Proposal for an IWC Bycatch Initiative[1].

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Abstract

The issue of bycatch is a global crisis, impacting all of the world's oceans, rivers and many marine animals (see Annex A for some details). It has been estimated that over 300,000 cetaceans die each year as a result of impacts from active fisheries operations. Bycatch threatens the existence of several cetacean populations and, despite being an issue that has been identified for many years as a major conservation and welfare concern, little real progress has been made. A concerted global effort, focusing on effective methods for avoiding and mitigating bycatch, is now urgently needed to address this chronic threat.

The IWC has the opportunity to play a significant role in addressing bycatch by helping to develop, assess and promulgate prevention and mitigation measures. As the leading international body addressing cetacean conservation and the management of whaling the IWC is exceptionally well placed to connect countries and lead them in a collaborative approach. It already houses extensive expertise in cetacean, fisheries and conservation science and policy. A bycatch prevention and mitigation initiative would have clear links to existing IWC programs and work, including the IWC's whale disentanglement initiative, work on strandings and the Scientific Committee's work on bycatch assessment. Importantly, the IWC also has existing linkages with other relevant intergovernmental organizations that are involved in managing this issue.

This paper explains the rationale for the development of a dedicated IWC bycatch focused work-stream and suggests possible mechanisms for implementation, including the options of a 'threat-based' Conservation Management Plan addressing Bycatch Mitigation; the establishment of a Bycatch Working Group of the Conservation Committee; a Bycatch Initiative similar to the IWC's work on disentanglement; or perhaps some combination of these approaches.

Whichever mechanism is chosen, critical to its success will be the strong lead provided by dedicated personnel and resources to drive this work forward following a comprehensive strategy. The person(s) concerned would ensure that all relevant groups within the Scientific and Conservation Committees are provided with the appropriate information, and that by-catch related recommendations from these groups are acted upon.

This paper is intended to contribute to the consideration of options to address this important issue at the next IWC Conservation Committee meeting. Annex A to this document provides a brief overview of the pervasiveness and severity of the threat posed by fisheries bycatch to cetacean populations around the globe, as well as a review of current progress and challenges of various initiatives that attempt to address this threat.

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[1] At its 2016 Meeting, the IWC's Scientific Committee stressed that the issue of bycatch is serious and extensive and that the IWC cannot fully address it alone. In addition to improved collaboration, the Committee agreed to establish an intersessional correspondence group under Simmonds. The Scientific Committee will consider the outputs from this group at its next meeting in 2017 (see IWC/66/Rep 01(2016) Section 7.1). Separately, the Conservation Committee planning meetings in 2015 and 2016 also tasked Simmonds to work with interested members and observers to develop suggestions for the Committee on advancing work to reduce cetacean bycatch (See IWC/66/CC/Rep 05 Section 5e). This report is the outcome of the work undertaken in response to the Conservation Committee planning meeting's request.

[2] Contributions to this document were made in personal capacities and, therefore, do not necessarily represent any national or institutional affiliations that authors may have.

1. Opportunity and Responsibility for the IWC

The IWC is the leading international body addressing cetacean conservation and the management of whaling. It houses extensive expertise in cetacean and fisheries science and also the development of conservation strategy. Via its almost ninety Contracting Governments, as well as those nations who attend as observers, it is truly global in its reach. A number of new conservation initiatives have been initiated in recent years, including the programmes on disentanglement and ship strikes, and the species-focused Conservation Management Plans (CMPs).

The IWC has long recognised the conservation significance of bycatch, especially to the survival of several threatened cetacean populations. As a result, a number of resolutions have been adopted requesting action by Contracting Governments (e.g. Resolution 2001-13 on Small Cetaceans, Resolution 2001-4 on the Incidental Capture of Cetaceans, Resolution 2000-8 on Western North Atlantic right whales, Resolution 1997-4 on Cetacean Bycatch Reporting and Bycatch Reduction, Resolution 1991-4 on Small Cetaceans).

In addition, at its last meeting, the Scientific Committee gave much consideration to bycatch and how best to address it (IWC/66/Rep 01(2016) Section 7.1). In the context of links to Conservation Management Plans, the Committee stressed "that the issue of bycatch is serious and extensive and that the IWC cannot fully address it alone. There is a need for greater collaboration with individual nations and other IGOs including FAO, CMS, CCAMLR, ACCOBAMS, ASCOBANS and ICES[3]. Recent international work to mitigate the bycatch of other species (e.g. seabirds, sharks, turtles) might provide useful models of cooperation. It was suggested that the Committee should seek collaboration with other experts who have knowledge (e.g. fisheries managers, fishing gear engineers)" (IWC/66/Rep 01(2016) Section 7.1.7).

In the context of certain endangered populations of small cetaceans, the Scientific Committee noted that "In 2013 and 2014, the Scientific Committee was very clear regarding the need to eliminate bycatch immediately and not wait to collect more data for a number of cases considered below[4]. Further research may continue but should not be interpreted as a substitute for management action. All the scientific results underline that the first priority should be to implement immediate management actions to eliminate bycatch, accompanied by research and monitoring to determine the effectiveness of these measures"(IWC/66/Rep 01(2016) Section 15.3).

The area where the IWC should focus and could help most is regarding bycatch prevention and mitigation in collaboration with the organizations mentioned above, this would seem to fit well with the objectives of the proposed 2016-2026 strategic plan for the Conservation Committee.

2. Components of the IWC Bycatch Initiative

There are four inter-related topic areas that if successfully developed and implemented by the IWC would greatly accelerate progress on this issue: investigation of mitigation methods, transfer of expertise, technology and management measures, improved assessment and engagement with other relevant fora.

2.1 Investigation of bycatch mitigation methods.

A key focus of an IWC plan should be on the identification of methods for bycatch prevention and mitigation measures including:

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[3] FAO: the Food and Agriculture Organisation of the United Nations; CMS: the Convention on the Conservation of Migratory Species; CCAMLR: the Commission for the Conservation of Antarctic Marine Living Resources; ACCOBAMS: the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area; ASCOBANS: the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas and Contiguous Areas; and ICES: the International Council for the Exploration of the Sea.

[4] The 'cases' in this section are the vaquita, Yangtze finless porpoise, Hector's dolphin, Māui dolphins, the River dolphins of Amazonia, franciscana, sousa and harbour porpoises in the Baltic.

- time/area closures,
- gear modifications and development of alternative gear,
- best fishing practices,
- reduction in fishing capacity, and
- improved fisheries management.

The IWC could encourage relevant research and the collation of relevant information by invited presentations/reports on particular topics related to bycatch prevention and mitigation from member countries, by setting appropriate agenda topics for its meetings, and/or by holding an appropriate series of workshops. Through its Scientific Committee and all its associated subcommittees each year, the IWC is well placed to coordinate the compilation of well-documented case studies of successful and unsuccessful bycatch prevention and mitigation research. It would be especially beneficial to identify where stakeholders have played a role in the development of such measures.

2.2 Transfer of expertise, technology and management measures

This is proposed as the primary focus for the contribution by the IWC.

In his paper, *'The Looming* Crisis', Read (2008) stated that one of the areas most needed to address this issue globally is a system through which successful mitigation measures can be made available to a global audience. The IWC is in an excellent position to help develop and house such a system.

The IWC Bycatch Initiative might usefully mirror the successful approach already taken by the IWC to its disentanglement and ship strikes work. These programmes benefit from the employment of a focal person(s) to compile information and disseminate materials and, most importantly, in the case of the disentanglement work, hands-on training as requested by countries. There are a number of areas where the IWC could enable the sharing of expertise relating to bycatch in a similar manner. These might include:

- species identification,
- tools to aid in data collection,
- survey methodologies,
- successful mitigation measures or research techniques,
- gear identification methods and alternatives,
- best practices and guidelines to reduce bycatch, as well as
- advising on suitable outreach activities.

This information could be made available to member states as well as others seeking advice.

A fundamental component of bycatch mitigation is the involvement of the key stakeholders and in particular the fishing industry, fisheries management organisations, fishing gear manufacturers and individual fishers. The IWC could encourage and facilitate information exchange between regions where promising mitigation options have been developed and/or implemented and others seeking advice. For example, the experiences of fishers in the Northeast US, Australia or Canada in relation to the reduction of vertical line could be shared with those in other regions with similar types of gear and entanglement issues.

An outreach strategy related to bycatch would also be important and the identification and development of suitable materials in appropriate languages could be another part of the IWC Bycatch Initiative.

2.3 Bycatch Assessment

There is a need to better understand the extent of this issue, both regionally and globally. Ideally, accurate information is needed regarding the sources and rates of cetacean bycatch (including entanglements where gear is carried away by whales) especially in developing countries and for emerging fisheries. Information relating to aquaculture and Fish Aggregation Devices (FADs) is also needed.

Through its Scientific Committee the IWC is already involved in the assessment of the significance of removals from populations, and could play a greater role in coordinating scientific activities aimed at more accurate assessment of bycatch-related mortality. This might include collating bycatch information, including that provided in National Progress Reports. Such a comprehensive risk assessment could aid in the identification of high risk issues, fishing methods, cetacean populations and geographical areas. Related to this, determining where high bycatch risk areas overlap with fishing overcapacity could help identify areas that should be the focus of initiatives to improve fisheries management. The IWC could also do more to encourage IWC member stations to contribute to assessment of bycatch through information provided in National Progress Reports.

2.4 Engagement with other relevant fora

There are several other international forums which are relevant to addressing this issue and which might themselves benefit from the input of the IWC. For example, there are several opportunities with the FAO/COFI that should be explored, including initiatives on gear marking, entanglement and bycatch in marine debris and bycatch reporting requirements. As well, given their previous work on International Plans of Action (IPOAs) for sharks, sea turtles and seabirds, there may be potential for the development of a cetacean IPOA, which the IWC could assist with (IPOAS are further discussed in the Annex). There are also other bodies (e.g. CMS, ASCOBANS/ACCOBAMS and CPPS[5]) through which the IWC could encourage the adoption or improvement of resolutions or other actions related to cetacean bycatch.

Nationally and regionally, the IWC could play an important role in encouraging the adoption or improvement of initiatives to monitor and mitigate bycatch. The IWC already formally engages with ICES and the EU, as well as ASCOBANS and ACCOBAMS, on this issue and this could be further developed related to specific bycatch mitigation issues and measures.

There is also a need to make the language of recommendations and calls to action from the IWC more accessible for non-scientists, including key decision makers.

3. Potential mechanisms to address Bycatch within the IWC

As mentioned, despite this being an issue that has been identified for some decades as a major conservation concern, little progress has been made to reduce impacts on the world's cetacean populations. While a global plan is needed, one of the key elements identified by many has been the need for a centralized hub for information, knowledge and technology exchange. As suggested above, this could be implemented via one or more dedicated individuals, who could be affiliated with the IWC Secretariat (as in the case for IWC disentanglement initiative), or taken forward via several experts forming an expert panel, or both.

3.1 The Development of the first 'threats-based' Conservation Management Plan addressing Bycatch Mitigation

CMPs have been adopted by the IWC as practical tools for improving the conservation status of the most at risk populations of whales. CMPs are conservation strategies based on the best available science and management

[5] CPPS: Permanent Commission for the South Pacific.

expertise and focus on reasonable, practical and achievable management actions that have the greatest chance of achieving measurable improvements in the conservation status of cetacean populations. They are designed to complement current management efforts and national legislation in participating range states. The CMP Working Group recommends priority cetacean populations, threats or habitats suitable for the preparation of a CMP and bycatch has been suggested as the focus of a CMP, although this would mean a departure from the population focus hitherto taken.

Many cetacean populations would benefit from such a focus. Because the mechanisms needed to understand bycatch and to research and implement conservation solutions are similar for the wide range of populations that it impacts, a global plan to address such a threat may be a more appropriate and effective approach rather than individual population-based CMPs, although the former could also feed into the latter.

As this is an issue of global significance, it will be important that many range states are involved in its planning and, in particular, its implementation. An essential component to CMPs is also the active involvement of key stakeholders - including those whose actions contribute to the threats and the bodies that manage them.

Given the complexity of the issue, a CMP may be the most appropriate mechanism within the IWC as it ensures a conservation strategy with accompanying dedicated resources and multi-lateral partnerships are identified and secured.

An alternative could be the development of regional bycatch CMPs or CMPs dedicated to small and large cetaceans separately.

3.2 The Establishment of a Bycatch Working Group of the Conservation Committee

Another approach could be to establish a working group with a coordinator(s) similar to that established for the Ship Strikes initiative. The Ship Strikes Working Group develops detailed proposals for mitigation of ship strike events, coordinates the compilation of a global vessel strike database, disseminates information globally and coordinates work between Contracting Governments.

3.3 Development of the Bycatch Initiative following the Example of the Disentanglement Initiative

If the IWC were to appoint a Bycatch Initiative Coordinator attached to the Secretariat then this person could pursue as the four key areas of work outlined in section 2 above - in a similar way to the work of the disentanglement coordinator, particularly in rolling out expertise to make specific interventions.

Key elements of this approach would be to:

- Maintain an up-to-date compilation of available research related to mitigation measures;
- Facilitate evaluation of effectiveness and practical implementation of mitigation measures;
- Ensure any new information is considered and evaluated by the Scientific Committee each year;
- Based on the evaluations of mitigation options by the Scientific Committee, provide advice regarding bycatch mitigation (including practical training sessions) to member governments on request. This advice could take the form of presentations to fisheries managers, fishers and other stakeholders in the area where the problem was occurring;
- Liaise between IWC and other inter-governmental fisheries bodies (e.g. FAO/COFI, IOTC) on bycatch issues and exchange relevant information between IWC and these bodies:
- Liaise with other intergovernmental organisations and International NGOs with bycatch initiatives to ensure complementarity of efforts and regular exchange of information and expertise;
- Facilitate coordination between the Conservation Committee and relevant subcommittees of the Scientific Committee (e.g. HIM, SM and others) to ensure agendas are set appropriately so that issues related to by-catch are covered efficiently and effectively but without undue overlap; and

- Report back to the IWC Conservation Committee and Commission at each biennial meeting or as appropriate.

3.4 Other Options.

There are several other avenues through which the IWC could address bycatch. These might include the establishment of an Expert Panel to advise nations and others seeking assistance to mitigate bycatch problems affecting cetaceans.

A series of projects – working with other international bodies – could also be developed focused on identifying and developing mitigation strategies. However, these may be less effective than the options proposed above which would ensure core continuity and coordination with other IWC initiatives.

3.5 Funding implications

The kind of funding required depends on which model the IWC might like to take forward. Someone to work part time in the first instance might cost in the region of £20,000 pa and with associated travel and other expenses perhaps £25,000 pa. This might in part be met with voluntary contributions and via appropriate fundraising.

A work stream with no associated personnel but intended to further flesh out a bycatch strategy, including to formalise an expert panel (to meet virtually in the first instance) would have little cost beyond the time of the secretariat to help coordinate this. Its first meeting – depending on the size of the group – might be budgeted at £5,000.

Annex A – IWC Bycatch Initiative: Background Information

The Conservation Threat.

Bycatch, the incidental capture of species in fishing gear, has been identified as the greatest immediate threat to cetaceans globally (Read 2008; Reeves *et al.*, 2005). It includes all entanglements in fishing gear and is an issue for both large and small cetaceans throughout the world's oceans and rivers, occurring as a result of a wide variety of fishing operations from artisanal to commercial in scale. Cetaceans have also been observed captured in discarded or lost fishing gear (i.e. "*ghost gear*"), although the scale of this issue is far less well understood.

The data needed to monitor cetacean populations (e.g. population abundance estimates, trends and life history data) and fisheries impacts (e.g. fishing effort, bycatch composition to the species-specific level and bycatch rates) are only rarely consistently collected. As such, the ecosystem impacts from fisheries are often misunderstood, underestimated or ignored. Thus, scientific data on the global extent of bycatch is limited and fragmentary. Based on data from observers on US fishing vessels between 1990 and 1999, Read *et al*. (2006) estimated that approximately 308,000 individual cetaceans die every year globally as a result of encounters with fishing gear.

Fisheries observer data are commonly used to monitor fishing operations and ecological impacts (Brown *et al*. 2014, Benoît and Allard 2008). However, fisheries observer programmes and deployment schemes are often not developed specifically for the detection of bycaught species, including marine mammals (Benoît and Allard 2008, Peltier *et al*. 2016) and can also have significant cost implications, especially for developing nations. There are also often issues with the lack of species identification training for observers and taxonomic lumping of species reported captured (e.g. reporting of a 'dolphin' or 'whale'). All of these factors hinder obtaining reliable species-specific bycatch data. In addition, fisheries operations have expanded and changed since the time Read *et al*. (2006) calculated their estimate. There has been an increase in the amount of gear deployed globally and often with stronger equipment being utlised, increasing the potential for bycatch and subsequent mortality (Pauly *et al*. 2002; Brown *et al*. 2015, Knowlton *et al*. 2015, FAO 2016). Noting in addition that large cetaceans may be underrepresented in fisheries observer data - as they often do not remain with the gear or will carry it away (Moore and van der Hoop 2012) - Read *et al.'s* estimate is now likely to be an underestimate of the real toll.

Based on other available data, it is clear that some portion of bycatch goes unobserved. Animals which are captured in fishing gear but subsequently escape often have scars on their bodies indicative of such events. Recent investigations documenting these scars on endangered North Atlantic right whales (*Eubalaena glacialis*) and humpback whales (*Megaptera novaeangliae*) along the East Coast of the US indicate that they regularly encounter and shed gear and that many more have been affected than have been reported entangled. Researchers found that between 65-85% of the individuals within these populations bear scars from having encountered gear and that on average 12-16% of these populations exhibit new scars each year (Knowlton *et al*. 2012, Robbins 2012). These studies have also shown that there has been a significant increase in the rate of serious entanglements detected over the last 30 years in the Northeast Atlantic (Knowlton *et al*. 2012).

Data from stranding and entanglement response networks are vitally important to documenting and characterising mortality and injury of cetaceans, including impacts from fisheries (e.g. Henry *et al*. 2013, Waring *et al*. 2016, Cole and Henry 2013, Peltier *et al*. 2016). At times, these rates have differed from those calculated for the same cetacean populations using fisheries observer data (Peltier *et al*. 2016) and, as a result, very different management consequences would result depending on which rates are utilised. It is thus important that consideration is given to how these data should be integrated into responses.

These results indicate that bycatch is a more frequent occurrence than fisheries observer data would indicate and, given the low rate at which these bycatch events have been reported (e.g. generally <10% in the case of carcass detection rates; Peltier *et al*. 2016, William *et* al. 2011, Fisheries and Oceans Canada 2008, Moore and Read 2008), the most effective management initiatives are likely to be those that focus on prevention (Slooten and Dawson

2016). There are also significant issues that may result from low observer coverage (see discussion in this year's Scientific Committee report see IWC/66/Rep 01(2016) Section 7.6).

Clearly, the issue of bycatch cannot be considered in isolation. The impacts to cetaceans from other human activities including shipping, direct hunting and pollution (chemical, marine debris and noise) also result in a significant number of animals being removed in addition to fisheries impacts also including overfishing and habitat destruction (Marino *et al.* 2012). As such, all removals must be considered cumulatively if we are to begin to understand the population and ecosystem impacts and address them from a conservation perspective.

For some populations and species, the observed deaths and serious injuries caused by bycatch continue to exceed what are considered to be sustainable levels (Robbins *et al.* 2015, Cole and Henry 2013, Waring *et al.* 2016, Slooten 2013, Slooten and Davies 2012, Slooten and Dawson 2010) and the proportion of lethal events that is detected is likely to be low, especially for larger cetaceans (Kraus *et al.* 2005, Williams *et al.* 2011). Lonergan (2011) examined several methods currently used to assess the status of marine mammal populations: the IUCN Red List Criteria, the regulations under the European Union Habitats Directive, the US MMPA method of Potential Biological Removal (PBR), the IWC's Revised Management Procedure, the HELCOM's approach to managing seals and the Canadian Objective-Based Fisheries Management system for harp seals. Potential Biological Removal of populations is a commonly utilised method. PBR is a conservative threshold of sustainable additive mortality, based on estimates of stock abundance and potential population growth rates and incorporating uncertainty in estimates of abundance, mortality and stock status (Lonergan 2011, Taylor *et al.* 2000, Wade 1998).

Bycatch is a particular conservation concern for some small cetacean populations (Read 2008). The recent extinction of the baiji (*Lipotes vexillifer*) largely due to bycatch in a variety of fisheries, underscores the seriousness of this threat (Turvey *et al.* 2007), and several other populations and species are currently at risk of extinction primarily due to impacts from fisheries. These include the vaquita (*Phocoena sinus*), a small endemic porpoise in the northern Gulf of California (Mexico), which sits on the brink of extinction solely because of bycatch in local fisheries (CIRVA 2017). With an average annual decline of 34%, this species faces imminent extinction if appropriate measures are not very swiftly taken to completely eliminate fisheries impacts throughout their entire range (CIRVA 2017). Similarly, fisheries bycatch is a serious threat to the continued existence of the Māui dolphin (*Cephalorhychus hectori maui*), now reduced to fewer than 55 animals (Maas 2016, Hamner *et al.* 2012, Davies et al. 2008, Slooten 2013, Slooten and Davies 2012, Slooten and Dawson 2010, Currey et al. 2012). Bycatch is also an important threat to many river dolphin populations, such as the Irrawaddy dolphin of the Mekong River where fishing with gillnets and explosives is an issue for a population estimated at only 85 individuals (Ryan *et al.* 2011). The situation is also bleak for the harbour porpoise (*Phocoena phocoena*) in the Proper Baltic Sea where bycatch reduction has been identified as the highest priority for its recovery (ASCOBANS 2009 a,b). This distinct population – estimated at around 500 individuals – is designated as "critically endangered" by the IUCN. The franciscana (*Pontoporia blainvillei)* survives as small population units and again is threatened by bycatch (Negri *et al.* 2012).

Given the large number of small cetacean species that are 'data deficient' there are likely to be populations that are not well described that are also threatened by bycatch, especially as the world's fishing fleets expand in some areas.

Recent estimates of the abundance of North Atlantic right whales put it at around 500 individuals (Kraus *et al.* 2016). Between 2009 and 2013 an average of 4.3 right whales were killed per year as a result of human activities, with nearly all of these deaths being attributed to entanglement in active fishing gear (Waring *et al.* 2016). With a scarring rate of almost 85 % and significant sub-lethal impacts from entanglement which can cause reproductive failure and declining health, this estimate is likely an underestimate of the true annual mortality due to fisheries interactions (Kraus *et al.* 2016, Rolland *et al.* 2016, van der Hoop *et al.* 2016). With a PBR of zero, this clearly puts North Atlantic right whales on the path to extinction if this threat is not reduced.

Welfare Concerns

Chronic entanglement is regarded as one of the most severe forms of animal cruelty (Moore and van der Hoop 2012) and a number of authors have recently reported on the often severe welfare concerns associated with entanglement in fishing gear including Moore *et al*. (2013a), Cassoff *et al*. (2011), van der Hoop *et al. (*2016), Wilson *et al*. (2014), Curry (1999), Gilman (2011) and Soulsbury *et al*. (2008). Breath-holding animals (such as cetaceans) caught in nets may not experience a swift death (Leaper et al., 2006, Soulsbury *et al*. 2008). Indeed, prolonged suffering may occur and this may be associated with severe wounding and/or impaired feeding leading to severe emaciation or other health consequences that can eventually lead to death or which may affect the health and fecundity of the animal even after gear is removed. These effects often go undetected following release or escape from fishing gear and there is often uncertainty about the outcome because "survivors" are not necessarily re-sighted and deaths not necessarily observed (Wilson *et al*. 2014, Robbins *et al*. 2015). Many studies on bycatch focus solely on quantifying mortality to understand the risk to population viability, however, the stress and suffering experienced by individual animals cannot be ignored (Moore and van der Hoop 2012, Moore *et al*. 2006, Soulsbury *et al*. 2008).

Unlike most small cetaceans, large whales often have the strength to break free of the initial entanglement but do not necessarily shed all of the gear (Moore *et al*. 2006). Many of these animals do not die immediately but the remaining rope and gear gradually constricts one or more body parts or winds through and around their mouths, hindering their ability to feed. These individuals are subject to a very slow death which can occur over the course of months to years. The time to death for entangled, free-swimming North Atlantic right whales averages 6 months (Moore *et al*. 2006, Moore and van der Hoop 2012). In chronic cases such as these, the individual can experience impaired foraging, increased drag, infection, haemorrhage and severe tissue damage (Moore and van der Hoop 2012, Cassoff *et al*. 2011). Even in non-lethal events, the stress of having been entangled and the resulting injuries can cause declining health long after the event (Rolland *et al*. 2016, van der Hoop *et al*. 2016).

Cetaceans are sophisticated mammals often living in social groups and there may also be consequences for conspecifics because of the death or impairment of group members (Soulsbury *et al*. 2008).

Prevention and Mitigation

Avoiding and mitigating cetacean bycatch and reducing its impact globally should be the priorities for international action. Dealing with bycaught and entangled animals, especially larger ones, can be difficult, costly, time consuming, may result in lost gear, is not always successful and is very dangerous for those involved. As such, it is widely recognized that the most effective management initiatives are those that focus on preventing entanglements from occurring in the first place (Robbins *et al*. 2015, Leaper 2016).

There are a number of methods which have been investigated and, employed to reduce impacts to bycaught species. The most effective method to reduce or even eliminate bycatch is to keep entangling gear, in particular gillnets and trawling, out of areas used by cetaceans. The next most effective method is modifications to the timing of fishing operations and areas where high risk fishing gear is used. This method has been employed in several areas to reduce risk of bycatch of endangered Hector's dolphins (*Cephaloryhnhchus hectori*) in New Zealand (Dawson and Slooten 2005, Gormley *et al*. 2012) and of endangered North Atlantic right whales in the United States via the implementation of Seasonal Management Areas (NOAA 2008).

There are a number of other options that have been utilised to reduce risk, serious injury or mortality (Leaper 2016, Reeves *et al*. 2005; Read 2008, Knowlton *et al*. 2015, Dolman *et al*. 2016a), including:

- Reducing the amount of fishing effort, including reducing number of fishing vessels and/or the amount of gear allowed to be set;

- Modifying fishing gear and practices to reduce the risk of contact occurring, including modifications to the configuration or amount of ropes used (e.g. reducing the number of vertical lines), utilizing acoustic deterrent devices, using acoustically more reflective materials, reducing soak time of gear and implementing fleet communication schemes for avoidance; and
- Modifying gear to reduce the consequences if contact occurs, including the use of weak links or ropes with lower breaking strengths and devising best handling and release practices.

Some mitigation measures are intuitive. For example, if the number of fishers and/or the amount of gear deployed into the water column is reduced in areas where cetaceans are found, there will be a reduction in the risk to cetaceans of becoming entangled. Fishers in Southwestern Nova Scotia, Canada and Western Australia have employed best practices in their lobster fisheries where they determined and then applied the minimum rope lengths needed to effectively fish, resulting in less rope in the water column and, hence, a reduction in the overall risk to cetaceans (and other marine wildlife; WWF 2009; How *et al.* 2016). In 2014, NOAA introduced a number of measures outlining a maximum number of traps per trawl (and thus, a reduction in the number of vertical lines) required in the Northeast based on area fished and miles from shore and seasonal trap/pot closures in select locations (NOAA 2014, 2015).

Overcapacity is a problem in many fisheries from the perspective of sustainability of the target species and other environmental impacts including bycatch. For example, Myers *et al*. (2007) demonstrated that a reduction in capacity or gear would result in minimal expense to industry, or even a benefit, while greatly reducing bycatch risks. They determined that a reduction in fishing capacity in the Northeast US inshore lobster fishery would likely not reduce catch-per-unit-effort (in fact it may increase) while it would greatly reduce the amount of potentially entangling rope in the water column. Fishing permit conditions for the South African experimental octopus longline were altered to include gear modifications to reduce the amount of rope in the water column both horizontally and vertically (IWC 2015). These conditions also included elements to reduce the profile of ground and vertical lines through the use of weighted and chained lines. Information on simple but effective initiatives such as these could be shared with fishing fleets globally.

Numerous other measures have been tested and/or implemented to reduce risk of capture, increase the ability of animals to escape and to reduce severity if an animal becomes captured. For example, the US has legislated several measures along the eastern seaboard to reduce the likelihood of entanglement of large whales in addition to seasonal area closures and a reduction in number of vertical lines. These have included the use of weak links, sinking groundlines and modifying fishing practices such as no wet storage of gear (NOAA 2002, 2007b, 2008, 2014, 2015). Weak hooks, which are strong enough to hold target species but not strong enough to hold cetaceans such as pilot whales (*Globicephala melas*) and false killer whales (*Pseudorca crassidens*), have been tested and resulted in management and research recommendations related to the hook size, shape offset, type of steel, thickness/diameter of steel, and cross-sectional shape (McLellan *et al*. 2004, Bayse and Kerstetter 2010, Bigelow *et al.* 2012). Net sleeves which cover the fish/hook when gear is being hauled have been employed in the Chilean Patagonian toothfish demersal longlines. This has resulted in a significant reduction in depredation of fish by killer whales (*Orcinus orca*) and sperm whales (*Physeter macrocephalus*) and is believed to be responsible for the subsequent departure of the whales from the fishing grounds (Moreno *et al*. 2008). Acoustic alarms are a commonly utilised mitigation measure to reduce the bycatch of small cetaceans. Following the deployment of acoustic pingers, bycatch of common dolphins (*Delphinus delphis*) was observed to decrease in the California drift gillnet fishery (Caretta *et al*. 2005) as did harbour porpoise (*Phocoena phocoena*) bycatch in Gulf of Maine gillnets (Kraus *et al.* 1997, Waring *et al*. 2005).

There are many other papers, reports and several reviews of various mitigation methods and their effectiveness available (e.g. Leaper 2016, Reeves *et al.* 2005, Werner *et al. 2006,* Werner *et al*. 2015, Reeves *et al*. 2013, Dolman *et al*. 2016a, Endangered Species Research 19 Theme Section on *Techniques for reducing bycatch of marine mammals in gillnets*). These resources could be used to help inform national or regional bycatch reduction programmes with the IWC acting in an advisory role.

Measures implemented need to be shown to be effective, via comprehensive research and monitoring programs, especially if there is to be widespread support and effective implementation (Zydelis *et al.* 2009). It is clear that measures do not always work and are sometimes implemented when their effectiveness has not been demonstrated (e.g. Pace *et al.* 2014, Knowlton *et al.* 2015, Dawson *et al.* 2013, Harcourt *et al.* 2014). Nonetheless, the literature strongly points towards reductions in fishing capacity, via limiting overlap between whales and gear and reducing the amount of gear in the water column, as the best options.

Given the variation in fisheries operations, management schemes and the species involved globally, it is clear that no one solution will solve this problem. What works for one may not work for another. Thus, the most effective mitigation measure(s) should be determined for each fishery based on data regarding the species involved, level of risk, environmental conditions, target fisheries and characteristics of the fishing operations. At the same time however, lessons learned in one setting may be transferable to another, especially where fishing methods and bycatch species are similar. In order for any measure to result in measurable reductions in risk to cetaceans, effective monitoring and compliance via enforcement and incentives is critical (Cox *et al.* 2007), as is regional coherence in legislative frameworks.

Current actions

A number of other bodies are also active in addressing conservation issues related to fishing, including bycatch. A workplan for IWC efforts to address this threat which works in concert with these other processes can only be beneficial.

It has long been recognised that, to address this threat, a global framework with effective regional agreements supporting regional and national implementation of bycatch monitoring and mitigation needs to be developed (Dolman *et al.* 2016b). In their review of worldwide bycatch of cetaceans, Young and Ludicello (2007) identified the "adoption of a UN General Assembly Resolution on cetacean bycatch and a need to foster greater engagement by inter-governmental bodies" as priorities. Additionally, they highlight that "because it requires a country to outline specific measures to address bycatch, the FAO's International Plan of Action (IPOA) model and resolutions adopted through regional fishery management organizations may provide useful mechanisms to address interactions between cetaceans and fisheries". To date though, this has not occurred at the level required and, this lack of an effective global coordinated effort, is likely one of the reasons that bycatch remains a significant conservation challenge that largely remains unaddressed.

Komoroske and Lewison (2015) listed six critical knowledge gaps or barriers to effective bycatch reduction:

1) lack of data and data sharing;
2) uncertainty of population level effects of bycatch;
3) limited understanding of the broader ecological effects of bycatch;
4) the challenges of how to address bycatch within dynamic ecological and social systems;
5) the need to address the linked socio-ecological factors that govern bycatch; and
6) the importance of fostering stakeholder engagement in the development of sustainable bycatch reduction strategies and actions.

Dolman *et al.* (2016b) provide an overview of the relevant bodies and their initiatives to address this threat in some capacity. These include the *Convention on the Conservation of Migratory Species* (CMS), which gives bycatch a high priority and has passed a number of resolutions (e.g. Resolution 9.18 and Resolution 10.14). The convention has also identified that its Secretariat and Scientific Council should establish an active collaboration agreement with relevant RFMOs, with the objective of measurably reducing cetacean bycatch. Under the auspices of CMS, the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas and Contiguous Areas

(ASCOBANS) and the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) have been established and both of these include activities to better monitor and support implementation of cetacean bycatch mitigation measures.

There are also several initiatives related to bycatch underway via the UN Fisheries and Agriculture Organization (FAO), including activities to address overfishing and illegal, unreported and unregulated (IUU) fishing. Particularly relevant for cetaceans could be the initiative to develop a gear marking program, though whether it would result in the level of detail needed to identify gear involved in bycatch remains to be seen. Another mechanism employed by the FAO are the International Plans of Action (IPOAs) mentioned above. IPOAs are voluntary instruments created within the framework of the Code of Conduct for Responsible Fisheries (FAO 1995). The benefit of these plans are that they apply to all States and entities, including Regional Fisheries Management Bodies (RFMOs) and to all fishers. To date, four IPOAs have been adopted to address conservation issues related to seabirds, sharks, the management of fishing capacity and IUU fishing. The first three IPOAs were developed as the UN's Committee on Fisheries (COFI) members in 1997 found it necessary to have some form of international agreement in order to manage the issues concerned with compliance with the Code of Conduct for Responsible Fisheries. On the other hand, in general, little has been done by RFMOs to address the issue of cetacean bycatch. A notable exception is the adoption of legally-binding multilateral agreements to address dolphin bycatch in Eastern Pacific Ocean tuna fisheries (IATTC 1999). Given the scale of the threat of bycatch to cetaceans, a collaborative IPOA-Cetaceans appears to be an effective option and might also be considered in due course.

Several national initiatives to address and reduce bycatch have been underway for some time. For example, in the US, measures related to fishing capacity and location and gear modifications have been legislated via the *Marine Mammal Protection Act* (MMPA), probably the most comprehensive national legislation protecting marine mammals in the world (NOAA 2007a, 2007b, 2008, 2014, 2015). In August 2016, NOAA also issued a final rule to implement import provisions of the MMPA. The rule aims to prohibit seafood imports from countries where marine mammal bycatch mitigation measures comparable to those in the US have not been implemented (NOAA, 2016). The rule also makes requirements for monitoring trends in populations and to be able to understand the extent of bycatch. The full implementation of this rule will have significant international implications for the 122 countries which export seafood to the US.

Challenges

Despite being recognized as a major conservation issue for cetaceans since the 1970s, issues related to bycatch remain incompletely understood and largely unresolved (Peltier *et al.* 2016, Cox *et al.* 2007, Reeves *et al.* 2005). Likely this is the result of the threat being virtually invisible to many as it occurs far from land and the sight of many and the focus of governments remains primarily on commercially-relevant fish stocks (Peltier *et al.* 2016). Programs to observe fisheries are thus not designed specifically to maximize the collection of data on cetacean bycatch. As well, in many areas, fisheries tend to be small-scale and decentralized, making assessment, monitoring and conservation intervention difficult (Reeves *et al.* 2005). Some progress has been made with trials of remote electronic monitoring of cetacean bycatch (e.g. Scheidat and Köningson 2015) to replace labour intensive on-board observer schemes, but further advances are required to make the technology affordable and adapted to small scale artisanal fisheries in developing countries.

Additionally, in the case of rare species, the incidence of bycatch is low and, as such, fishermen seldom encounter one of these animals in their gear. This rarity has made it difficult to persuade not only fishermen but also many governments that this issue is very serious for these populations (Read 2008, Reeves *et al.* 2005).

Furthermore, situations where "bycaught" animals have financial value and, therefore, fishers have incentive to catch them need to be considered. For example, in certain areas where bycatch was rare, the opportunistic consumption of the bycaught individuals has led to the development of a market for cetacean products. This may have a bearing on how bycatch develops in a country or region (Cosentino and Fisher, 2016).

Given that impacts from threats such as bycatch affect multiple cetacean species in multiple fisheries, a more holistic and ecosystem-based approach, rather than a species-specific one, may be needed (Read 2008). This is particularly important as there are often different legislative tools, agencies and goals between fisheries management and species recovery initiatives. Threat-based plans could bring these two issues together so that they can be addressed in a comprehensive manner.

In general, and in conclusion, despite knowledge of the severity of this threat for over 40 years, very little genuine progress has been made to reduce its impact. Little concerted effort has been made globally to implement any real conservation measures, even for species which we know are on the brink of extinction due to fisheries interactions. For a threat of this magnitude, only a global concerted effort, involving all stakeholders, especially industry, will result in the successful reduction of this chronic threat and the IWC is very well placed to play a major role in this.

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