



Towards an EU Action Plan on Cetacean Bycatch



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ABSTRACT

For decades, cetacean bycatch has been a major conservation and welfare concern in Europe, with high numbers of harbour porpoises, dolphins and whales continuing to die each year. Despite binding legal requirements to reduce bycatch, there has been limited effective monitoring or mitigation. Bycatch is also an important welfare issue. At this critical juncture, with discussion of incorporating monitoring and mitigation of bycatch of protected species in Europe into the Data Collection Framework and Technical Measures Framework taking place to help deliver the reformed Common Fisheries Policy (CFP), a clear, effective strategy could identify the steps that are required by all EU Member States to reduce bycatch towards zero. Here, implementation of current monitoring and mitigation obligations are reviewed. Recommendations are made for the provision of clear EU guidance in order to improve and unify population surveillance and bycatch monitoring, with enhanced implementation and enforcement from Member States. A more regionalised evidence-based approach to monitoring and mitigation is in line with the move to more regionalised management under the CFP, with Member States robustly showing that bycatch levels are decreasing over a set period of time (e.g. 5 years) by a specified amount. To this end, an EU Action Plan on Cetacean Bycatch, comparable to the existing 2012 Action Plan for reducing incidental catches of seabirds in fishing gear, might be beneficial and could ultimately form a model for an international Food and Agricultural Organisation (FAO) Cetacean Bycatch Reduction Action Plan.

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1. Introduction

Direct interaction with fishing gear, both commercial and artisanal, is considered to be the greatest global threat to the conservation of cetaceans [1,2]. In Europe, incidental catches are of concern for a number of cetacean species [3], including the harbour porpoise (*Phocoena phocoena*) which is particularly vulnerable to bycatch in gillnets [4–13]. However, despite binding European legislation that mandates monitoring and mitigation, knowledge of bycatch numbers remains poor, there has been little change in fisheries management and, in general, inadequate effort to reduce the numbers of cetaceans caught in nets. As a result, thousands of cetaceans continue to die each year in European waters, for some species at levels likely to be causing population level impacts [3,10–12,14].

In Europe, all cetaceans are strictly protected under Article 12 of the EU Habitats Directive (HD). Additional obligations on Member States include the conservation of cetacean populations and the monitoring and mitigation of bycatch and other

anthropogenic impacts under the Marine Strategy Framework Directive (MSFD) and Council Regulation (EC) No. 812/2004, as well as through regional agreements such as ASCOBANS and ACCOBAMS. Under the EU Habitats Directive it is an offence to deliberately capture, kill or disturb cetaceans; or to cause deterioration or destruction to their breeding or resting places (Articles 12 and 16). Article 12 requires that Member States establish a system to monitor the incidental capture and killing of all cetaceans, and to take measures to ensure that incidental capture and killing does not have a significant negative impact on the species concerned, whilst Article 11 requires Member States to implement surveillance of the conservation status of habitats and species of Community Interest. The EU Biodiversity Strategy to 2020 [15] also contains specific actions in relation to bycatch. In particular, Action 14a states that the EU will design measures to avoid the bycatch of unwanted species in accordance with EU legislation and international obligations, with financial incentives to support implementation of the MSFD, as required under Action 14b.

The MSFD requires Member States to implement a programme of assessment, targets, monitoring and measures designed to achieve or maintain Good Environmental Status (GES) by 2020. Under Descriptors 1 and 4 of the MSFD there are requirements that “the distribution and abundance of species are in line with

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prevailing physiographic, geographic and climatic conditions” and that “all elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity”. Actions to achieve GES for other descriptors relating to noise and other forms of pollution, marine litter and fish stocks should also positively contribute to cetacean conservation. However, the European Commission has stated that Member States have shown a lack of ambition and coherence in the targets and measures defined [16]. Whilst it is clear that bycatch remains a significant issue, the majority of Member States are relying on existing legislation as their measures to reach GES for marine mammals, neither proposing new measures nor strengthening implementation and enforcement, and sometimes even reducing the number of measures. Such limited ambition seems highly unlikely to be sufficient to meet GES, and is likely to only serve to maintain the status quo. The MSFD is now entering its critical phase, with lack of funding for monitoring, and uncertainty about how conservation objectives will be reconciled with the needs of other marine sectors being among the main concerns [17].

In an effort to further address cetacean bycatch, Council Regulation (EC) No. 812/2004 (Reg. 812) introduced technical measures aimed at reducing the number of cetaceans caught incidentally through the use of acoustic deterrent devices (ADDs), introducing a system for monitoring bycatch in certain European fisheries. The Commission reviewed Reg. 812 in 2009 and 2011, and found on both occasions that while it had improved the knowledge on bycatch, it had significant weaknesses, both in its constitution and its implementation [18,19]. It excludes many areas and fisheries where bycatch rates are high, excludes small vessels from observer monitoring, mitigation and reporting of effort data, relies too heavily on ADDs, and has poor linkage with reporting under the EU Habitats Directive [20]. Vessels less than 15 m in length are not required to take part in the on-board observer scheme mandated under Reg. 812, with monitoring generally conducted through scientific studies and pilot projects instead. However, delivery of the ‘scientific studies’ has been limited, likely due to the lack of specificity around what monitoring levels are required [20]. As such, the observer monitoring and mitigation undertaken under Reg. 812 covers only a small proportion of the fishing fleet, with the specified geographical coverage failing to encompass some key hotspots and contributors to bycatch [20]. Furthermore, even in areas and fisheries covered by the regulation, there has been inconsistent implementation, low inspection and enforcement of mitigation measures or monitoring of their efficacy. Although some Member States have conducted additional monitoring of those fisheries falling outside the scope of Reg. 812, in line with the requirements of the Habitats Directive, overall monitoring levels fall short of that required to provide robust estimates of cumulative bycatch levels, and large sectors of the European fishing fleet remain unmonitored [21].

The ICES Working Group on Bycatch of Protected Species database currently stores nine years (2006–2014) of data on dedicated monitoring effort and bycatch of cetaceans, as reported to the European Commission (EC) by Member States affected by Reg. 812 [22]. However, in addition to the inherent shortcomings of monitoring coverage achieved under Reg. 812, evaluation of the magnitude of bycatch mortality has been hindered by the lack of an accurate measure of total fishing effort of different fisheries from relevant European waters, as well as inconsistent submission and content of annual reports by some Member States. It has been concluded that the regulation is still not fully meeting its objectives, with high bycatch evident in a number of fisheries, and the actual impacts of bycatch on populations continuing to be poorly understood [21].

Hence, whilst there is strong and coherent legal protection of cetaceans, along with requirements for population surveillance and bycatch monitoring and mitigation on paper, these obligations have not been fully implemented and enforced by Member States. Thus, the application of effective mitigation has been extremely patchy and, more than twenty years on from implementation of the Habitats Directive, we are in a situation where knowledge of the status of populations and current bycatch levels remains limited. Yet existing monitoring clearly indicates the potential for bycatch mortality to be unsustainable in some areas [23]. ASCOBANS Resolution 3.3 on Incidental Take of Small Cetaceans (*extant*) states “that the general aim should be to minimise (i.e. to ultimately reduce to zero) anthropogenic removals within some yet-to-be-specified time frame, and that intermediate target levels should be set”. However, no timeframe has been set as yet despite 15 years passing since this resolution was adopted.

In its position document EP-PE_TC1-COD(2012)0216, the European Parliament stated that “... the Commission should, before the end of 2015, submit a legislative proposal for a coherent, overarching legislative framework for ensuring the effective protection of cetaceans from all threats” [24]. The review of Reg. 812 and potential legislative proposal was subsequently formally called for in Regulation No. 597/2014 of the European Parliament and of the Council, amending Council Regulation (EC) No. 812/2004 [25], which states that “In view of the requirement for Member States to take the necessary measures to establish a system of strict protection for cetaceans in accordance with Regulation (EC) No 812/2004, and given the shortcomings of that Regulation identified by the Commission, the appropriateness and effectiveness of the provisions of that Regulation for protecting cetaceans should be reviewed by 31 December 2015. On the basis of that review, the Commission should, if appropriate, submit to the European Parliament and to the Council an overarching legislative proposal for ensuring the effective protection of cetaceans, including through the regionalisation process”.

The European Commission has now indicated that, rather than proposing new overarching legislation, it will seek to, in time, repeal Reg. 812 and incorporate monitoring of bycatch of protected species into proposed changes to the Data Collection Framework (DCF), with mitigation requirements to form part of the Technical Measures Framework (TMF) under the reformed Common Fisheries Policy (CFP).¹ In the recent EC proposal for a new DCF it is suggested that data on bycatch of protected species could be collected by scientific observers during their routine fisheries sampling programmes (for which the primary purpose is monitoring fish and fish bycatch). However, ICES has advised that, although useful, this would not be sufficient as fisheries selected to monitor commercial fisheries are not necessarily the ones that should be sampled to monitor bycatch of protected species [26]. For example, the existing DCF was primarily designed to quantify discards of commercial species, and therefore only maintains low level monitoring of set-net and pelagic trawl fisheries which whilst not generating large amounts of commercial discard, represent a relatively higher risk of protected species bycatch [21].

The recent EC proposal for the DCF suggests that the EU Multi-Annual Plans (EU MAPs) will state that Regional Coordination Groups, in consultation with end-users, specify which species and fisheries to sample for bycatch of protected species, as well as the variables (what data to collect and how to collect it) and the way in which the sampling should be carried out [27]. With discussions at an early stage, and scant details of monitoring protocols, it remains unclear as to whether a revised DCF will be fit for purpose

¹ Letter from European Commission to UNEP / CMS / ASCOBANS Secretariat titled ASCOBANS recommendations on the requirements of legislation to address monitoring and mitigation of small cetacean bycatch, dated 2/12/2015.

[21]. If DCF monitoring programmes are used, it is essential that protocols require targeted monitoring of protected species, with appropriate fisheries coverage and sampling methods [26]. In addition to collecting data via existing fisheries sampling programmes, dedicated sampling programmes for non-target species are likely to be required to ensure that the relevant fisheries are covered [21,26], and management using new Remote Electronic Monitoring (REM) systems should be created [28].

Since 2014, the CFP has a new process for conservation and management measures, where the purpose of Article 11 is widened to environmental conservation rather than fisheries conservation [29]. All measures passed under CFP Article 11 need to be sufficiently robust to meet the Member States' obligations under the Habitats Directive and MSFD as well as the objectives of the CFP. As part of its Work Programme 2015, the Commission has announced that it will focus its efforts on putting the recent CFP reform smoothly into operation, and that the top priority is to explore synergies between existing legislation [27]. We recommend that this process be utilised to concurrently develop an EU Action Plan on Cetacean Bycatch to achieve progressive reductions in bycatch towards the zero goal. The main objective of an Action Plan is to reduce the incidental catch of cetaceans using a set of measures to quantify and reduce bycatch over a specified period – a requirement for monitoring (training, data collection, research, technological developments, ongoing monitoring and review) and adoption of appropriate mitigation measures to reduce cetacean bycatch. A Best Practice Technical Guidance to include a coherent framework of systematic measures (including sampling design for relevant fisheries, data collection and analysis requirements, a list of responsible parties and stakeholders, as well as a timetable), should be developed, perhaps by the ASCOBANS Bycatch Working Group or the ICES Working Group on Bycatch of Protected Species. It is anticipated that an Action Plan might include explicit monitoring requirements to demonstrate effectiveness of bycatch reduction within a specified timeframe. The 'zone' between zero bycatch and any 'threshold' or 'limit' used to identify areas that require further monitoring or where mitigation measures are most urgently required would not be one of inactivity but one of precautionary action. In addition to prioritising mitigation in fisheries where there is a known high risk of bycatch, monitoring and mitigation should also be applied to fisheries where there is an existing lack of data. Like the Seabird Action Plan (AP), such an AP should identify provision of EU funds for research to develop and test mitigation measures, tailored to specific fisheries, and for enabling distribution of best practice mitigation to relevant fleets, accompanied by awareness-raising and training programmes for fishers, along with training programmes for observers.

2. Levels of bycatch

To date, the failure of Member States to meet the required levels of monitoring, as well as differences in data collection and reporting, has meant that it has been difficult to extrapolate observed catches to fleet level [3] or to compare numbers across countries. Accurate estimates of cumulative incidental catch levels over time, across populations, and across fishery sectors are therefore not available. The data do however, indicate that in the seas around Europe, incidental catches are of conservation concern for a number of species [3,30–32], including, but not limited to:

- harbour porpoises in static nets in the Baltic, Kattegat, North Sea and Skagerrak, eastern North Atlantic, particularly the Celtic Sea, and the Black Sea;
- short-beaked common dolphins (*Delphinus delphis*) in pelagic

trawls for sea bass (*Dicentrarchus labrax*) and tuna (*Thunnus alalunga*) in the Atlantic;

- short-beaked common and striped dolphins (*Stenella coeruleoalba*) in static nets in the Atlantic and Black Sea;
- common bottlenose dolphins (*Tursiops truncatus*) in the Mediterranean; and,
- minke (*Balaenoptera acutorostrata*) and humpback whales (*Megaptera novaeangliae*) in creel lines and discarded nets in the north-eastern North Atlantic.

As a result, the existing data show that there is a problem with cetacean bycatch that needs to be addressed but insufficient data to predict population consequences. This lack of data on population consequences appears to be restricting further action to reduce bycatch levels, let alone to continue to reduce them towards zero, even though the direct killing of any cetacean is prohibited under EU environmental law. However, the current lack of adequate data should not prevent some precautionary bycatch mitigation action.

Finer scale analyses for harbour porpoises have documented that mortality, over different time periods, has likely exceeded sustainable levels in several areas, including, but not limited to, the Bay of Biscay [3], Iberian Peninsula [10], Norwegian coastal waters [11], Baltic [12], Black Sea [7,8], inner Danish waters [6], parts of the North Sea [22,23], and the Celtic Sea [5,33–35].

A preliminary and heavily caveated assessment of overall harbour porpoise bycatch rates in UK fisheries in 2014, based on data gathered since 1995, provides a current estimate of 1400–1700 porpoise deaths annually [13]. This assessment indicates that bycatch rates in some UK fisheries could be unsustainable and above any proposed reference limits, but the uncertainty remains large [36]. Furthermore, this estimate excludes non-UK vessels fishing within the same geographical areas. Since fishing effort can change from year to year as can cetacean distributions, it is important that both are monitored regularly so as to promptly identify potential bycatch problem areas. Better quality data on bycatch rates and fishing effort is required from all relevant EU Member States so that assessment of the overall bycatch of harbour porpoise in these areas can be made. These same issues apply across Europe [36], with limited data on bycatch, total fishing effort, population status and structure preventing a robust assessment of either the impacts of bycatch or the status of cetacean populations [21].

2.1. Sub-lethal and welfare impacts of bycatch

Whilst research on bycatch has largely focused on quantifying mortality, much less is known about sub-lethal impacts of fisheries on cetacean populations. Bycaught cetaceans can suffer injuries and high levels of stress during incidental capture, with documented effects following escape or release from fishing gear including behavioural alterations, physiological and energetic costs, and associated reductions in feeding, growth, or reproduction (i.e. fitness) [37]. Furthermore, due to the highly social nature of many odontocete species where survival and reproductive success can depend on social cohesion and organisation, the effects of social disruption caused by bycatch mortalities may go beyond the dynamics of individual removals and further impede population recovery [38,39]. In the case of mothers dying, a calf or dependent juvenile must be assumed to be a secondary victim [40]. The extent of such sub-lethal and social effects is unknown.

Bycaught cetaceans suffer a variety of injuries, ranging from skin abrasions to amputations, with the degree and severity of injuries varying with the method of fishing and species [41]. Necropsies indicate that the majority of bycaught cetaceans asphyxiate in the nets. The stress associated with capture, pre-mortem injuries and asphyxiation are likely to be high and for

individuals that escape, the stress and injuries incurred may cause prolonged suffering and/or subsequent mortality [37,41,42]. Whilst there are no quantitative data on the duration of suffering associated with bycatch, undoubtedly they can significantly exceed animal welfare standards set in other arenas, such as for the slaughter of farm animals and the catching of wild mammals in killing traps [36]. Evidence shows that larger whales that become entangled in fishing gear, break free from, and subsequently carry, fixed trap and net gear, are subject to a very slow demise, averaging, for example, six months in the case of the North Atlantic right whale (*Eubalaena glacialis*) with some persisting for multiple years [43].

Public concern regarding cetaceans and animal ethics requires that cetacean bycatch is not treated as a necessary evil of fisheries management nor is it solely an issue of the levels of mortality, in view of the concerns over welfare and the potential disruption to complex social systems.

3. Setting ‘thresholds’ to resolve bycatch: a sensible way forward?

Calculation of thresholds has been under consideration in the UK for more than a decade [44]. The establishment of precautionary/interim objectives for bycatch has also been agreed by Parties under ASCOBANS. For example, Resolution 3.3 states “*that the general aim should be to minimise (i.e. to ultimately reduce to zero) anthropogenic removals within some yet-to-be-specified time frame, and that intermediate target levels should be set*” [45]. The determination of ‘safe limits of bycatch’ was proposed by the UK Joint Nature Conservation Committee (JNCC) in 2013 [46] and has been requested by the EC. In 2013, the EC requested that ICES ‘*propose effective ways to define limits or threshold reference points to bycatch that could be incorporated into management targets under the reformed CFP. Limits or threshold reference points should take account of uncertainty in existing bycatch estimates, should allow current conservation goals to be met, and should enable managers to identify fisheries that require further monitoring, and those where mitigation measures are most urgently required*’ [47].

In 2009, 2010 and 2013, ICES advised the EC of the need for explicit conservation and management objectives prior to developing a management framework, also noting that ‘*improved information on bycatch and the biology of the species would improve the procedure.*’ Most recently, in 2013, it informed the Commission that ‘*ICES has reviewed the existing procedures to establish limits and reference points (Catch Limit Algorithm (CLA), Potential Biological Removal (PBR), and 1.7% of the best population estimate as recommended by ASCOBANS) several times in the past decade [48–51]. In all cases it was found that the choice of the most appropriate procedure depended on choices by managers in defining precisely the conservation objectives. These objectives essentially describe a societally-chosen balance between exploitation of resources and conservation of protected species. The most appropriate way of working is therefore jointly between managers and scientists to explore and define conservation objectives. Further than that, the choice of the most appropriate procedure to be adopted to achieve the conservation or management goal should be driven by the availability of suitable data*’ [51].

As enshrined in ASCOBANS resolution 3.3 [45], the ultimate aim must be to achieve zero bycatch, a target which is also in line with the Habitats Directive requirement for “strict protection” (Article 12). Any ‘threshold’ value agreed upon should therefore be viewed as what Resolution 3.3 [45] calls an “intermediate target level”, i.e. a stepping stone on the way to achieving zero bycatch. The ‘zone’ between zero bycatch and any ‘threshold’ is therefore not one of inactivity, but one where adequate bycatch mitigation would still

be applied in order to deliver the zero bycatch aim. The ASCOBANS conservation objective “to allow populations to recover to and/or maintain 80% of carrying capacity in the long term” remains in place, with Resolution 3 defining “unacceptable interactions” as being, in the short term, a total anthropogenic removal above 1.7% of the best available estimate of abundance. ASCOBANS deliberations on this percentage value were specific to harbour porpoise and should not have been applied to other species. Furthermore account was not taken of total anthropogenic removals and other sources of mortality. Setting limits based on fixed percentages of best estimates can be risky when there are large uncertainties and possible biases, and this applies particularly to rarer species for which there are less data [52]. This approach has been justified as either a short term pragmatic approach or as an approach that is easy to explain to stakeholders, but cannot be considered as the best available science [53]. A recent ASCOBANS/Defra workshop on “The Further Development of Management Procedures for Defining the Threshold of ‘Unacceptable Interactions’” agreed that clarity was necessary to ensure that the establishment of environmental limits/triggers resulted in positive action, and continued to stimulate current efforts by Member States to reduce bycatch to its lowest possible levels, and ultimately to zero [54].

The management approach selected should be on the basis of that most likely to be effective, following a critical review of the full range of management frameworks, their suitability, the limited resources and poor baseline population and bycatch data available. The extent to which thresholds would help overcome the obstacles that have thus far prevented meaningful action, and their reliability in light of the considerable data limitations, is unclear. The framework that would support mitigation actions to reduce bycatch, both above and below any thresholds, is also yet to be outlined.

4. Alternative management frameworks

Environmental limits/triggers often form a central component of decision making, and can provide managers with a tool to prioritise conservation action and effectively allocate resources; but other approaches, including prioritisation exercises, provide alternative approaches. For example, the Agreement on the Conservation of Albatrosses and Petrels (ACAP) conducted a prioritisation exercise to identify priority fisheries for reducing bycatch and has significantly reduced demersal long-line seabird bycatch, with up to 98% reductions with the use of streamers [55]. Lessons may be learned from implementation of ACAP that might be applicable to cetaceans.

Where thresholds are used to identify areas that require further monitoring, and those where mitigation measures are most urgently required, the ‘zone’ between zero bycatch and any ‘threshold’ or trigger should not be one of inactivity, but one where adequate bycatch mitigation would still be applied in order to deliver the zero bycatch aim. The form that management frameworks should take must be informed by adequate consideration of the full range of management approaches and the data and resources available to ensure that they result in effective action. This does not mean that the existing lack of data equates to a lack of immediate management action.

Thresholds are central to fisheries management in the U.S. Marine Mammal Protection Act (MMPA) but it is important to note that the U.S. MMPA is supported by substantial financial and personnel resources, legal and scientific infrastructure, including take reduction teams and layers of independent oversight. There are a number of requirements that must be put in place before any regulations that use a PBR approach can be successfully implemented. In the U.S., Stock Assessment Reports are required,

based upon the best scientific information available and include, at a minimum: population identification, population range, minimum population estimate, current population trend, status of the population, estimates of all human related serious injury and mortality, and, descriptions of other factors that may be causing a decline or impeding the recovery of the population. Governments should allocate deliberate funding for the collection of data as well as the development and review of these reports. These reports are reviewed annually for strategic populations [56] and for populations where new information is available, and at least once every three years for all other populations. Population estimates are particularly important because of the challenges faced in monitoring marine mammal populations. Studies suggest that without regular population surveys it is possible that a population can be declining for several years without being recognised [57,58]. Indeed, to detect a trend over 6 years (the Habitats Directive time period for assessing Favourable Conservation Status) with a Coefficient of Variation of 0.2 (about the best one can expect), an annual rate of decline of 0.15 is required, equivalent to loss of c. 60% of the population [58]. Scientific Review Groups (SRGs) comprise marine mammal researchers with in depth knowledge of the population under consideration and provide advice on all these factors and any research needed to address uncertainties. As a result, the MMPA clearly specifies the path to reducing bycatch and not just the goal.

In Europe's Natura 2000 sites, it is a requirement for EU Member States to conduct adequate assessment and monitoring before demonstrating that fisheries do not have a negative impact on management units, or local populations. In order to meet the requirements of the Habitats Directive, MSFD and CFP, similar analyses should be undertaken at a regional level to ensure that fisheries activities do not have a negative cumulative and synergistic impact on achieving conservation objectives for cetaceans, both from various fisheries and other anthropogenic activities. Modelling of the Population Consequences of Disturbance (PCOD) using expert opinion is moving towards this, and might be developed to include bycatch, for example [59].

In light of the current lack of a clear European framework identifying the steps to be taken by Member States to progressively reduce bycatch towards the zero bycatch goal, and ensure the strict protection required for cetaceans under the Habitats Directive, an EU Action Plan on Cetacean Bycatch, similar to the existing Action Plan for Reducing Incidental Catches of Seabirds in Fishing Gear [61], would be a beneficial next step for Member States to take to ensure a coordinated and coherent approach to tackling this conservation issue. The Seabird Action Plan highlights the priority issues and species of concern, the measures for consideration, and coordinated actions recommended. It also outlines key elements which should be taken into account in the impact assessment. Development and implementation of an EU Action Plan on Cetacean Bycatch would ensure that a timely, systematic, coordinated and practical approach is taken for the implementation of adequate monitoring and mitigation regionally. The main objective of such an Action Plan would be to provide the technical and scientific detail not contained within the DCF and TMF to reduce the incidental catch of cetaceans, using a set of measures to quantify and reduce bycatch over a specified period – a requirement for fishery specific data collection, research, adoption of mitigation measures to reduce cetacean bycatch, and ongoing monitoring and review. Here we propose some potential key components of such an Action Plan, centred around improving (i) bycatch monitoring; and (ii) effective mitigation based upon a regionalised, stakeholder and evidence-based approach. In order to drive continued progress towards the goal of zero bycatch under such an Action Plan, the efficacy of mitigation should be monitored and Member States required to robustly show that bycatch

levels in relation to population size are decreasing by a specified amount, over a set time period (e.g. 5 years), as evidenced through monitoring and mitigation.

4.1. Improving bycatch monitoring

Current bycatch monitoring has proved inadequate to inform management action due to inadequacies in the implementation of Reg. 812, variable implementation of monitoring obligations under both Reg. 812 and the Habitats Directive, and a lack of clear, specific EU guidance. This has meant that monitoring of bycatch is often undertaken using different methodologies and to greatly varying standards by different Member States, resulting in insufficient fishery coverage, inadequate information on fishing effort, and/or sampling designs that have prevented the extrapolation and integration of data across Member States [21,26]. This has often prevented the calculation of total bycatch estimates for individual cetacean populations, and with large sections of the European fleet remaining unmonitored it has in turn largely prevented the application of effective management action [19].

In order to inform effective, targeted mitigation, a monitoring strategy is required that is coherently implemented across Member States. Essential components of monitoring, and components to be included in the Action Plan, include:

- Where one data gap is the disparity of information from different fishing sectors [61], adequate geographic and fishery coverage, where monitoring effort within a fishery should be proportionate to the fishery/metier's overall contribution to bycatch (taking into account fleet size, effort and bycatch rate per vessel, as cumulative bycatch may be high in a large fleet even if bycatch rate per vessel is low). For trawlers, the duration of towing and dimensions of the aperture of the fishing gear should be collected in addition to fishing time and days at sea. Different types of trawls should be distinguished as they have different bycatch rates. For set-net and driftnet fisheries, the data to be collected in addition to fishing time should include the number of vessels involved, the length, height and soak time of the net used, the target species, the mesh size, and gear type [21,26];
- Knowledge of total fleet size per fishery;
- Adequate monitoring coverage, using independent observers, and/or development of remote electronic monitoring (REM);
- Recording details of all bycatch events in order to help determine factors influencing bycatch rates.

Collection of such data will require investment in monitoring by Member States to ensure adequate geographic and fishery coverage. A unified approach to data collection will allow observed catches to be extrapolated to fleet level, and integrated across Member States to obtain robust estimates of bycatch levels by fishery type per management unit area. Monitoring smaller boats, which represent the large majority of total vessel number in many countries, is vital as these vessels typically operate in coastal waters predominantly deploying static gears and therefore potentially pose a substantial risk to cetacean species inhabiting shelf waters [62]. Annual collation and analysis of bycatch data and reporting of new measures to be put in place should continue to be undertaken by the ICES Working Group on Bycatch of Protected Species.

In addition, an Action Plan might include a provision for an 'emergency response' following a sudden increase in bycatch reports (either from observers or through strandings). The aim would be to respond quickly to address an emerging bycatch problem either caused by changes in fishing practices or changes in the distribution of animals. This would require an agreed

procedure to identify such situations plus possible actions to be taken and the data required to do so.

Further, collaboration with stranding monitoring schemes, analysis of carcasses from fishing vessels and drift analysis are all useful for monitoring purposes. Data from stranded and bycaught animals, despite some biases and limitations, remain the main (and often only) source of life history information for many populations [63]. Unusually high stranding rates can highlight anomalies in distributions and critical areas with a high level of interaction with fisheries [64] whilst the establishment of a European wide monitoring strategy is required [63] that includes investigation into the sub-lethal effects of bycatch-related injury and stress on fitness [37].

4.2. Developing an evidence-based, regional approach to bycatch mitigation

The implementation of stakeholder-led cetacean bycatch reduction teams could, as in the U.S., be focused on implementing specific monitoring and mitigation measures across particular fisheries to reduce bycatch at a local level. One approach suggested by ASCOBANS is a precautionary one whereby appropriate mitigation measures are applied in all set-net fisheries irrespective of vessel size, gear type or geographic area; given that they are known to be a major cause of bycatch for species like porpoises, but with exemptions made for those fisheries with demonstrated negligible (rate and/or cumulative) bycatch (see under regional recommendation for required mitigation and monitoring measures, as well as exempted fisheries) [21]. This could become a component of an EU approach.

Assessing and mitigating the impact of bycatch also requires an understanding of the conditions under which animals are caught, the sections of the population affected, and the key factors influencing bycatch rates [63]. It is therefore important that, in addition to implementing precautionary mitigation measures, data continue to be collected to inform any refinements necessary and assessment of their efficacy. A complex combination of environmental, operational, technical and biological factors can all influence bycatch rates. A comprehensive review of evidence of factors associated with trends in bycatch rates in gillnet fisheries has recently been conducted [65]. Seasonal changes in cetacean and fisheries distribution, behavioural processes that can vary with age, sex and reproductive status, and oceanographic dynamics can all influence bycatch rates [63]. For example, in the albacore tuna gillnet fishery in the northeast Atlantic, young male common and striped dolphins dominate the catch. Adult females constitute the second largest portion of the bycatch for both species, with potential consequences for population sustainability [63]. In this fishery, depth was identified as the most important parameter influencing bycatch, with the extent to which operations were conducted in daylight also a factor, effort alone having little influence on the capture probability [62]. In other fisheries, effort has been identified as a likely key factor, for example in UK static net fisheries where net length appears to be a key factor in predicting bycatch rate, and is more important than the metier² [13]. Changes have also been observed in the UK bycatch rate, potentially due to a change in porpoise distribution, a change in foraging behaviour, or subtle changes in gear configurations not revealed by the metier descriptions utilised [13]. In the context of seabird

bycatch in Australia's Eastern Tuna and Billfish Fishery (ETBF), significant variation in bycatch rates was observed at the individual vessel level, suggesting that operator behaviour influenced bycatch rates and that individual level incentive-based management measures may be the most effective (C. Wilcox, pers. comm.). Such studies indicate variation between geographic regions and fisheries in the main factors influencing bycatch rates, and caution against a 'one size fits all' approach to mitigation.

Thus, where possible, the adaptive refinement of mitigation measures should be informed by robust knowledge of the operational and environmental factors influencing bycatch rate. At the same time, the perceived burden of data collection should not become a barrier to (or reason to postpone) implementing precautionary mitigation, and data requirements need to be balanced with an urgent need to implement conservation action. Consultation with fisheries stakeholders, and trials and monitoring of mitigation success, are key to ensuring industry support for mitigation measures. As mitigation is implemented, both efficacy and compliance should be monitored, with its development an evolving process that allows continued refinement of mitigation in partnership with stakeholders. A range of potential mitigation methods are now available, a selection of which are summarised below.

4.2.1. Time-area fishing restrictions or closures

For time-area measures to be effective, clear differences in geographical and temporal density of the animals are required, so that bycatch can really be reduced and not simply shifted. For example, bycatch of common dolphins in pair trawls off north-western Spain could be reduced significantly if trawlers were restricted to operating in water deeper than 250 m, and likely avoided entirely if they were restricted to water deeper than 300 m and only operating in daylight [66].

Although a fishery might pose high risk to a species, low or moderate risk areas can exist within the range of the fishery, enabling management measures to focus upon those areas of greatest risk [67], especially if these represent critical habitats for cetaceans. Adoption of time-area closures was the first tangible conservation action taken to reduce the bycatch of harbour porpoises in the Gulf of Maine, USA, where three such areas were incorporated into a number of management actions and remain part of the bycatch reduction strategy in place today [68].

4.2.2. Gear modifications and alternative gear types

Modification of existing gear types and the development of alternatives can also make fisheries less destructive and reduce cetacean bycatch. As an example, gillnets might be replaced in the long run by more environmentally friendly fishing methods in the Baltic Sea Proper, where only ca. 450 harbour porpoises remain, representing one of the most threatened cetacean populations in the world [69]. Projects to investigate the feasibility and efficacy of long-lines (historically used widely in the Baltic), jigging machines (automated angling systems), baited pots or large fish traps such as pound nets or pontoon traps have been conducted [70] or are currently under way, respectively (Kim Detloff, pers. comm.). Research into alternative fishing methods and their promotion has to be encouraged and accordingly incentives are required. Collaboration with fisheries stakeholders and scientists will be essential to this process. Regional Bycatch Reduction Teams, like those that exist in the U.S., might help to focus attention and build stakeholder support. There is significant EU funding under the European Maritime and Fisheries Fund (EMFF) which could provide sufficient support for the development of alternative fishing gear and to support associated studies.

² A metier is defined as a fishing activity which is characterised by a certain gear, group of target species, operating in a given area during a given season, within which each boat's effort exerts a similar exploitation pattern on a particular (group of) species or group of species. In other words, the species composition and size distribution in catches taken by any vessel working in a particular metier should be approximately the same [27].

4.2.3. Acoustic methods

The range of acoustic bycatch reduction techniques for small cetaceans includes passive alerting and active ADDs, including pingers, vessel noise reduction, production of animal sounds, metal oxide nets, echolocation disrupters, and pyrotechnics [71].

To date, pingers have been the most frequently used ADD. To allow their further development, ICES recommends that a performance standard should be set. For an ADD to become acceptable, it should have a proven ability to reduce bycatch of the relevant species in the setting of a commercial fishery [47]. Pingers are unlikely to be adopted and/or used appropriately unless their use is mandated [72] and post-implementation monitoring is required to assess temporal trends in compliance and efficacy [72].

New developments include an “interactive” programmable Porpoise Alarm (PAL) using synthesised life-like, electronic harbour porpoise communication signals to modify the behaviour of the animals around nets [73].

Other acoustic mitigation strategies have focused on increasing the detectability of static fishing gear by adding passive reflectors, braided rope, air-tube nylon threads, multi-filament threads or increasing the acoustic reflectivity of twine using a chemical filler [74–77]. Most recently, the focus has been on the development and testing of nylon nets filled with barium sulphate or iron oxide to increase the acoustic reflectivity of the net [78–84]. Results have been variable [see 85]. Whereas a significant reduction in harbour porpoise bycatch rates was observed in ‘acoustically reflective’ gillnets [80,84], the use of reflective or stiff nets did not lead to a reduction in franciscana (*Pontoporia blainvillei*) bycatch rates in gillnets [86], and the use of barium sulphate filled polyamide (nylon) nets actually significantly increased bycatch in the UK [87].

4.2.4. Using all the tools in the box

Many other mitigation strategies may also be effective, depending on the primary factors influencing bycatch rates. The danger of this approach is that a lot of tools can be used to ineffectively tinker around the edges of a problem, while ignoring the main issue because it is too difficult to tackle.

Mitigation measures should not be restricted to the application of acoustic devices, but should also incorporate other appropriate mitigation measures, according to the key factors influencing bycatch rate, and they should be developed in close collaboration with the fishing industry and other stakeholders, as a key component of any EU approach. Limiting or placing restrictions on effort (e.g. soak time, net length) are likely to be the most effective way to reduce bycatch. Others include modification of the depths of gear deployment, mesh size, net height and length, and in some cases, potentially a move from industry-wide regulation to individual incentive-based management, which rewards low impact operators while simultaneously driving poorly performing operators to adopt better practices or leave the industry.

The role of working with and educating fishers can also be an important mitigation approach. In some fisheries, perhaps most prominently in the tuna purse-seine fisheries in the eastern tropical Pacific Ocean (ETP), the behaviour of the fishermen can influence levels of bycatch. Where schools of yellowfin tuna (*Thunnus albacares*) are caught by locating, chasing and encircling herds of associated dolphins, such behaviour increases the chance of capture of dolphins in the net [e.g. 88]. Educating skippers about the impacts of this behaviour was a key part in the solution of the ETP tuna-dolphin issue, and promoted the adoption of alternative fishing techniques.

In many cases, the best strategy may require a combination of approaches, ‘using all the tools in the box’. In the two longest-running programmes that employ pingers globally (in the Gulf of Maine and California-Oregon, see [72]), multiple mitigation approaches, such as time-area closures and gear modification, were

also employed. Similarly, in Norwegian waters, recommendations to address harbour porpoise bycatch have included a mixture of approaches, from the prohibition of large-mesh gillnets in waters shallower than 50 m as a proxy for the closed area approach, to the use of pingers for gillnets in waters exceeding 50 m depth, along with the continuation of a bycatch monitoring programme, with increased coverage, including of small vessels [11].

Market-led approaches based on certification and eco-labelling can potentially influence incidental bycatch if it is adequately considered as a component of certification, although there is also a risk that consumers may be misled if third-party standards are too lenient or discretionary [89]. A review of one such certification, the Marine Stewardship Council, identified that consideration of best practice bycatch mitigation would improve MSC requirements [90]. Increased transparency in labelling would help the consumer to decide through personal choice, and pressure on, and from, supermarket retailers has been effective in highlighting bycatch of some species and reducing impacts in certain cases.

Globally, wider availability of information on bycatch rates through dedicated studies and monitoring, in combination with increased transparency and stricter rules for the reporting of bycatch and fishing effort by all fisheries, would greatly help in the assessment of bycatch risks and the design of effective mitigation for species of conservation concern [91]. Populations should also be routinely monitored, with management areas revised regularly based upon changes in the animals’ distribution. This is particularly important in a time when the marine environment is changing due to a wide range of anthropogenic activities and climate change, which may fragment and degrade ecological niches [92].

5. Conclusions

For decades, cetacean bycatch has been a major conservation and welfare concern in Europe. Despite 20 years of EU Habitats Directive implementation, and 40 years of the CFP, there has been limited effective monitoring or mitigation, with high numbers of harbour porpoises, dolphins, and whales continuing to die each year. It is clear that implementation of both bycatch and population monitoring needs to be improved and that a renewed effort to reduce bycatch is required.

Important policy decisions are urgently needed to bridge the gap between policy makers, scientists, NGOs and the fishing industry, to ensure that bycatch reductions are achieved immediately. The reformed CFP process includes a commitment to adequate surveillance, bycatch monitoring and effective mitigation, and a clear strategy to this end is needed as soon as possible. Given the considerable data gaps identified, a precautionary approach to management must be considered. As monitoring improves, a more adaptive evidence-based approach to mitigation may become possible. A region-wide policy framework must provide a means to demonstrate the continued reduction of bycatch towards the zero goal, for example through a requirement that annual monitoring and mitigation robustly show that bycatch levels are decreasing by a specified amount over a set time period. To this end, an EU Action Plan on Cetacean Bycatch, like the existing Action Plan for reducing incidental catches of seabirds in fishing gear [60], is urgently needed to provide a management framework to reduce cetacean bycatch towards zero. Ultimately, this could in turn form a model from which to develop an international FAO Action Plan on Cetacean Bycatch.

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