

Towards an EU Action Plan on Cetacean Bycatch

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SUMMARY

For decades, cetacean bycatch has been a major conservation and welfare concern in Europe, with high, and likely unsustainable, numbers of harbour porpoises, dolphins and whales continuing to die each year. Despite binding legal requirements to reduce bycatch, as mandated by the EU Habitats Directive and Marine Strategy Framework Directive (MSFD), as well as the Agreement on the Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) and the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS), there has been limited effective monitoring or mitigation. In addition to significant conservation concerns, bycatch is also a significant welfare issue, with injuries and suffering incurred during the bycatch process. At this critical juncture the optimum framework for monitoring and mitigating bycatch requires careful consideration. It is essential to put a clear, effective strategy in place to identify the steps that are required by all Member States to reduce bycatch towards zero. Here, various management frameworks are considered and recommendations made for 1) Improved and unified population surveillance and bycatch monitoring with adequate geographic and fishery coverage through the provision of clear EU guidance and enhanced implementation and enforcement from Member States; 2) A framework for bycatch mitigation that demonstrates the continued reduction of bycatch towards the zero goal, through a requirement for Member States to robustly show that bycatch levels in relation to population size are decreasing over a set period of time (e.g. 5 years) by a specified amount, evidenced through monitoring and mitigation; and, 3) a more regionalised evidence-based approach to mitigation. To this end, an EU Action Plan on Cetacean Bycatch, similar to the existing 2012 Action Plan for reducing incidental catches of seabirds in fishing gear, is urgently needed and could ultimately form a model for an international FAO Action Plan.

INTRODUCTION

Direct interaction with fishing gear, both commercial and artisanal, is considered to be the greatest threat to the conservation of cetaceans globally (Read et al., 2006; Read, 2008; Reeves et al., 2013; Brown et al., 2015). In Europe, incidental catches are of concern for a number of cetacean species (ICES, 2010), including the harbour porpoise which is particularly vulnerable to bycatch in gillnets (Tregenza et al., 1997; Vinther, 1999; Birkun, 2002; Radu *et al.*, 2003; Vinther and Larsen, 2004; Deaville and Jepson, 2011; Read et al., 2012; Bjørge et al., 2013; Benke et al., 2014; Northridge, 2015). However, despite binding European legislation that mandates monitoring and mitigation, knowledge of bycatch 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 harbour porpoises, dolphins and whales continue to die each year in European waters, at levels

likely to be causing population level impacts (ACCOBAMS & GFCM, 2008; ICES, 2010; Read et al., 2012; Bjørge et al., 2013; Benke et al., 2014).

With the considerable scientific uncertainty regarding the status and trends of many cetacean populations in the four European marine regions: Baltic Sea, Northeast Atlantic Ocean, Mediterranean Sea and Black Sea, bycatch solutions lie in the hands of decision makers and fisheries stakeholders. Clear policy decisions and rigorous implementation are urgently needed to bridge the gap between our poor biological and impact knowledge and what is happening at sea.

In Europe, cetaceans are offered strict protection under Article 12 of the EU Habitats Directive. 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. 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. The EU Habitats Directive explicitly requires Member States to implement surveillance of the conservation status of habitats and species of Community Interest (Article 11). The EU Biodiversity Strategy to 2020 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 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 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”. Other descriptors relating to noise and other forms of pollution, marine litter and fish stocks could also positively contribute to cetacean conservation. However, to date, Member States have shown a lack of ambition and coherence in the targets and measures defined (European Commission, 2014). 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. 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 (Santos & Pierce, 2015).

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 and puts in place a system for monitoring bycatch in certain European fisheries. The Commission reviewed Reg. 812 in 2009 and 2011 and found in both cases that while it had improved the knowledge on

bycatch, it had significant weaknesses, both in its constitution and its implementation (European Commission, 2009; 2011). It excludes many areas and fisheries where bycatch rates are high, excludes small-scale vessels from observer monitoring and mitigation and reporting of effort data, relies too heavily on acoustic deterrent devices, and has poor linkage with reporting under the EU Habitats Directive (Northridge, 2011). Vessels less than 15m in length are not required to take part in the on-board observer scheme mandated under Reg. 812, with monitoring 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 (Northridge, 2011). As such, the observer monitoring and mitigation undertaken under Reg. 812 covers only a small proportion (<20%; Eurostat, 2015) of the fishing fleet, with the specified geographical coverage failing to encompass some key hotspots and contributors to bycatch (Northridge, 2011). 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 (ASCOBANS, 2015a).

The ICES Working Group on Bycatch of Protected Species database currently stores eight years (2006–2013) of data on dedicated monitoring effort and bycatch of cetaceans as reported to the European Commission by Member States affected by Reg. 812 (ICES WGBYC, 2015). However, in addition to the inherent shortcomings of Reg. 812, evaluation of the magnitude of bycatch mortality has been hindered by the lack of an accurate estimate or census of total fishing effort 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 objective, with high bycatch evident in a number of fisheries, and the actual impacts of bycatch on populations continuing to be poorly understood (ASCOBANS, 2015a).

Hence, whilst there is strong and coherent legal protection of cetaceans and 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 informed 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 a potential for mortality through bycatch to be unsustainable in some areas (ASCOBANS NSSG, 2014). 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 despite 15 years passing since this resolution was adopted.

In its position document EP-PE_TC1-COD(2012)0216 the 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*" (European Parliament, 2013). 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 (Official Journal of the European Union, 2014), 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”*.

While the review of Reg. 812 is ongoing, there has also been discussion of incorporating monitoring of bycatch of protected species into proposed changes to the Data Collection Framework (DCF) under the reformed Common Fisheries Policy (CFP). In the recent European Commission (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 (of which the primary purpose is monitoring fish). However, ICES has advised that, although useful, this would not be sufficient as fisheries selected to monitor commercial fish are not necessarily the ones that should be sampled to monitor bycatch of protected species (ICES WGBYC, 2014b). For example, the existing DCF was primarily designed to quantify discards of commercial species, it 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 (ASCOBANS, 2015a).

The recent EC proposal for the DCF suggests that the EU Multi-Annual Programmes (EU MAPs) would 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 and the way in which the sampling should be carried out (European Commission, 2015). With discussions at an early stage, and scant details of monitoring protocols, it remains unclear as to whether a revised DCF would be fit for purpose (ASCOBANS, 2015a). If DCF monitoring programmes are used, it will be essential that protocols require specific monitoring of protected species, with appropriate fisheries coverage and sampling methods (ICES WGBYC, 2014b). In addition to collecting data via existing fisheries sampling programmes, dedicated sampling programmes for non-target species are likely to be required to ensure the relevant fisheries are covered (ICES WGBYC, 2014b; ASCOBANS, 2015a).

Since 2014, the CFP has a new process for conservation and management measures, where the purpose of Article 11 is environmental conservation, and not fisheries conservation (Luk et al., 2014). All such measures passed under CFP Article 11 need to be sufficiently robust to meet the Member States' obligations under the Habitats Directive, 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 for fisheries is to explore synergies between existing legislation (European Commission, 2015). We hope this process can be utilised to develop an EU Action Plan on Cetacean Bycatch to achieve progressive reductions in bycatch towards the zero goal.

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 (ICES, 2010). Accurate estimates of cumulative incidental catch levels are therefore not available. Thus the European Commission concluded that there has been insufficient sampling in the appropriate fisheries or areas to enable sound management decisions to be made with respect to cetacean bycatch (European Commission, 2011a). The available data, does however, indicate that incidental catches are of concern for a number of species (ICES, 2010), including, but not limited to:

- harbour porpoises in static nets in the Baltic, Kattegat, North Sea and Skagerrak, Atlantic and Black Sea;
- common and striped dolphins in static nets in the Atlantic and Black Sea;
- common dolphins in pelagic trawls for bass and tuna in the Atlantic; and
- bottlenose dolphins in the Mediterranean.

Finer scale analyses for harbour porpoises have documented that mortality is likely exceeding sustainable levels in several areas including, but not limited to, the Bay of Biscay (ICES, 2010), Iberian Peninsula (Read et al., 2012), Norwegian coastal waters (Bjorge et al., 2013), the Baltic (Benke et al., 2014), Black Sea (Birkun, 2002; Radu et al., 2003), inner Danish waters (Vinther, 1999) the North Sea (ASCOBANS NSSG, 2014), Channel and Celtic Sea (Northridge et al., 2015).

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 1,400-1,700 porpoise deaths (Northridge et al., 2015). This assessment indicates that bycatch rates in some UK fisheries may be unsustainable and above any proposed reference limits, but the uncertainty is large (ICES WGBYC, 2014b). This estimate excludes non-UK vessels fishing within the same geographical areas and better quality data on bycatch rates and fishing effort is required from all relevant EU Member States before conclusions can be drawn as to the overall bycatch of harbour porpoise in these areas. These same issues apply across Europe (ICES WGBYC, 2014b), with limited data on bycatch, total fishing effort, population status and population structure preventing a robust assessment of either the impacts of bycatch or the status of cetacean populations (ASCOBANS, 2015a).

Wider fisheries impacts

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) (Wilson et al., 2014). Furthermore, due to the highly social nature of many odontocetes 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 impede population recovery (CMS, 2015; Wade et al., 2012). In the case of mothers dying, a calf or dependent juvenile must be

assumed to be a secondary victim (Noren and Edwards, 2007). It is unknown whether such sub-lethal and social effects have significant consequences at the population level in European waters.

Other yet unquantified impacts of fisheries include disturbance to local cetacean populations through noise and vessel activity, as well as indirect effects resulting from the ecosystem impacts of fisheries and their effects on habitats and food webs. Some disturbed individuals may remain in an area, particularly if it contains a high-quality resource (Gill et al., 2001). This in turn may have physiological and behavioural consequences (Pirotta et al., 2015; Beale & Monaghan, 2004), such as reductions in foraging activity and increased stress that can affect survival and fertility (Wright et al., 2007; Rolland et al., 2012). Moreover, whilst direct interactions might be low in certain fisheries (e.g. bottom trawling or scallop dredging) there may be significant impacts on marine habitats contributing to a decrease in quality or even loss of available habitat and/or feeding grounds (N2K group, 2015).

In addition to concerns regarding the wider conservation impacts of cetacean bycatch, it is a major welfare issue. Bycaught cetaceans suffer a variety of injuries, ranging from skin abrasions to amputations, with the degree and severity of injuries varying with method of fishing and species (Soulsbury et al., 2008). Pathological data 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 (Wilson et al., 2014; Soulsbury et al., 2008; Myrick, 1988). Whilst there are no quantitative data on the duration of suffering, 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 (Soulsbury et al., 2008). When managing bycatch, Member States need to consider that 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 of complex social systems

EUROPEAN EFFORTS TO RESOLVE BYCATCH

Setting 'thresholds'

Calculation of thresholds has been under consideration in the UK for more than a decade (Northridge & Thomas, 2003). 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*" (ASCOBANS, 2000). The determination of 'safe limits of bycatch' was proposed by the UK in 2013 (ASCOBANS, 2013) and have been requested by the European Commission. In 2013, the European Commission 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 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*' (ICES, 2013).

In 2009, 2010 and 2013 ICES advised the European Commission 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 (CLA, Potential Biological Removal (PBR), and 1.7% of the best population estimate as recommended by ASCOBANS) several times in the past decade (SGFEN, 2002a, 2002b; ICES 2012b). 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'* (ICES WGBYC, 2013).

There is a need for further in-depth consideration of the implications of a 'thresholds' approach, prior to its implementation, including: (i) a cost-benefit analysis, including clarification of whether this will divert limited funds away from practical mitigation actions; (ii) an analysis of the legal implications, as relates to the language used and existing requirements under the Habitats Directive and international conventions; (iii) whether there is sufficiently reliable and accurate data to inform modelling; (iv) the pros and cons of the proposed approach, including the extent to which this will facilitate action to reduce bycatch with the EU and overcome the factors which have hindered progress to date; (v) a critical review of the success and failures of existing 'threshold'-based regimes in achieving their aims for bycatch; and (vi) a consideration of whether other methods, such as the determination of critical priorities as occurs under Agreement on the Conservation of Albatrosses and Petrels (ACAP), or impact assessment methods may better achieve bycatch reduction goals. The European Commission has now to decide how to take such work forward (ASCOBANS, 2013).

As enshrined in ASCOBANS resolution 3.3 (ASCOBANS, 2000), 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 (ASCOBANS, 2000) 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. 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 zero (ASCOBANS, 2015b).

SOLUTIONS

Identifying the best management framework

Thus far, attention in ICES, ASCOBANS and the EU has largely focused only on threshold-based regimes. Instead the choice of management approach should be selected depending on that most likely to be effective, based upon critical review of the full range of management frameworks, their suitability and taking into account the 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 management actions to reduce bycatch, both above and below any thresholds, is also yet to be outlined.

The form that management measures 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 and that modelling efforts do not divert scarce resources away from the monitoring and mitigation that is urgently needed. Environmental limits/triggers often form a central component of management approaches, and can provide managers with a tool to prioritise conservation action and effectively allocate resources; but other approaches, including prioritisation exercises (e.g. ACAP) and impact and/or risk assessments, provide alternative approaches. Thresholds are used 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.

It is a requirement for Member States to conduct the assessments and monitoring to demonstrate that fisheries do not have a negative impact on local populations, particularly in Natura 2000 sites. In order to meet the requirements of the Habitats Directive, MSFD and CFP, we recommend that an analysis should be undertaken at a regional level to ensure that fisheries activities do not have a negative impact on achieving conservation objectives for cetaceans. Cumulative impacts, both from fisheries and other anthropogenic activities, must also be taken into account in management frameworks to ensure that threats are not assessed in isolation.

Towards this goal, an EU Action Plan on Cetacean Bycatch, similar to the existing Action Plan for Reducing Incidental Catches of Seabirds in Fishing Gear (European Commission, 2012), would be a beneficial next step for Member States to ensure a coordinated approach is taken. Development and implementation of an EU Action Plan on Cetacean Bycatch would ensure that a timely, systematic and practical approach is taken to adequate monitoring and mitigation regionally. Here we propose some potential key components of such an Action Plan, centred around improving (i) baseline population data; (ii) bycatch monitoring; and (iii) effective mitigation based upon a regionalised, stakeholder and evidence-based approach. 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.

Improving baseline population data

Irrespective of which management framework is put in place, there is a need to improve baseline population data in order to inform management strategies and provide a measure of their efficacy in achieving favourable conservation status for cetacean species. Currently there is considerable scientific uncertainty regarding the status and trends of European cetacean populations, including a lack of clarity on population structure and appropriate management units, and a lack of robust data on abundance and trends and historic population size. The size of historic populations is unknown but evidence suggests harbour porpoise populations have reduced in some areas and management objectives would therefore need to take into account the need to restore already depleted populations (for example, Evans, 2010; Hammond et al., 2013).

Appropriate management units for conservation remain uncertain for a number of species. For harbour porpoises, the ICES Working Group on Marine Mammal Ecology (ICES WGMME, 2012) recommended that there should only be a single management unit for the North Sea, whereas Evans & Teilmann (2009) proposed two, and Evans & Hoelzel in ASCOBANS NSSG (2013), either two or three, on the basis of genetic, morphometric and ecological information. There remain challenges in disentangling population structure and delineating boundaries, and as this can have a significant impact on the outputs of management models, the lack of clarity on population structure leads to a risk of setting any thresholds at inappropriate levels.

Whilst large-scale abundance surveys have been undertaken (such as SCANS, SCANS-II), there is a need for future surveillance to incorporate population structure in the survey strata delimitations (ICES NSSG, 2014; Sveegaard et al., 2015). The future of SCANS surveys is now uncertain due to lack of funding, calling into question the ability to meet reporting obligations under the EU Habitats Directive, as well as the CFP and MSFD. More frequent, finer-scale population level abundance estimates are also required, as well as improved coordination of activities across national boundaries. Since the harbour porpoise and many other cetacean species are wide ranging, abundance assessments on a national scale may be influenced by temporary or permanent movement to neighbouring countries, i.e. due to movement of food sources or in search of more favourable habitats and may thus over- or underestimate the abundance. Even if there were funding for large-scale synoptic surveys like SCANS, the more or less decadal temporal scale makes it difficult to detect significant trends in abundance particularly for the less common species, or to respond to changes in a timely fashion. There is a need for a sampling regime that allows for annual (and even some seasonal) surveillance. Since management units are currently tentative, survey designs should be precautionary and use finer scale units rather than amalgamate these. European countries therefore need to collaborate to determine population status, and coordinate management measures under the EU Habitats Directive, CFP and MSFD.

Inadequate knowledge of the wider impacts of fisheries and other anthropogenic activities on cetacean populations means that cumulative and long-term impacts are difficult to adequately account for in modelling efforts. Levels of chemical pollutants may impact reproduction (e.g. harbour porpoises: Pierce et al., 2008; Murphy et al., 2015), and increasing noise pollution (e.g. vessel noise, Dyndo et al., 2015; wind farm construction, Bailey et al., 2014) and climate change (Learmonth et al., 2006) may also have effects at the population level. With little quantification of such impacts, a high degree of uncertainty must be incorporated into any models.

Improving bycatch monitoring

Current bycatch monitoring has proved inadequate to inform management action due to inadequacies in the coverage 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 variable standards by different Member States, resulting in insufficient fishery coverage and/or sampling designs that have prevented the extrapolation and integration of data across Member States. Extrapolation from independent observer programmes to entire fleets using those gear types is also hindered by inadequate and variable information on fishing effort (ICES WGBYC, 2014a; ASCOBANS, 2015a). This has prevented the calculation of total bycatch estimates for individual populations by fishery and geographical area and large sections of the European fleet remain unmonitored, making assessment of the impact of bycatch at a population level, let alone a sub-population level, difficult. This has in turn largely prevented the application of effective management action (European Commission, 2011a).

Assessing and managing the impact of bycatch requires an understanding of the conditions under which animals are caught, the sections of the population affected and the key factors influencing bycatch rate (Brown et al., 2015). A complex combination of seasonal changes in cetacean and fisheries distribution, as well as behavioural processes that can vary with age, sex and reproductive status can apply to bycatch (Learmonth et al., 2014 and references therein). 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 (Brown et al., 2015). 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 (Brown et al., 2015). In other fisheries, effort has been identified as a likely key factor, for example in UK static net fisheries, net length appears to be a key factor in predicting bycatch rate, and is more important than the metier¹ (Northridge et al., 2015). Changes have 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 (Northridge et al., 2015). 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 highly effective (C. Wilcox, pers. comm.).

In order to inform effective, targeted mitigation, a unified sampling strategy is required that is coherently implemented across Member States. Essential components of monitoring include:

- 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

¹ A métier 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 métier should be approximately the same (European Commission, 2015).

fleet even if bycatch rate per vessel is low). If days at sea are used, it should be decimalised so as to be more accurate. 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 of vessels 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 (ICES WGBYC, 2014a; ASCOBANS, 2015a);

- Knowledge of total fleet size;
- Adequate monitoring coverage, by independent observers where possible (e.g. vessels > 15m) and development of remote electronic video recording/other methods for small vessels;
- Collaboration with strandings monitoring schemes and analysis of carcasses from fishing vessels. 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 (Learmonth et al., 2014) and the establishment of a European wide monitoring strategy is required (Learmonth et al., 2014), that includes investigation into the sub-lethal effects of bycatch-related injury and stress bycatch on fitness (Wilson et al., 2014);
- Collection of operational parameters in monitoring programmes such as effort, net length, soak time, depth, operator) in addition to recording details of bycatch events in order to determine factors influencing bycatch rates.

Collection of such data will require investment in monitoring by Member States, to ensure adequate geographic and fishery coverage, and a unified approach to data collection that 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 (Brown et al., 2015b).

Mitigation

Scientific studies clearly demonstrate that mitigation should be informed by robust knowledge of the operational and environmental factors influencing bycatch rate, and that the best mitigation approach may vary according to fishery, species and geographical area. At the same time, the perceived burden of data collection should not become a barrier to implementing mitigation, and data requirements need to be balanced with the urgent need to implement conservation action. Consultation with fisheries stakeholders, and trials and monitoring of mitigation, are key to ensuring industry support for mitigation measures. As mitigation is implemented, both efficacy and industry 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:

(i) *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 northwestern 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 (Fernandez-Contreras et al., 2010).

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 on areas of greatest risk (Brown et al., 2015), 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 (Read, 2013).

(ii) *Acoustic methods*

The range of acoustic bycatch reduction techniques for small cetaceans includes pingers, passive alerting and active acoustic deterrent devices, vessel noise reduction, production of animal sounds, metal oxide nets, echolocation disrupters and pyrotechnics (Werner et al., 2006).

To date, pingers have been the most frequently used acoustic deterrent device (ADD). However, schemes which rely entirely on pingers, such as those enacted in Europe, remain of unknown effectiveness (Dawson et al., 2013), due to variable pinger designs; inadequate testing and monitoring of their efficacy; technical problems; and variable compliance. To allow further development of ADDs, 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 (ICES, 2013b). Pingers are unlikely to be adopted and/or used appropriately unless their use is mandated (Dawson et al., 2013) and post-implementation monitoring is therefore critical to assess temporal trends in compliance and efficacy (Dawson et al., 2013).

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 and increasing the acoustic reflectivity of twine using a chemical filler (Dawson, 1991, 1994; Hatakeyama et al., 1994; Silber, 1994; Koschinski 1997). 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 (Trippel et al., 1999, 2003, 2009; Mooney et al., 2004, 2007; Koschinski et al., 2006; Larsen et al., 2007). Results have been variable (see Mackay, 2011). Whilst a significant reduction in harbour porpoise bycatch rates was observed in 'acoustically reflective' gillnets (Larsen et al. 2007; Trippel et al. 2009), the use of reflective or stiff nets did not lead to a reduction in franciscana (*Pontoporia blainvillei*) bycatch rates in gillnets (Bordino et al., 2013) and the use of barium sulphate filled polyamide (nylon) nets significantly increased bycatch in the UK (Northridge et al., 2003). 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 (Culik et al., 2015).

(iii) *Using all the tools in the box*

Many other mitigation strategies may also be effective, depending on the primary factors influencing bycatch rates. These may include restrictions on effort (e.g. soak time, net length), modification of depth of gear deployment 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. In many cases, the best approach may require a combination of approaches, 'using all the tools in the box'. In the two longest-running programmes that employ pingers globally, other mitigation approaches, such as time-area closures and gear modification, were also employed. Similarly in Norwegian waters, recommendations to address harbour porpoise bycatch include a mixture of approaches, including the prohibition of large-mesh gillnets in waters shallower than 50m as a proxy for the closed area approach, the use of pingers for gillnets in waters exceeding 50m depth, and the continuation of the bycatch monitoring programme, with increased coverage, including on small vessels (Bjorge et al., 2013).

Among 12 actions proposed in the ASCOBANS harbour porpoise conservation plan, four are aimed at evaluating the effect of fishery activities on porpoise populations based on data collected on boats and in strandings (Reijnders et al., 2009). These indicators could be further refined by the estimation of the origin of stranded porpoises and the distribution inferred from stranded porpoises with evidence of bycatch. Anomalies in distributions would highlight critical areas with a high level of interaction with fisheries. This information is very important to assess small cetacean conservation status and could help in designing better adapted mitigation actions (Peltier & Ridoux, 2015).

One approach suggested by ASCOBANS is a precautionary approach whereby appropriate mitigation measures should be applied in all set-net fisheries irrespective of vessel size, gear type or geographic area; but exemptions should be 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) (ASCOBANS, 2015a). Such measures should clearly 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 be developed in consultation with the fishing industry and other stakeholders.

Globally, wider availability of information on bycatch rates including 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 (Fosette et al., 2015). Populations should be routinely monitored, with management areas revised regularly based on changes in the animals' distribution. This is particularly important in a time when the marine environment is under pressure from a wide range of anthropogenic activities and climate change that may fragment and degrade ecological niches (Sveegaard et al., 2015).

CONCLUSIONS

For decades, cetacean bycatch has been a major conservation and welfare concern in Europe and despite 20 years of Habitats Directive implementation, and 40 years of CFP, there has been limited

effective monitoring or mitigation, with high, likely unsustainable, 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. A clear strategy is needed, identifying the steps to undertake surveillance, monitor and reduce bycatch, as soon as possible. Given the considerable data gaps identified, a precautionary approach to management must be considered. To this end, an EU Action Plan on Cetacean Bycatch, like the existing Action Plan for reducing incidental catches of seabirds in fishing gear (European Commission, 2012), 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.

To this end, we offer the following recommendations, that we believe should be included as components of an EU Action Plan on Cetacean Bycatch:

i) Bycatch monitoring and population surveillance

There is a strong legal basis for cetacean protection and monitoring, but with insufficient implementation and guidance to EU Member States specifying the amount, frequency or quality of bycatch monitoring or population surveillance required. This has led to variable implementation by Member States and, hence, a failure to obtain the data needed to support effective management action. With no specific MSFD requirements related to bycatch of protected species, Member States typically have relied on existing legislation as their measures to reach GES for marine mammals, such an approach is unlikely to be adequate to meet GES or to achieve favourable conservation status for cetacean species. Clear guidance, strengthened implementation and enforcement from the European Commission and Member States, and coherent advice from scientific bodies (e.g. ICES, ASCOBANS, SCTEF, OSPAR etc.) on bycatch monitoring and population surveillance is required to help ensure that data are robust and can be better integrated across Member States, and that the resources invested by Member States result in informed, effective management action.

A unified sampling strategy is required that is coherently implemented across Member States. Essential components of bycatch monitoring include:

1. Adequate geographic and fishery coverage, where monitoring effort reflects the métiers contribution to overall bycatch;
2. Knowledge of total fleet size;
3. Adequate monitoring coverage, by independent observers where possible (e.g. vessels > 15m) and development of remote electronic video recording/other methods for small vessels;
4. Collection of operational parameters in monitoring programmes (such as effort, net length, soak time, depth, operator) in addition to recording details of bycatch events in order to determine factors influencing bycatch rates;

5. Collaboration with strandings monitoring schemes and analysis of carcasses from fishing vessels to gather life-history data and study sub-lethal effect, through the establishment of a European wide monitoring strategy.

ii) A framework for bycatch mitigation towards zero

Any 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 in relation to population size are decreasing by a specified amount over a set time period.

Subsequent to the ASCOBANS workshop in July 2015 on “the Further Development of Management Procedures for Defining the Threshold of ‘Unacceptable Interactions’” (ASCOBANS, 2015b) it is evident that there should be further in-depth consideration of the implications of a ‘thresholds’ approach prior to implementation. Whilst environmental limits/triggers can often form a central component of management approaches, and can provide managers with a tool to prioritise conservation action and allocate resources, there has as yet, been inadequate analysis to show that this is the best approach in Europe. At such a critical juncture in addressing bycatch it is important that careful consideration is given as to what strategy will result in meaningful action by Member States, taking into account the resources and data available. To this end, there is a need for cost-benefit analyses of a threshold-based approach, a critical review of available frameworks (threshold-based, prioritisation exercises, impact and risk assessment), data limitations, and consideration of the policy, legal and scientific framework.

With some cetacean populations facing unsustainable impacts, it is important that efforts to model often inadequate data, and determine ‘thresholds’ do not delay decisions, or distract attention and funds from reducing cetacean deaths in fishing nets. Any use of ‘thresholds’ would need to demonstrate that such points were triggers for further conservation actions to meet the goal of zero bycatch and ensure strict protection for cetacean species in European waters.

The reformed CFP process includes a commitment for adequate surveillance, bycatch monitoring and effective mitigation. There is significant EU funding under the European Maritime and Fisheries Fund (EMFF) which should provide sufficient support for improved data collection, compliance monitoring and improved sustainability of fisheries, including the development of alternative fishing gear to achieve a higher ongoing reduction in cetacean bycatch. One aim might be a requirement for Member States to robustly show that bycatch levels in relation to population size are decreasing over a set time period by a specified amount, evidenced through monitoring and mitigation.

iii) A regionalised, stakeholder and evidence-based approach to mitigation

We also propose that a more regionalised evidence-based approach is taken to mitigation where the mitigation approach is informed by the best available data on the key factors influencing bycatch rates. Engagement with fisheries stakeholders and scientists will be essential to this process. A cetacean bycatch strategy should be integral to the development of multi-annual plans under the CFP. Regional Bycatch Reduction Teams, like those that exist in the U.S., might help to focus

attention and build stakeholder support. Monitoring of the implementation of mitigation actions and their efficacy will also be key to ensuring continued improvement in mitigation techniques and achieving meaningful reductions in cetacean bycatch.

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