution to address and implement cross-border solutions is needed.
- Marine debris should be recognised as a threat to cetaceans and especially the deep-diving ones where reports show increasing evidence of ingestion.
- Microplastics admixture in personal care and cleaning products should be banned.
- Global extended producer responsibilities for all plastic products (including fishing gear) should be introduced.
- Clear product design requirements (e.g. with reference to recycled content and recyclability) should be put in place.
- Single-use plastics should be banned / phased out.
- Waste exports to countries with poor environmental and waste management standards should be prevented.
- The use of toxic chemicals in plastic products should be regulated using the precautionary principle.

Management measures

- Plastic waste needs to be addressed at source and the flow of plastics into the marine environment halted.
- Plastic waste should be fully processed by the countries where it has been generated in environmentally sound waste management systems.
- Marine plastic pollution (mega-, macro-, micro- and nano-plastics) needs to be monitored on beaches, in surface waters, on the sea floor and riverine bodies based on internationally harmonized protocols.
- Countries and regions should exchange technical knowledge on waste management.

Private sector

- Plastic production needs to be transformed from a linear plastic economy into a circular plastic economy.
- Massive technological development is needed in order to prevent microplastic emissions from synthetic clothes and tyre abrasions into the environment.
- Practices should be changed to avoid the generation of waste such as single-use plastic products (including plastic bags and plastic packaging) and plastic sheeting in agriculture.

Science

- Better understanding of the impacts of plastic pollution on cetaceans is needed and international initiatives such as the IWC's work on this should be supported.
- Development of a classification scheme of plastic materials according to their hazardousness.
- Research should continue on biological, ecological, social and economic impacts of marine plastic pollution as well as the plastic flows and plastic stocks in the marine environment.
- Research dedicated to informing solutions should be encouraged.

Public

- Education programmes to improve knowledge about the consequences of marine plastic pollution and necessary behavioural changes should be introduced.
- Beach clean-up programmes with associated systematic data collection based on harmonized protocols on the collected debris by the public (i.e. dedicated citizen science programmes) should be encouraged.
- The correct disposal of plastics including not leaving litter on beaches needs to be strongly promoted.
- The use of reusable shopping bags and containers over the use of single-use plastics should be promoted.
- Supermarkets and other companies should be called on to avoid unnecessary plastic packaging.

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Climate Change and Ocean Acidification – A Looming Crisis for Europe's Cetaceans

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> *"Without urgent and decisive action, the climate crisis will have dire welfare and conservation consequences for many of Europe's cetaceans."*
> Mark P. Simmonds

Introduction

Climate-related changes, including increased sea surface temperature (SST), decreasing ice cover, rising sea levels and changes in ocean circulation, salinity, rainfall patterns, storm frequency, wind speed, wave conditions and climate patterns are all affecting cetaceans (Learmonth *et al*., 2006; Silber *et al*., 2016). Additionally, an increase in the amount of carbon dioxide (CO_2) being absorbed by seawater is leading to ocean acidification, which – in turn- amplifies the adverse effects of global warming (Pace *et al*., 2015; IPCC, 2018).

Understanding the mechanisms through which climate change impacts any given species is a challenge, and scientists are increasingly focused on trying to predict consequences (Simmonds, 2016). The International Whaling Commission (IWC) has held a series of workshops about climate change and has highlighted the need to understand the relationship between cetacean distribution and measurable climatic indices such as SST (IWC, 2010).

The impacts of climate change on cetaceans can be direct, such as thermal stress, or indirect, such as changes in prey availability (Learmonth *et al*., 2006). Effects can lead to changes in distribution, abundance and migration patterns, the presence of competitors and/or predators, community structure, timing of breeding, reproductive success and survival. Other potential outcomes of climate change could be more dramatic, such as the exacerbation of epizootics (Simmonds, 2016). The incidence of harmful algal blooms may also increase as a result of climate change. The Scientific Committee of the IWC has recently looked at this topic and concluded that the toxins from the blooms have resulted in an increasing risk to cetacean health at the individual and population levels (IWC, 2018).

Human activities have caused approximately 1.0°C of global warming above pre-industrial levels (IPCC, 2018) and it is estimated that global warming will reach 1.5°C between 2030 and 2052. In the last 50 years the world's oceans have absorbed more than 90% of the excess heat in the climate system (IPCC, 2019). The rate of ocean warming has more than doubled since 1993 and marine heatwaves have become common and more intense.

Climate change and cetaceans in European waters

Much of the science looking at cetaceans and climate change has focused on Arctic species. Only some 10% of scientific papers published on this topic between 1997 and 2016 related to Europe (Nunny and Simmonds, 2016) and more recent articles tend to look north; for example, at the Norwegian Sea, the waters around Svalbard, and Iceland (e.g. Nøttestad *et al*., 2015; Víkingsson *et al*., 2015; Vacquié-Garcia *et al*., 2018). Nonetheless, there have also been studies focusing on North Atlantic and Mediterranean waters (e.g. Azzellino *et al*., 2008; Lambert *et al*., 2014; Cañadas and Vázquez, 2017; Sousa *et al*., 2019).

In Europe the increase in SSTs has been more rapid than the global average (Reid, 2016). In northerly waters there have been elevated sub-surface temperatures in the Norwegian Sea (Nøttestad *et al*., 2015) and waters around Svalbard have been warming, contributing to a decline in sea ice (Descamps *et al*., 2017). Sea temperature and salinity have also increased in Icelandic waters (Víkingsson *et al*., 2015). Across the UK continental shelf, SSTs have been increasing over the last 30 years with warming the strongest in the North Atlantic north of 60°N and the fastest rate of warming off the east coast of Iceland (Tinker and Howes, 2020). Significant SST increases have been recorded North of Scotland and in most of the North Sea of up to 0.24°C per decade.

In the Western Mediterranean the average annual maximum temperature for 2002 – 2006 was 1°C above the mean maximum temperature (MMT) of 26.6°C for 1988-1999 (Marbà and Duarte, 2010). Warming of SST in the Mediterranean in recent decades is due in part to anthropogenic-caused climate change combined with the positive phase of a natural oscillation in temperature called the Atlantic Multidecadal Oscillation (AMO) (Macias *et al*., 2013). A recent slowdown in warming in this region is probably due to a shift in the AMO phase, which may mask warming effects in the coming decades in the Mediterranean and adjacent waters.

Indeed, some sea areas have even seen a cooling in ocean temperatures, for example in the area known as the 'Big Blue Blob' in the North Atlantic. This is a phenomenon which started in 2013 and recorded its lowest temperature in 2015 (Tinker and Howes, 2020). This has also meant that the UK's south-west coast, for example, has not warmed significantly in recent years.

Since 1987, the abundance of humpback whales (*Megaptera novaeangliae*) and fin whales (*Balaenoptera physalus*) in Icelandic waters has increased and the abundance of minke whales (*Balaenoptera acutorostrata*) on the Icelandic continental shelf has decreased (Víkingsson *et al*., 2015). Blue whale (*Balaenoptera musculus*) distribution has also altered with a shift northwards. In the North Atlantic, models have predicted that species that favour warmer waters (e.g. striped dolphin (*Stenella coeruleoalba*)) will expand northwards and that cooler water species (minke whale, northern bottlenose whale (*Hyperoodon ampullatus*) and white-beaked dolphin (*Lagenorhynchus albirostris*)) will contract their range northwards (Lambert *et al*., 2014). A collation of survey data from 1986-2016 covering the North-West European continental shelf from south-west Norway to Portugal revealed that white-beaked dolphins and Atlantic white-sided dolphins (*Lagenorhynchus acutus*), species which have cold temperate to low-arctic ranges, have decreased in abundance whereas short-beaked common dolphins (*Delphinus delphis*) and striped dolphins (species which have warm temperate ranges) have increased (Evans and Waggitt, 2020).

Anthropogenic CO_2 concentration in the Mediterranean is relatively high and acidification has been detected (Pace *et al*., 2015; Lacoue-Labarthe *et al*., 2016). Combined with rising temperatures, acidification may impact cetaceans by affecting the availability of their prey (Pace *et al*., 2015; Lacoue-Labarthe *et al*., 2016). Long-finned pilot whale (*Globicephala melas*) distribution and population structure in the Mediterranean may be affected as some of their prey, e.g. squid, is sensitive to temperature and ocean acidification (Verborgh *et al*., 2016). Ocean acidification in the Mediterranean will affect the trophic web in a number of ways such as a reduction in productivity of seagrass (*Posidonia oceanica*), and impacts on productivity and biodiversity of phytoplankton and zooplankton (Lacoue-Labarthe *et al*., 2016). These changes will, in turn, affect higher levels of the food web. Deoxygenation of the ocean due to warming is another threat and could be a particular problem in enclosed areas such as the Black and Baltic Seas (Reid, 2016).

Ability to adapt

Some cetaceans may be able to adapt to climate change-driven alterations to some, as yet unknown, extent (Simmonds, 2017a). For example, as macro-zooplankton becomes less available because of higher temperatures in the Norwegian Sea, fin whales and minke whales have adapted their feeding to focus more on pelagic fish such as Norwegian spring-spawning herring (*Clupea harengus*) (Nøttestad *et al*., 2015).

Belugas (*Delphinapterus leucas*) in Svalbard continue to use glacier fronts as foraging areas but, following the decline in sea ice, have recently started to spend more time in the fjords of west Spitsbergen during summer and autumn (Vacquié-Garcia *et al*., 2018). This suggests a change in diet, or at least a broadening of their diet, as they start to feed more on Atlantic fish species which are arriving in the fjords with warmer Atlantic water (Vacquié-Garcia *et al*., 2018). Similarly, in Icelandic waters, changes in sea temperature and salinity have been accompanied by a change in the distribution of a number of fish and krill species and the distributions and abundance of several cetacean species (Víkingsson *et al*., 2015).

Inability to adapt and loss of habitat

Some cetaceans, such as those which inhabit continental shelf areas, may find that continued changes in temperature and/or prey availability make their home areas inhospitable (Simmonds, 2017a). McLeod *et al*. (2008) anticipated that white-beaked dolphins living in shelf waters off the United Kingdom and Ireland would experience a loss of habitat. Indeed the abundance of this species in Europe shows a strong negative relationship to increasing temperature (Evans and Waggitt, 2020). Lambert *et al*. (2014) have predicted that, by 2060, their habitat will have been reduced by 80% in this region (in medium or high emission scenarios).

Another species that may lose habitat is the minke whale. It has been predicted that the southern part of the North Atlantic minke whale's range will see a reduction in suitable habitat and feeding opportunities by the 2080s (in medium and high emission scenarios) (Lambert *et al*., 2014). Beaked whales which rely on deep sea trenches may be especially vulnerable (Simmonds, 2016) as may the cetaceans that live in enclosed areas such as the three delphinid species resident in the Black Sea (short-beaked common dolphin (*Delphinus delphis ponticus*), Black Sea bottlenose dolphin (*Tursiops truncatus ponticus*) and Black Sea harbour porpoise (*Phocoena phocoena relicta*)) (Simmonds, 2017a).

Sousa *et al*. (2019) assessed seven cetacean species around Madeira and found that the sperm whale (*Physeter macrocephalus*) is likely the most vulnerable, followed by the fin whale, bottlenose dolphin (*Tursiops truncatus*) and Bryde's whale (*Balaenoptera edeni*). Sperm whales were found to be particularly vulnerable because of their low genetic variability and diet diversity, their vulnerable status and because of their migratory behaviour (Sousa *et al*., 2019).

In the Ligurian Sea, fin whales, striped dolphins and sperm whale distributions may alter in response to climate change (Azzellino *et al*., 2008). Likewise, a rise in SST in the Alboran Sea is predicted to reduce the suitable habitat available for local common dolphins, a subpopulation already listed as endangered by the IUCN (International Union for Conservation of Nature) (Cañadas and Vázquez, 2017).

Biological timing issues

Many cetaceans are migratory, ranging from bigger species that regularly oscillate between polar feeding grounds and warm breeding grounds to smaller species that regularly move between inshore and offshore areas. The animals need to find certain conditions for their survival and the timing of migrations allows exploitation of resources such as the spring bloom of prey in the Arctic. However, climate change may affect the timing of key phenomena causing whales to arrive out of sync with the resources they seek (Simmonds and Elliott, 2009). In the Norwegian Sea some shifts in the distribution and abundance patterns of cetaceans have recently been linked to changing levels of abundance in their prey and elevated SSTs (Nøttestad *et al*., 2015). Similar plasticity in behaviour has been suggested for fin whales in the Mediterranean (Notarbartolo di Sciara *et al*., 2016). However, the extent that populations will be able to respond to changing conditions is unknown.

Human behaviour, welfare and synergies

Climate change will cause humans to alter some of their behaviours, in turn impacting cetaceans (Simmonds, 2017a). For example, if humans become more reliant on marine species as food, cetaceans may find themselves facing increased prey depletion and bycatch or even being taken directly (Alter *et al*., 2010). Potential increases in aquaculture could lead to local eutrophication and conflict with local marine mammals. Other human-mediated effects might include:

- increased shipping;
- more coastal construction work;
- increased exposure to pollution and pathogens; and
- an increase in disasters such as oil spills as vessels move into new areas (Simmonds, 2017a; Alter *et al*., 2010).

Welfare will also be impaired if individual cetaceans find their ability to feed and reproduce is impacted or their health otherwise compromised and climate-driven changes will act synergistically with other stressors, including ocean acidification, pollution (including PCBs (persistent polychlorinated biphenyls)) and other threats (Simmonds, 2017b; Jepson *et al*., 2016). Figure 1 shows some of the interacting variables and the link between welfare at the individual level and conservation of the population.

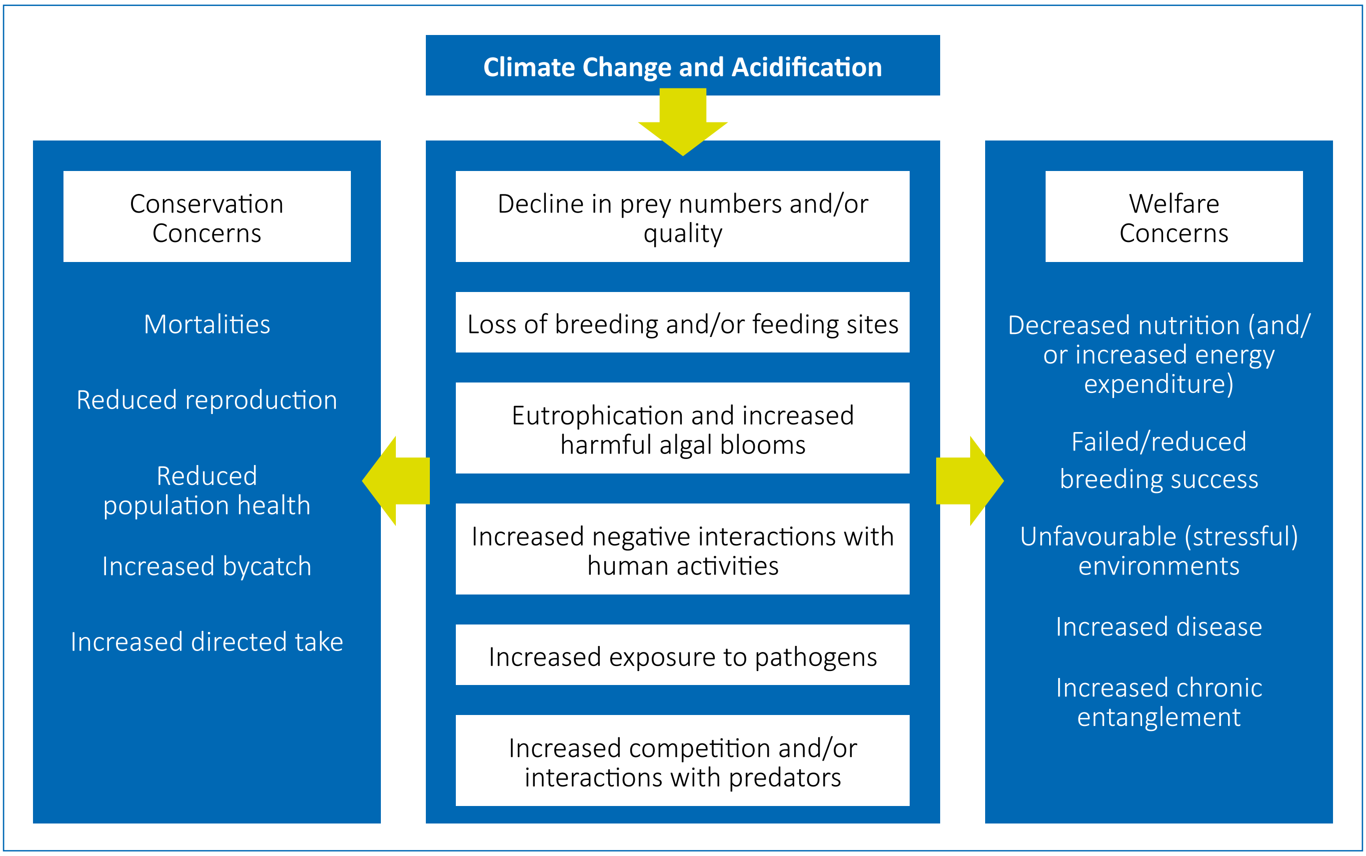

Figure 1: Examples of the cetacean conservation and welfare concerns that may be driven by climate change and acidification.

Indeed, how cetaceans are impacted by climate change needs to be considered alongside other threats to their health and wellbeing. For example, Jepson *et al*. (2016) reported that certain European cetaceans are particularly at risk from PCBs contamination. The resulting immunosuppression and reproductive failure which this contamination can produce, when combined with changes in the marine environment due to climate change, may make some cetaceans more susceptible to disease (Simmonds, 2016; Simmonds, 2017b; Jepson *et al*., 2016).

Conclusion

Climate change and ocean acidification can already be seen to be having an impact on European marine systems and some European cetacean species. Urgent action is needed to limit the negative welfare and conservation consequences that the climate crisis will cause for the cetaceans living in the cold temperate water habitats of Europe. Those limited to enclosed waters, and less able to move away from adverse changes, may be especially vulnerable.

Recommended actions

Policy

- Urgently address other non-climate threats to cetacean populations to take pressure off them.
- Use the precautionary approach in conservation policy and educate the public about how climate change can impact cetaceans.
- Meet targets to reduce CO_2 and other relevant emissions.

Management measures

- Introduce larger protected marine areas, potentially with flexible or mobile boundaries to take into account the fact that changes in their habitat may prompt cetaceans to move outside of established habitat areas.

Private sector

- Reduce consumption of fossil fuels that contribute to CO_2 production and climate change.
- Invest in green energy.

Science

- Continue comprehensive monitoring of cetaceans in European waters including health studies.
- Use models to predict impacts of climate change on different species/populations in different locations and so inform conservation actions.

Public

- Reduce dependence on and consumption of fossil fuels.
- Reduce consumption of meat and other animal products which cause the emission of greenhouse gases.
- Buy local produce to reduce "food miles".

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Conclusions and Recommendations

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Given the status of many cetacean species and populations and the myriad of significant threats that they are now facing, it is obvious that existing legislation and conservation schemes are either not properly implemented and/or are insufficient in their scope, and greater effort is required from all stakeholders to make real change. We certainly need to scale up appropriate actions to avoid losing cetacean populations and species, including by better protecting their habitats, which will also improve the health and resilience of European waters.

Reflecting on the conclusions from the experts within the individual chapters and taking into consideration our experience over many years of working within national, regional and international conservation schemes, we have come up with a number of specific asks and recommendations. These are directed at the decision-makers of Range States, Multilateral Environmental Agreements (MEAs) and international bodies and detail how the protection of whales, dolphins and porpoises in European waters can be improved, including how to address gaps in existing conservation frameworks and legislation. If not mentioned explicitly, our recommendations and asks are directed at decision makers and management authorities of *all* European States, regardless of whether they are Member States of the European Union or not.

Asks and Recommendations

Legislation

- Legislation should reflect that cetaceans are granted the highest level of protection.

- The precautionary principle in conservation policy must be rigorously applied.

- All European States need to follow best environmental practices within their Programmes of Measures and Conservation Action Plans to achieve Good Environmental Status within European waters[1].

- Priority must be given so that the legislative provisions and internationally agreed conservation measures intended to protect cetaceans are properly implemented, controlled and enforced.

Marine Protected Areas (MPAs)

- Marine Protected Areas (MPAs) must have an associated and effective conservation management plan in place, and the measures described in the plan must be implemented and properly resourced to achieve the set conservation objectives.[2]

- Important Marine Mammal Areas (IMMAs) shall guide the declaration of new MPAs and shall be taken into account within marine spatial planning processes.

Hunting

- The deliberate take of all cetacean species must be prohibited by all European States[3].

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[1] Programmes of Measures are core to Marine Strategies for the implementation of Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008, establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive/MSFD). Article 13 says "Member States shall, in respect of each marine region or subregion concerned, identify the measures which need to be taken in order to achieve or maintain good environmental status". The MSFD encourages regional cooperation, which is defined in Article 6 as follows: "Member States shall, where practical and appropriate, use existing regional institutional cooperation structures, including those under Regional Sea Conventions, covering that marine region or subregion". Therefore, OceanCare encourages all European States to make use of this approach.

[2] Invasive activities such as intense or non-selective fishing activities, impulsive noise-generating activities in, and even outside, the MPA (which shall establish noise-buffer-zones) and other detrimental activities must be prohibited.

[3] Deliberate takes of cetaceans should only be permitted for subsistence purposes by indigenous communities and should be subject to the strict oversight of and regular review by the International Whaling Commission (IWC). When such 'aboriginal subsistence whaling' quotas are calculated by the IWC Scientific Committee, they will need to be based on clear subsistence needs. All removals should be taken into account and cumulative and synergistic impacts should also be considered in order to ensure that appropriate management advice is generated.

Fisheries[4]

- Illegal, unreported and unregulated (IUU) fishing should be stopped immediately through the application of appropriate monitoring, enforcement and sanctions.

- Spatial and temporal time-area closures are needed to avoid large-scale bycatch. Fishing gear known to cause significant cetacean mortality should be banned.

- In general, methods to reduce or avoid bycatch should primarily target the fisheries involved, rather than be technical fixes that cause collateral damage to marine life including cetaceans (e.g. through the use of harassment devices that may result in displacement from key habitat, hearing impairment, reduced food intake, social disruption and other problems).

- Fishing gear known to damage marine habitats, thus hampering an ecosystem's potential to support healthy populations of marine predators including cetaceans, should be banned.

- Overall fishing effort must be reduced, with the ultimate aim of preserving diverse and resilient ecosystems where whales and dolphins (as well as marine life in general) can recover and thrive.

Visible and invisible pollution

- Reducing input at source is the most effective way of reducing the impact of various forms of pollution (including chemical pollution, marine plastic pollution and noise pollution).

Noise pollution

- A ban on oil and gas exploration activities in European waters, including pending licences, should be imposed.

- Speed reductions and limitations for shipping should be put in place where possible.

- A European-wide shipping strategy should be adopted focusing on multi-environmental benefits, including the reduction of noise emissions, CO_2 and other air pollutants.

- The greening of ports strategies should be adopted.

- The use of technologies and improved design that reduce the transmission of sound from ship engines and propellers to the marine environment should be encouraged.

- Time and area closures for impulsive noise generating activities should be imposed[5].

- The mandatory application of the CMS Family Guidelines on Environmental Impact Assessments (EIAs) for Marine Noise-generating Activities should be required prior to granting permission for noise-generating activities which do not fall under the aforementioned specific provisions.

Plastic pollution

- A legally binding global plastic treaty, addressing the full lifecycle of plastics, should be developed[6].

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[4] While fishing was only marginally addressed in the various contributions to the Report, it remains the main threat to marine life in general. Hence, this recommendation section elaborates further on this.

[5] This approach shall include military activities such as the employment of active sonar systems or explosions, the establishment of buffer-zones to reduce the impact of noise in particular for sensitive habitats, including MPAs, etc.

[6] European States should support a new international, legally binding plastic treaty, addressing the full lifecycle of plastics, including measures to reduce virgin plastic production and prevent microplastic pollution.

- Local, national and European strategies are needed to drastically reduce plastic consumption through behavioural change campaigns.

- European States need to phase-out and totally ban the most hazardous substances and materials used in plastic packaging[7].

- Port reception facilities need to be improved with separate waste collections for plastic waste from ships, including fishing gear, as well as facilitating reuse, recycling and adequate waste management.

- European governments shall apply the Voluntary Guidelines for the Marking of Fishing Gear developed by FAO (Food and Agriculture Organization of the United Nations) as well as becoming members of the Global Ghost Gear Initiative.

Chemical pollution

- The most hazardous chemicals and pesticides need to be banned as a priority.

- Chemical pollutants should be included in risk analyses and impact assessments of other activities that impact cetaceans to take potential cumulative effects into account.

Climate change

- Exploration for any new hydrocarbon resources in the seabed should be banned. All concessions already in force for the exploitation of fossil fuel deposits should be phased-out and abandoned[8].

Strandings and diseases

- Stranding response protocols and data-sharing among European States should be harmonised and collaboration should be intensified.

Whale watching

- Whale watching tours shall be subject to a permit system, including defining a carrying capacity on a regional basis. A certification system promoting high quality whale watching shall be established.

European Union specific

- Measurable actions, implementation oversight, incentive and enforcement tools are essential for reaching Good Environmental Status. Similarly there should be harmonization of the Programmes of Measures with a best practice approach and annual reporting of efficiency and progress.

International

- European governments shall pro-actively promote the highest level of protection for cetaceans within multilateral negotiations and international policy frameworks.

- An international moratorium on directed hunts of all cetacean species should be called for[9].

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[7] This includes nine substances used in plastic packaging according to the “Database of Chemicals associated with Plastic Packaging (CPPdb)” (Groh *et al.*, 2018). https://zenodo.org/record/1287773#.YBPvrHkxlEY, as well as a ban of the hazardous material Polystyrene (PS) including Expanded Polystyrene (EPS) in food contact materials.

[8] Abandonment of all concessions already in force for the exploitation of fossil fuel deposits that are located in any part of the territory of European States, including their territorial sea, their Exclusive Economic Zones (EEZ) and the continental shelf, establishing January 1, 2035, as the end date of activity for all of those concessions.

[9] Exemptions shall only be granted selectively and under strict management oversight for cultural and subsistence needs for indigenous communities (see above).

- Regional and International Agreements need compliance and enforcement mechanisms to ensure proper implementation of provisions and decisions[10].

- European States not yet Party to species conservation treaties are urgently requested to join such Conventions, for example the Convention on Biological Diversity (CBD), the Convention on the Conservation of Migratory Species of Wild Animals (CMS), and Regional Agreements such as the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) and the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS), as appropriate.

- European States should increase engagement and elevate their efforts to the highest diplomatic levels to secure an ambitious treaty for the high seas[11].

- Economic interests should not continue to override conservation measures[12].

- Given that species monitoring and assessments at sea are inherently difficult, slow and, once published, often quickly outdated, actions addressing threats no matter what the species' Red List status must not be delayed.

- A new conservation approach should be promoted and implemented focusing on protecting individuals and social units decoupled from the species or population-focused approach by recognising the social complexity of cetacean species and the academic acceptance that many cetacean species have cultures[13].

It is a crucial time. Greater ambition is required by all stakeholders to address the many threats that whales, dolphins and porpoises in European waters are facing. Conservation effort and collaboration need to be intensified to prevent losing further populations or even species. Protecting cetaceans and their habitats will also improve the health and resilience of European waters.

Whales and dolphins depend on us and we depend on them.

[10] Such mechanisms need to provide tools to impose sanctions, as well as acting in a transparent manner by allowing civil society participation.

[11] Beyond national European marine waters and beyond the 200 nautical miles EEZ, i.e. outside the realm of national laws, EU laws (e.g., the EU Habitats Directive), Regional Seas Conventions, international UN Treaties (e.g., UNCLOS, CBD), MEAs and non-UN treaties (e.g., the Bern Convention, ICRW) and where legislative gaps exist, the new legally binding treaty to protect the High Seas (BBNJ ILBI) will be ever so important filling the governance gap for biodiversity beyond national jurisdictions.

[12] The precautionary principle needs to be a fundamental part of the Blue Economy. As the Agenda 2030 for Sustainable Development shows, conservation and sustainable development are intrinsically linked.

[13] In such an approach, the most recent developments, decisions and recommendations within and by the CMS to which most European States are Party to, shall be followed.

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