Report of the Workshop to Support the IWC's Consideration of Non-Hunting Related Aspects of Cetacean Welfare

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CHAIR'S SUMMARY AND RECOMMENDATIONS

The Workshop was held in Kruger National Park, South Africa from 3-4 May 2016. There were 33 participants from 12 different countries. Participants included individuals from a wide range of stakeholders including national authorities from IWC member countries; veterinarians and veterinary pathologists; animal welfare specialists; biologists and academics working on aspects of cetacean welfare; and experts from animal welfare organisations. This Workshop was held back to back with the Workshop Developing Practical Guidance for the Handling of Cetacean Strandings Events held from 5-6 May 2016 (IWC/66/WKM&WI Rep02).

The primary objectives of the Workshop were to: (i) facilitate coherent discussion of the welfare aspects of non-hunting threats to cetaceans within the IWC (Commission and the Scientific Committee) by synthesising the state of current knowledge and identifying priority issues on which the IWC should work to develop management advice on and/or work to address knowledge gaps; (ii) provide clarity on the role of the IWC and other organisations in addressing non-hunting threats to cetacean welfare; and (iii) to support the IWC in becoming a leading body for the provision of advice on this issue.

Key principles established by the Workshop at the outset were: (1) the term 'cetaceans' was taken to refer to both large and small cetaceans; (2) discussion of threats was confined to non-hunting threats and did not include discussion of the impacts of scientific research; and (3) the Workshop focus was on the welfare of individual animals, though it also sought to identify where this may translate to a conservation concern.

The first part of the Workshop explored the concept of animal welfare, its ethical and philosophical dimension and its development as an academic discipline. It reflected on the relationship and differences between welfare and conservation. The Workshop reviewed national perspectives on welfare including legislation, policies and responsibilities and explored international organisations' efforts on animal welfare including those of the World Organisation for Animal Health (OIE), Organisation for Economic Cooperation and Development (OECD), the Food and Agriculture Organization of the United Nations (FAO), the European Union (EU), the North Atlantic Marine Mammal Commission (NAMMCO) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Drawing on a series of expert presentations, participants considered a range of non-hunting threats to cetacean welfare including entanglement in active fishing gear and Abandoned, Lost and Discarded Fishing Gear (ALDFG); ship strikes; whale watching; marine litter and matters related to habitat degradation (climate change, chemical and noise pollution and prey depletion). The Workshop considered the science of animal welfare and how welfare status can be assessed. In particular, the Workshop reviewed the Five Domains model for assessing welfare status (Mellor and Beausoleil, 2015; Mellor and Reid, 1994) and its potential application for the consideration of non-hunting threats to cetacean welfare. The use of the Five Domains welfare assessment model within the Workshop also represented the first time that it had been considered for wild cetaceans. The Workshop tested the model against a range of welfare threats and applied it to a series of defined welfare scenarios. The Workshop also explored means to assess welfare status over time, in order to consider the implications of a welfare-impacting event against 'normal life' and to examine long-term cumulative impacts. The Workshop considered the potential application of a welfare assessment framework, adapted from the Five Domains model in informing: (i) the assessment of welfare threats to inform the case for (or against) action; (ii) the review of policy and mitigation options, including to ensure that welfare issues are appropriately addressed in conservation strategies; and (iii) the development of response and rescue guidelines, for example entanglement and strandings response.

Finally, on the basis of the above considerations, the Workshop created a version of the Five Domains model adapted specifically as a framework to consider and guide the assessment of welfare in wild cetaceans. The Workshop proposed this for further development and use by the IWC and its member countries.

Conclusions and recommendations
The Workshop agreed that, despite some limitations in its application to wild animals, the use of the Five Domains model for assessing welfare status (Mellor and Beausoleil, 2015; Mellor and Reid, 1994) had been relevant and useful as a tool to help consider non-hunting threats to cetaceans, particularly for defined case studies and scenarios. It was agreed that a cetacean welfare assessment framework (adapted from the Five Domains model, and further developed by the IWC), designed for the assessment of non-hunting welfare threats, would be useful for a range of potential applications. These could include the review of welfare threats to inform the case for (or against) action, informing the development of policy and mitigation strategies, and the development of response and rescue guidelines. On this basis, the Workshop proceeded to develop and test a draft Cetacean Welfare Assessment Framework and **recommended** that the IWC endorse the further development and application of the draft Cetacean Welfare Assessment Framework in assessing non-hunting threats to cetacean welfare and promote its use beyond the IWC.

The Workshop **recommended** that further work on the assessment framework be taken forward, in particular to continue to adapt the Five Domains model for wild cetaceans; address how best to assess welfare impacts and changes in welfare status over time; define and incorporate potential stressors and include accepted best practice/limits (e.g. for whale watching and noise); determine the most appropriate scale for scoring severity; address how best to incorporate a consideration of cumulative, in-combination effects and long-term impacts and identify any further improvements that can be made. The Workshop thus **recommended** that Terms of Reference be drafted to guide further work to refine the assessment framework and that its refinement and application be progressed through the existing IWC Intersessional Working Group on Welfare with the aim of submission to IWC67 in 2018 for endorsement. The Workshop **recommended** that the Intersessional Working Group on Welfare and the IWC Secretariat ensure that appropriate experts are engaged in the continued development and application of the assessment framework.

The Workshop emphasised that appropriately trained experts should be engaged in the assessment of welfare threats. It, however, agreed that the results from application of the assessment framework could be useful in engaging local communities and industry in the development of mitigation options and best practice guidelines. Thus the Workshop **recommended** that care be taken to ensure that the practical application of the assessment framework be assisted by appropriately trained experts, including animal welfare experts and cetacean experts and that the conclusions be shared with local communities in order to facilitate education and promote best practice.

The Workshop agreed that the assessment of welfare threats is more feasible where there is a strong evidence base. It acknowledged that it was more difficult to assess the significance of, and develop appropriate mitigation strategies for threats, species and areas of the world for which there were more limited data and agreed that further work was necessary to address evidence gaps. The Workshop therefore **recommended** that consideration is given to progressing further work where uncertainty may reduce the confidence in the application of the proposed assessment framework including in relation to prey depletion, chemical pollution, anthropogenic sound, marine litter, and biotoxins. It also **recommended** that a process be established that allows for the continued re-assessment of welfare threats as knowledge and understanding improves.

The Workshop noted that it is appropriate, in some cases not to wait until the full scientific evidence is available before taking mitigation action and thus notes the value of application of the precautionary principle when assessing animal welfare and providing mitigation advice to avoid potentially poor welfare situations.

The Workshop **recommended** that in cases where the welfare implications of certain activities are only poorly understood, management of a particular activity or threat should be precautionary and adopt a risk-based approach based on best available scientific knowledge.

The Workshop agreed that the development and application of the proposed cetacean welfare assessment framework could help to further strengthen the consideration of welfare within existing IWC programmes. The Workshop emphasised that this would require a greater understanding of the welfare implications for individual animals over time (including wound healing, wound progression and times to death); and of the welfare implications of disruption of normal behavioural routines and social behaviours. The Workshop emphasised the need for improved data collection associated with welfare threats and in particular the importance of the IWC ship strikes database in this regard.

Thus, the Workshop r**ecommended** that the assessment framework be submitted to the Scientific Committee and other relevant IWC committees and working groups for further scrutiny and comment, and eventual transmission to the IWC Commission for endorsement. The Workshop further **recommended** that application of the assessment framework be considered by the IWC entanglement expert group for its utility and potential addition to the existing entanglement intervention framework to enhance welfare considerations in the decision-making process.

The Workshop **recommended** that the IWC give further consideration to identifying any conservation strategies that may inadvertently compromise individual cetacean welfare and to seek solutions that optimise both welfare and conservation goals. The Workshop **recommended** the encouragement of monitoring of wound healing, wound progression, and time to death in cetaceans in the wild that have incurred vessel-strike or entanglement injuries, in order to provide greater understanding of the welfare implications for individuals.

The Workshop **recommended** that IWC Contracting Governments ensure national ship strike data, including non-lethal incidents, are submitted to the IWC Ship Strike Database and that the IWC promote the importance of submission of this data directly to the IWC database in order to develop understanding of the welfare risk to cetaceans.

The Workshop emphasised that, of the threats considered by the Workshop, entanglement in fishing gear is the most significant threat to wild cetacean welfare. Thus the Workshop **recommended** that IWC Contracting Governments and the IWC Secretariat place a high priority on developing effective entanglement mitigation and prevention measures, and until such time as that is developed, continue support for the palliative care offered by further developing the Global Whale Entanglement Response Network and database. The Workshop **recommended** that a more detailed consideration is carried out on the implications of entanglement and bycatch for small cetaceans.

During the Workshop participants were asked to identify any additional cetacean welfare threats that were relevant to the work of the IWC including existing threats not sufficiently discussed at the Workshop and new and emerging threats. The Workshop noted other issues of concern including biotoxins from harmful algal blooms; the consequences of the repeated entrapment and release of dolphins in tuna purse seine nets; habitat loss from human activities such as mining and the animal welfare implications of swim-with cetacean programmes.

The Workshop noted that there were a range of other international organisations engaged in efforts related to animal and cetacean welfare including OIE, OECD, FAO, EU, NAMMCO and CITES and agreed that it would be useful for the IWC to engage with these organisations. The Workshop acknowledged with gratitude the contribution of animal welfare experts to the Workshop and agreed that the IWC should continue to engage these experts as this work progresses. The Workshop thus **recommended** that the IWC Secretariat proactively engages with organisations with a welfare remit and experts to share information and facilitate the use of existing welfare principles, standards, and definitions as appropriate, for example with the OIE, NAMMCO, and CITES. The Workshop **recommended** that IWC Contracting Governments identify national experts in the assessment of welfare for inclusion on the list of welfare experts to be compiled under the IWC Welfare Action Plan.

The Workshop emphasised that further work to deliver the IWC Welfare Action Plan and to take forward recommendations from the Workshop would have cost implications and agreed that it would be useful to establish these costs in order to inform budgeting processes and potential fundraising. The Workshop **recommended** that the Secretariat provide clear cost estimates for work necessary to facilitate the delivery of the IWC Welfare Action Plan, starting with the completion of the welfare assessment framework. The Workshop therefore further **recommended** that the IWC gives consideration to the establishment of a dedicated funding stream to help progress the assessment and mitigation of non-hunting threats to cetacean welfare.

Table 1

Table of recommendations.

The Workshop recommended that:	Action by:
The IWC endorse the further development and application of the cetacean welfare assessment framework in assessing non-hunting threats to cetacean welfare and promote its use beyond the IWC.	Whale Killing Methods and Welfare Issues Working Group (WKM&WI) (Intersessional working group on welfare)
Further work on the assessment framework be taken forward, in particular to continue to adapt the Five Domains model for wild cetaceans; address how best to assess welfare impacts and changes in welfare status over time; define and incorporate potential stressors and include accepted best practice/limits (e.g. for whale watching and noise); determine the most appropriate scale for scoring severity; address how best to incorporate a consideration of cumulative, in-combination effects and long-term impacts and identify any further improvements that can be made.	WKM&WI (Intersessional working group on welfare)
Terms of Reference be drafted to guide further work to refine the assessment framework and that its refinement and application be progressed through the existing IWC Intersessional Working Group on Welfare with the aim of submission to IWC67 in 2018 for endorsement.	WKM&WI (Intersessional working group on welfare)
The Intersessional Working Group on Welfare and the IWC Secretariat ensure that appropriate experts are engaged in the continued development and application of the assessment framework.	WKM&WI (Intersessional working group on welfare) IWC Secretariat
Care be taken to ensure that the practical application of the assessment framework be assisted by appropriately trained experts, including animal welfare experts and cetacean experts and that the conclusions be shared with local communities in order to facilitate education and promote best practice.	IWC Contracting Governments
Consideration is given to progressing further work where uncertainty may reduce the confidence in the application of the proposed assessment framework including in relation to prey depletion, chemical pollution, anthropogenic sound, marine litter, and biotoxins	WKM&WI IWC Scientific Committee IWC Conservation Committee
A process be established that allows for the continued re-assessment of welfare threats as knowledge and understanding improves.	WKM&WI (Intersessional working group on welfare)
In cases where the welfare implications of certain activities are only poorly understood, management of a particular activity or threat should be precautionary and adopt a risk based approach based on best available scientific knowledge.	IWC Contracting Governments IWC Scientific Committee
The assessment framework be submitted to the Scientific Committee and other relevant IWC committees and working groups for further scrutiny and comment, and eventual transmission to the IWC Commission for endorsement.	WKM&WI IWC Scientific Committee IWC Conservation Committee
Application of the assessment framework be considered by the IWC entanglement expert group for its utility and potential addition to the existing entanglement intervention framework to enhance welfare considerations in the decision-making process.	IWC Secretariat
The encouragement of monitoring of wound healing, wound progression, and time to death in cetaceans in the wild that have incurred vessel-strike or entanglement injuries, in order to provide greater understanding of the welfare implications for individuals.	IWC Contracting Governments IWC Scientific Committee IWC Conservation Committee IWC Ship Strikes Working Group
IWC Contracting Governments ensure national ship strike data, including non-lethal incidents, are submitted to the IWC Ship Strike Database and that the IWC promote the importance of submission of this data directly to the IWC database in order to develop understanding of the welfare risk to cetaceans.	IWC Contracting Governments IWC Ship Strikes Working Group
IWC Contracting Governments and the IWC Secretariat place a high priority on developing effective entanglement mitigation and prevention measures, and until such time as that is developed, continue support for the palliative care offered by further developing the Global Whale Entanglement Response Network and database.	IWC Contracting Governments IWC Secretariat
A more detailed consideration is carried out on the implications of entanglement and bycatch for small cetaceans	IWC Conservation Committee IWC Scientific Committee
IWC Secretariat proactively engages with organisations with a welfare remit and experts to share information and facilitate the use of existing welfare principles, standards, and definitions as appropriate, for example with the OIE, NAMMCO, and CITES.	IWC Secretariat
IWC Contracting Governments identify national experts in the assessment of welfare for inclusion on the list of welfare experts to be compiled under the IWC Welfare Action Plan.	IWC Contracting Governments IWC Secretariat
The Secretariat provide clear cost estimates for work necessary to facilitate the delivery of the IWC Welfare Action Plan, starting with the completion of the welfare assessment framework.	IWC Secretariat
IWC gives consideration to the establishment of a dedicated funding stream to help progress the assessment and mitigation of non-hunting threats to cetacean welfare.	IWC Contracting Governments

1. INTRODUCTION
The Workshop was held from 3-4 May 2016 at Skukuza Rest Camp, Kruger National Park, South Africa. Nigel Gooding, Chair of the intersessional Working Group on Welfare, was appointed Chair. The list of participants is given as Annex A and the Agenda as Annex B. This Workshop was held back-to-back with the Workshop Developing Practical Guidance for the Handling of Cetacean Stranding events held from 5-6 May 2016 (IWC/66/WHM&WI Rep02).

1.1 Participants
Participants included individuals from a wide range of stakeholders including national authorities from IWC member countries; veterinarians and veterinary pathologists; animal welfare specialists; biologists and academics working on aspects of cetacean welfare and animal welfare organisations. There were 33 participants from 12 different countries.

2. MEETING OPENING
2.1 Opening remarks
Nigel Gooding welcomed participants. He thanked South Africa for hosting the Workshop and the Workshop steering group and Secretariat for all their preparatory work. Herman Oosthuizen, on behalf of the South African Government, welcomed everyone to Kruger National Park and wished them a successful Workshop.

Simon Brockington, Executive Secretary of the IWC introduced the IWC and its previous work on welfare, and noted that the programme had evolved over the years to consider aspects ranging from recording of data on hunting methods, improvements to harpoons, and more recently to responding to entanglements and to strandings. The Welfare Action Plan, adopted by the Commission at IWC65 in 2014 (IWC/65/WKM&AWI05rev 2 Annex 1) now reflects this wider scope of IWC considerations relating to welfare. He noted that this Workshop was the first time that the IWC would consider welfare implications arising from other factors including issues such as prey depletion and climate change. In concluding, he thanked the government of South Africa for hosting the Workshop, as well as the governments of the United Kingdom and New Zealand and World Animal Protection for funding the Workshop.

2.2 Appointment of rapporteurs
Sarah Smith was appointed rapporteur with assistance from Claire Bass, Simon Brockington, and Rob Deaville.

2.3 Available documents
Gooding drew attention to the Workshop supporting document [IWC/M16/CW/01] and to the IWC Welfare Action Plan [IWC/65/WKM&AWI05rev 2 Annex 1]. A set of information documents was also available. The list of documents is given at Annex C.

3. WORKSHOP AIMS, OBJECTIVES AND FOCUS
3.1 Overview
Gooding outlined the primary objectives of the Workshop which were to: (i) facilitate coherent discussion of the welfare aspects of non-hunting threats to cetaceans within the IWC (Commission and the Scientific Committee) by synthesising the state of current knowledge and identifying priority issues on which the IWC should work to develop management advice on and/or work to address knowledge gaps; (ii) provide clarity on the role of the IWC and other organisations in addressing non-hunting threats to cetacean welfare; and (iii) support the IWC in becoming a leading body for the provision of advice on this issue. The Workshop would focus on identifying the priority welfare issues for wild cetaceans and to the identification of and communication of evidence, advice and mitigation needs to the Working Group on Whale Killing Methods and Welfare Issues (WG WKM&WI) and other IWC working groups.

Key principles were established for the Workshop by participants at the outset: (1) the term 'cetaceans' was taken to refer to both large and small cetaceans; (2) discussion of threats was confined to non-hunting threats and would not include discussion of the impacts of scientific research; and (3) the Workshop focus was on the welfare of individual animals, though it also sought to identify where this may also translate into a conservation concern.

3.2 Relationship with the IWC Welfare Action Plan
Jamie Rendell introduced the IWC Welfare Action Plan agreed at IWC65 in 2014. This sets out key welfare actions to take forward to improve our understanding of, and efforts to improve, the welfare status of cetaceans globally. Following agreement at IWC65, an Intersessional Group was established, reporting to the IWC Working Group on Whale Killing Methods and Welfare Issues, to progress the actions contained within the plan. This Workshop is the culmination of the work of the Intersessional Group and seeks to address the following actions.

(i) *Action 2.1.1 - Identify and agree upon priority areas of work, where welfare issues are considered most relevant; and*

(ii) *Action 2.1.2 - Identify and quantify (where possible) the nature and extent of threats to cetacean welfare, gaps in our understanding, and specific data needs. Where appropriate, propose possible mitigation measures for consideration by the Commission.*

Rendell noted that this is not a new issue for the IWC. Both the Conservation and Scientific Committees consider issues with welfare implications, in particular whale watching, marine litter, entanglement, noise, contaminants, and strandings. There was a need for this Workshop to provide a clear steer on key issues and the most effective way to address them, and to identify any additional actions for the IWC.

4. GENERAL BACKGROUND ON WELFARE APPROACHES FOR CETACEANS
4.1 Understanding animal welfare and recent developments in the field
Christine Nicol gave an overview of the concept of animal welfare, the ethical and philosophical dimension and its development as an academic discipline. She noted that societal interest in improving human relations with animals is increasing globally (Anon., 2016; Manfredo *et al.*, 2016). One strand of this interest relates to animal welfare and, from its early focus on cruel treatment, animal welfare science now takes a broad perspective of all aspects of animal experience. In reflecting on the relationship between conservation and welfare, Nicol noted that conservation has traditionally been concerned with healthy and sustainable populations, and not with individual animal experience, but that this is also changing (Castle *et al.*, 2016; Dubois and Fraser, 2013; Ramp and Bekoff, 2015). There are some shared aims to build on and individual animals with good welfare may contribute to healthy, sustainable populations. But there are also some potentially conflicting aims which need to be identified, argued and dealt with.

Nicol went on to describe the concept of sentience, and associated subjective experience. This cannot be directly measured, but can be ascribed with increasing confidence to mammalian species as knowledge about the shared neural and cognitive correlates of human consciousness increases. Cetaceans are classified as sentient animals. The subjective experiences that matter to animals – those that are experienced positively or negatively are termed affective states. Animal welfare science has developed tools and methods to measure welfare state across a range of domains, and to infer associated affective state using animal-centred information obtained from preference and cognitive bias tests. The cumulative impact of an animal's experiences can be integrated over time to assess its quality of life.

Nicol noted that wild animals are also impacted by human activities and there is increasing recognition that their welfare is also a legitimate moral concern. By sharing expert knowledge across different fields of endeavour, protocols to assess the welfare of wild cetaceans can be developed and methods of future validation proposed.

In concluding, Nicol commented on the role of welfare assessment in decision-making. Welfare assessment by itself does not dictate policy, but it provides objective background information. Policy will depend on ethical, cultural, economic and political contingencies. For cetaceans there are a range of ethical perspectives ranging from a utilitarian view to a view that these animals have a special moral status and should be treated ethically in a different way.

4.2 National perspectives
4.2.1 USA
Sarah Wilkin presented an overview of the United States legislation relevant to animal welfare generally, wildlife welfare, and marine mammal welfare. The Animal Welfare Act of 1966 (AWA) is the primary statute in the US to explicitly cover animal welfare, and it is enforced by the US Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS). The AWA applies to a subset of animal species in certain settings. For marine mammals, the AWA requires licensing for exhibitors (public display) and registration for transporters and research facilities. Licensed and registered entities must comply with minimum standards of care spelled out in AWA implementing regulations, and are periodically inspected by USDA-APHIS to assess compliance. Additionally, the AWA established Institutional Animal Care and Use Committees (IACUCs) for each research facility or laboratory to provide oversight when conducting research on animals; for marine mammals this has been applied to both captive and wild animals. Therefore, the relevant IACUC for the researcher's facility reviews any research protocols proposed for work on wild marine mammals. Besides the AWA, other US legislation for animal cruelty, neglect, and abuse is typically at the state or local level. Additionally, numerous laws have been passed that reference the minimum standards in the AWA and may provide additional protections for certain species or groups. The Marine Mammal Protection Act of 1972 (MMPA) is one example. The MMPA prohibits the 'take' of marine mammals, where take is defined as harass, hunt, capture or kill. Exemptions to the prohibition may be obtained for scientific research, enhancement, public display, or incidental take. Marine mammals that are considered threatened or endangered (at risk of extinction) also fall under the Endangered Species Act of 1973 (ESA). The ESA also has a prohibition on take, where take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct. Wilkin noted that in the implementation of these statutes for marine mammals, impacts of activities have been considered and limited or mitigated, but such consideration has typically been from a conservation perspective (reducing reproductive impacts, serious injury and mortality) rather than from a welfare perspective. For stranded marine mammals, the Marine Mammal Health and Stranding Response Program (a program operated by the National Oceanographic and Atmospheric Administration, National Marine Fisheries Service) has developed policies that do provide a welfare context for stranded marine mammals, namely the Rehabilitation Facility Guidelines and minimum qualification standards for stranding network members.

4.2.2 Discussion on the approach to cetacean welfare in the USA
In response to a question about the provisions on wound and harm and whether there was any differentiation between intent or not, Wilkin confirmed that agencies have prosecutorial discretion. So, for example, a ship strike could be seen

as a violation of the MMPA, but the decision to prosecute lies with agency. It was also asked whether there were updates planned to the MMPA. It was confirmed there are minor modifications underway but no significant update planned.

4.2.3 Colombia

Andrea Recalde-Salas presented the Colombian perspective on threats to cetacean welfare. She reported that Colombia has a high diversity of cetaceans distributed along the Pacific and Caribbean regions (including islands and archipelagos), and in river ecosystems. The threats affecting cetaceans have been identified as follows.

(1) Unregulated whale watching: the information for this threat is on behavioural responses for particular species (i.e. humpback whales, river dolphins).

(2) Entanglement and ship strikes: there are estimates on numbers of individuals impacted and rates of impact according to type of fishing method (i.e. humpback whales are more likely to be entangled in nets, bottlenose dolphins are more affected by long-lines and river dolphins by monofilament nets). An increment in the rates of entanglements/ship strikes have been observed for humpback whales since 1996 but there is certain uncertainty in terms of the reason behind it.

(3) Habitat degradation threats (noise and chemical pollution, and damage to the habitat): these are increasing threats and there is not much baseline information available. Legislation to regulate and mitigate the impacts is in progress for many of the threats and include guidelines for whale watching, entanglements and stranding, and for marine seismic explorations.

At the moment, some regional or local regulations (i.e. Directiva 001/2001 DIMAR for whale watching), manuals and guidelines and international policy for seismic exploration are followed. In addition, national environmental offices (i.e. Ministry of Environment and Sustainable Development, National Agency for Environmental Licences) consider the impact of industrial activities to cetaceans through environmental impact assessment processes and other regulations. She noted that development of policy is important but ensuring that the regulations are followed is also a priority. In that sense, work with communities in environmental education and training in the legislation is very important as it could lead to self-regulation and support of environmental office's actions. Finally, she reported on some observed gaps in research/policy including long-term impacts, cumulative effects and the development of a local network for entanglement response.

4.2.4 Discussion on the approach to cetacean welfare in Colombia

In response to a question on whether policy was developed at governmental or NGO level, Recalde-Salas confirmed that this was at government level with ongoing collaboration with both NGOs (providing reports and support to government) and the local community. There was also a question on regulation and whether there was an approval or certification system for the whale watching industry. Recalde-Salas confirmed that each year there was training for whale watching operators. However, it had been observed that those licensed from outside of the area (Pacific Coast) may not have the same level of attachment to the resource. Therefore, the long term conservation of the resource requires continuity in terms of community engagement.

4.2.5 South Africa

Mike Meyer gave an overview of legislation and policy relevant to cetacean welfare in South Africa. He presented excerpts from the Marine Living Resources Act that applied to welfare in South Africa, highlighting that only persons appointed and trained by the Department were allowed to assist trapped or entangled whales. These regulations are expected to move to the Threatened and Protected Species Regulations under the Biodiversity Act (NEMBA). He noted that, presently the Department of Environmental Affairs (DEA) has a draft National Policy for Cetacean Disentanglement and Stranding Response, to provide guidance for the development of a national management plan, including response plans for the rescue and management of stranded and entangled cetaceans. The objective was to facilitate and ensure a national coordinated management and the establishment of regional partnerships for responses to stranding and disentanglement of cetaceans and to manage and control rescue attempts using appropriate response plans (developed by the South African Stranding Network; SASN) for the safe and effective release of cetaceans. The response plans would ensure that the correct procedures and humane treatment of entangled, stranded, sick or injured cetaceans and the compliance with the Occupational Health and Safety Act would be undertaken. To address the complexities of managing events DEA created the SASN and the South Africa Whale Disentanglement Network (SAWDN) to coordinate responses. The response plan outlines response strategies, procedures and protocols, legislative responsibilities and the key roles and responsibilities of SASN members as well as external stakeholders under a SASN communication control system. In these cases, DEA's responsibility is limited to the welfare of the animals, safety of rescuers, post mortem investigation and sampling, while other partners would have the responsibility of crowd control, traffic control and carcase disposal.

4.2.6 Discussion on cetacean welfare in South Africa

Meyer was asked about health and safety of volunteers in the water (e.g. strandings responders). He confirmed that they sought to establish first responders who are well trained in how to handle animals, and that beaches were closed during strandings events to people without identification and training. Coordinators have the authority to instruct different groups, by agreement with the army/navy. Meyer was also asked about the strength of marine mammal legislation. He noted that the provisions of the Marine Living Resources Act were set to move under the Threatened and Protected

Species Regulations under the Biodiversity Act (NEMBA) which would bring them in line with high profile terrestrial species such as rhino and elephant.

4.3 International organisations perspectives on animal welfare
Claire Bass presented on multilateral efforts to promote good animal welfare. She outlined the key motivating factors behind such efforts, including disease prevention and control; food security, rural economic development and food quality; responding to consumer and public demands for good animal welfare, for example in agricultural supply chains; and harmonisation of international markets for traded goods, including via free trade agreements. She noted that in recent decades there has been a growing societal focus on and recognition of animal welfare as 'a global common good', for example by the UN Organisation for Food and Agriculture - FAO (*http://www.fao.org/3/a-i4002e.pdf*, page v), and that this has been underpinned by increasing scientific understanding of key concepts in animal welfare, such as sentience. The presentation provided case studies on policies and actions on animal welfare in six other intergovernmental/multilateral organisations – the World Organisation for Animal Health (OIE), the Organisation for Economic Cooperation and Development (OECD), FAO, the European Union (EU), the North Atlantic Marine Mammal Commission (NAMMCO) and the Convention on International Trade in Endangered Species (CITES), including examples of collaborative efforts between some of these organisations. Bass noted that animal welfare is increasingly widely recognised as both a science and a management imperative and that while perceptions of animal welfare are influenced by scientific, ethical, historical, cultural, religious, economic and political dimensions in different countries and regions, multilateral agreement on animal welfare principles and goals is achievable (see chapter 7 of the OIE's Terrestrial Health Code) and, often, desirable. The presentation concluded by recognising that while the majority of animal welfare science and management to date has been focused on captive animals, and to wild animals trapped, hunted or traded, there is a growing philosophy of thought that collective responsibility towards animal welfare should extend to all wild animals whose welfare is negatively impacted by human activities in their habitats.

4.3.1 Discussion on International Organisations perspectives on animal welfare
The Workshop reflected on the work of other international organisations engaged in efforts related animal and cetacean welfare and agreed that it would be useful for the IWC to further engage with organisations with a remit on animal welfare, including to share information and facilitate the use of existing welfare principle, standards and definitions. A recommendation on this issue can be found in Item 8.4.

5. ASSESSING WELFARE THREATS TO WILD CETACEANS AT THE INDIVIDUAL AND THE POPULATION LEVEL
5.1 The science of cetacean welfare
David Mattila gave a presentation on behalf of Greg Donovan (Head of Science, IWC) on the scientific aspects of examining non-hunting issues relating to cetacean welfare. He noted that the IWC has a history of examining the welfare impacts of specific human activities on wild cetaceans. Originally it looked at those associated with hunting and more recently those associated with the entanglement of whales in man-made materials. As the IWC expands its scope of concern to the welfare impacts from other human activities (e.g. non-hunting or research related), it is helpful to examine the role that science can play, and cases where some immediate actions may be warranted. Human activities can be directly lethal (e.g. entanglement and ship strike) or have indirect impacts, that are often not lethal (e.g. noise and chemical pollution, coastal development and loss of critical habitat, marine debris, overfishing and climate change). A simplified categorization, with which to consider the welfare impacts of human activities, might be as follows:

(1) non-'instantaneous' death (>a few minutes?);

(2) pain (e.g. wounds, trauma);

(3) 'excess' individual stress (how to define and quantify/measure?); and

(4) 'social' stress (how to define and quantify/measure?).

Of these four, the first (i.e. time to death) may be the most quantifiable. We cannot currently measure or interpret 'pain' for wild cetaceans, but we might safely assume that severe wounds (e.g. from entanglement and ship strikes), generate pain. Stress, both individual and social, can be a natural response to elicit compensatory behaviours (e.g. feed, flee from predator, establish social stability), but in excess can negatively impact an individual or group's welfare. Whilst new techniques are being developed to assess stress levels (e.g. hormone assays, behaviour cues, visual health assessments), we are still just beginning to understand baselines and make interpretations.

The presentation noted that welfare in wild animals will likely be complicated by considerations of time (e.g. acute, chronic, duration) and synergies between multiple stressors of both human and/or natural origin. These are further complicated because wild cetaceans are often difficult (and expensive) to study, and thus determining impact, and cause and effect can be extremely difficult. However, in some instances the IWC can and has taken mitigating action without full scientific evidence, for instance:

- developing a global response network to (in part) offer palliative care to entangled whales, while also working to prevent entanglements before they happen;

- work to understand and reduce chemical pollutants under the assumption that their impact is not positive; or

- developed good practice mitigation principles for some forms of acute noise (e.g. seismic surveys).

This presentation asserted that, whilst further work is needed to develop tools to assess welfare impacts, it is appropriate to take action in some key cases where actions are both feasible and prioritised by the existing weight of evidence and level of effect. These actions must also take into consideration the synergy between individual welfare and population conservation goals, perhaps using a process similar to Conservation Management Plan's tabulation of issues and knowledge.

5.1.1 Discussion on the science of cetacean welfare
Following discussion, the Workshop agreed with the assertion made in the presentation by Donovan/Mattila that it is appropriate, in some cases not to wait until the full scientific evidence is available before taking mitigation action and thus noted the value of application of the precautionary principle when assessing animal welfare and providing mitigation advice to avoid potentially poor welfare situations. It was further noted that this is supported by existing IWC Scientific Committee recommendations on issues such as pollution. A recommendation on this can be found in Item 8.1.

5.2 The 'Five-Domains' model for assessing welfare status
Craig Johnson presented the background and rationale of the 'Five Domains model' for assessing welfare status (Annex D). He noted that the 'Five Freedoms' defined by the Farm Animal Welfare Council (Farm Animal Welfare Council, 1979) have been used for many years as a scaffold to aid the analysis of animal welfare in a variety of situations. Over time since the freedoms were first described, there have been a number of developments in thought relating to the cognitive abilities of animals. Most notably, mammals and a number of other animals are now thought to be sentient and to be subject to affective states. The Five Freedoms model was no longer fully able to cope with animal welfare analysis in this environment, especially in relation to changing concepts of physiological drives and positive welfare and the Five Domains model was evolved and later adapted to encompass positive welfare (Mellor and Beausoleil, 2015; Mellor and Reid, 1994).

Johnson noted that animal welfare thought has been developed primarily through work with domestic animals and using the principles of welfare in the analysis of animals in the wild is a very recent development. He expressed the view that care needs to be taken to avoid approaching the welfare of wild animals with a conservation perspective. While conservation deals with animals at a population level and is more concerned with the implicit value of animals in their natural environment, welfare is much more focussed on the subjective experience of individual animals and applies utilitarian principles rather than the value ethics of conservationism. He noted that the 'compassionate conservation' concept (Bekoff, 2010; Paquet and Darimont, 2010; Ramp and Bekoff, 2015) is an effort to bring conservation and welfare together. It recognises that humans have an impact on wild animals and that therefore it is appropriate to have some concern for their welfare.

He concluded that, despite the difficulty of adapting the Five Domains model to wild animals, this approach represents a valuable way of analysing the welfare costs of situations that cetaceans may find themselves subject to and prioritising needs for interventions to improve welfare in these animals.

5.2.1 Discussion on application of the Five Domains model to wild populations
In response to a question on whether there had been any attempts to apply the Five Domains model to wild population, Johnson reported that it had been applied to the potential eradication of possums (due to their impact on natural habitats) and to look at the experience of animals subjected to different toxins. This example was concerned with mitigating harm and Johnson was not aware of any research on improving the welfare of wild animals, presumably because of presumption that a natural environment is the optimum environment. Domestic and farm animals are not in natural environments. One participant explored further the issue of natural *vs* non-natural environments with the example of whales covered in barnacles. This is considered natural, and something that we would not intervene on, regardless of whether they cause pain (itchiness), though it was also noted that barnacles are often an indication of health and poor prognosis so they may indicate the presence of other welfare impacts. The issue of man-made changes to environments (e.g. climate change, pollution) that could also have welfare impacts was also raised. It was also noted that cetaceans are far less well known than species for which this model have been traditionally applied (e.g. farm animals), and that this should be allowed for.

6. SUMMARY OF NON-HUNTING THREATS TO CETACEAN WELFARE
6.1 Entanglement in active gear and ALDFG (abandoned, lost and discarded fishing gear)
David Mattila gave a presentation (on behalf of Mattila and van der Hoop) on the welfare implications of entanglement and bycatch. All large whale species have been reported entangled in fishing gear. This can be any type of fixed or drifting fishing gear wherever whales are found. Impacts include acute impacts (e.g. underwater entrapment) or chronic death (e.g. bleed out, infection, starvation, killed while mobility is impaired); physical wounds (pain) and deformity; energetic costs and other possible non-lethal impacts disturbance (fleeing contact); and possible displacement. Most entanglements occur in actively fished gear; an unknown percentage of entanglements are in Abandoned Lost and Discarded Fishing Gear (ALDFG) with a continuing risk profile in water column. New technologies such as Fish Aggregation Devices (FADs) are having an impact, as are other ropes and nets similar to fixed gear (e.g. moorings, aquaculture). Variables which can be measured to determine effects include time to death; duration and severity of physical wounds; assessment

of energetic costs and other possible non-lethal impacts; geographic scope and encounter rates (e.g. annual scarring); measurable stress and/or health impacts (e.g. visual assessments, skin bacteria, stress hormones) and displacement and/or exclusion (though this is difficult).

In discussing the potential role of different stakeholders in monitoring and identifying welfare threats Mattila highlighted the role of: (1) fishers, in accommodating observers, report and photograph entanglements, work toward prevention, provide some indication of geographic fishing areas; (2) management to provide observers, support scar monitoring and prevention studies and trials; (3) researchers to monitor population scarring and health, compare population vs. fishery distribution, develop stress assessments and other measures of welfare impacts; and (4) the public, to exert pressure management on high risk fishing and ALDFG, support products from low risk fishing, and to report and photograph observed entanglements.

Mattila outlined a number of knowledge gaps including for the development of socioeconomically acceptable risk-free fishing gear and/or practices, on to what extent is ALDFG a portion of the problem and the need for better quantitative measures (e.g. stress, energetics, health). He outlined a set of existing or potential mitigation and prevention measures and identify organisations or bodies that have advisory or regulatory interests at national and international levels. These included seasonal closures (responsibility of national, and provincial/State fisheries management and possibly some IGO regional fisheries management); a reduction of rope and net in water column (national and provincial fisheries managers, possibly regional IGOs), and perhaps FAO-COFI; visual and/or auditory alerting devices; a ban on high risk or switch to lower risk gear (national and provincial fisheries managers, possibly some IGO regional fisheries and perhaps FAO-COFI) and the formation of disentanglement networks.

Mattila outlined the existing work of the IWC in this field including the work of the Scientific Committee (Human Induced Mortality subgroup) in determining the scope and impact on populations; the IWC Global Whale Entanglement Response Network, and capacity building initiative; the IWC entanglement prevention Workshops; various marine debris initiatives and IWC engagement on the issue with other relevant IGOs, for example FAO Committee on Fisheries (COFI), the United Nations Environment Programme Caribbean Environment Programme (UNEP-CEP), the South Pacific Regional Environment Programme (SPREP) and the Permanent Commission for the South Pacific (CPPS).

Mattila noted that, from a welfare perspective, the higher priorities are not necessarily the high priority conservation populations (e.g. Arabian Sea, western gray whale, North Atlantic right whale), but are more likely in areas where high numbers of whales overlap with high-risk fishing activities (e.g. Coastal Australia, Brazil, much of the Pacific coast of South America, much of the Pacific and Atlantic coasts of North America, South Africa); and many coastal artisanal fisheries (e.g. Brazil, Pacific coast of South America, Mexico). There are a number of areas where the evidence base is insufficient including much of Africa, the Indian Ocean and the Arabian Sea.

6.1.1 Discussion on entanglement in active gear and ALDFG
During the discussion it was noted that this presentation and the IWC entanglement programme was focused primarily on large whales. Simmonds noted that for there are also major welfare concerns associated with death by entanglement for small cetaceans and cited evidence from research undertaken at the University of Bristol on sub-lethal impacts in small cetaceans (Soulsbury *et al.*, 2008). Recommendations relevant to entanglement of large whales and small cetaceans can be found in Item 8.2 and 8.3.

6.2 Ship strikes
Julie van der Hoop presented on vessel-strike threats to cetaceans and highlighted the varied outcomes of a vessel-strike incident between any size of cetacean and any size of ship. While lethal vessel strikes are a conservation issue for some specific species or populations where incidence is high and population levels are low, non-lethal strikes or those that are not immediately lethal present a welfare concern. Van der Hoop highlighted the importance of continuing to collect morbidity and mortality data to diagnose the extent of the issue and identify conservation issues where relevant, and that the use of high-resolution shipping and cetacean distribution data (dynamic in space and time) can identify areas with high risk and/or potential for mitigation. Van der Hoop stressed that we currently do not know the prevalence of wounds in living populations which would reflect the extent to which vessel-strikes are survived, or the incidence of non-lethal interactions; the time course to death and the processes it may entail; the processes of wound healing and progression specific to vessel-strike sharp trauma; or whether or to what extent blunt trauma injuries are survivable and what healing or recovery entails. The role of all communities to report observations of incidents whether lethal or non-lethal, and to document, diagnose, and share data to contribute to long-term data sets was emphasised. Education of all parties (mariners, managers, researchers, public, stranding networks) to collect information and share it at the global level (i.e. to the IWC Ship Strike Database) is necessary. Management needs to work with research and mariner communities to develop mitigation to address both welfare and conservation aspects of the issue, and to communicate and enforce these regulations to ensure compliance. Vessel strikes can be reported from the perspective of the incident (i.e. by a mariner) or of the observation of the wounded, live or dead, animal. The degree to which data from these two streams are reported at each local, regional, national, and global levels are unknown and need to be encouraged. Vessel strikes have historically been mitigated as a conservation issue, leaving the welfare aspects largely unquantified.

6.2.1 Discussion on ship strikes
During the discussion attention was drawn to the TSS proposal for Panama humpbacks (Guzman *et al.*, 2013) which was approved by the IMO in 2014. This was discussed at the IWC-SPAW Workshop to Address Collisions Between Marine Mammals and Ships with a Focus on the Wider Caribbean (IWC, 2016a) and it was noted that the Workshop report provided a good review of current mitigation measures. Participants also recalled the importance that had been attached to the initial establishment of the Ship Strike Database and the need for this to become operational. It was suggested that the Commission should be provided with information about the current challenges associated with the Ship Strike Database and what is needed to further develop it.

It was noted that in addition to the welfare impacts described in the presentation, it was possible that ship strikes could lead to more blood in the water and therefore to increased predation.

Recommendations relevant to ship strikes and the ship strikes database can be found in Item 8.2.

6.3 Whale watching
6.3.1 The impacts of whale watching tourism
Lars Bejder presented lessons from studies evaluating impacts of whale watching tourism. He noted the significant global growth in marine and whale watching tourism (Higham *et al.*, 2016; Hoyt, 2001; O'Connor *et al.*, 2009). Whale watching tourism has significant potential to contribute to conservation and local economies but the potential for welfare issues and biological impacts must be recognised. Impacts of whale watching tourism are difficult to detect because they are indirect, cumulative and not readily detectable. Over 30 years of impact assessment (Higham *et al.*, 2014) has found that typical short-term behavioural responses to whale watching include changes in behaviour, movement and social dynamics. This can lead to impacts on abundance and reproduction and can lead to cumulative population-level impacts (Bejder *et al.*, 2006a; Bejder *et al.*, 2006b; Higham *et al.*, 2014; Lusseau and Higham, 2004). A study in Shark Bay (Monkey Mia), Australia demonstrates a unique scenario in which the dolphin population had been studies for 130 years, with greater than 1,500 individuals identified, and data on age, sex, habitat use and reproductive success. Data was available before the onset of tourism and the tourism activity was in a well-defined area. The study showed an increase in tour vessel activity over 15 years from 1988 to 2003 (0 trips per day to 8 trips per day), with a corresponding long term decline in relative dolphin abundance of 14.9% within the tourism site over the same period as compared to an increase in relative abundance of 8.5% in the control site. This finding contributed to a Ministerial decision in 2006 to reduce the number of commercial boat tour licences in the area.

6.3.2 Case studies on whale watching in Argentina
Miguel Iñíguez presented three different case studies of whale watching in Argentina and Panama. The first one, relating to Bocas del Toro, Panama, summarises the information already presented at the IWC mainly by May-Collardo (2015; 2015) and Kassamali-Fox *et al.* (2015) on the bottlenose dolphin resident population and reiterated previous IWC recommendations (IWC, 2013; 2015; 2016b). The second case study was on the open process developed in Península Valdés until the promulgation of a new whale watching regulation in 2008, which had also been previous discussed by the IWC. The third presentation related to an acoustic study developed by Reyes Reyes *et al.* (2016) in Argentina. Broadband acoustic recordings for different types of vessels were obtained using an omnidirectional hydrophone in two shallow waters of Patagonia Argentina: Ría Deseado and San Julián Bay. Both areas are inhabited by Commerson's dolphins (*Cephalorhynchus commersonii*), especially during spring and summer seasons, where they are exposed to recreational nautical activities, whale watching and in the case of Ría Deseado to the ship traffic of the harbour located there. The potential range reduction for communication on Commerson's dolphins was calculated for third-octave bands of 1, 10 and 125 kHz for each single vessel. Ship noise from a range of different vessel types substantially elevated ambient noise levels across the entire recording band from 0.2 to 250 kHz at ranges between 10 and 1,000m. Vessel noise is able to produce about 90% range reductions within a distance of 500m in the third-octave bands of 1 and 10 kHz and increase noise levels by 18 dB at a range of 100m from the recording platform. These results support previous studies on harbor porpoises (*Phocoena phocoena*) showing that several types of vessels produce substantial noise at medium and high frequency, where toothed whale hearing is most sensitive, and thus have the potential to mask relevant sounds used by the species.

6.3.3 Discussion on whale watching
In response to a question on whether animals would not simply move if they were adversely impacted by repeated interactions with whale watching vessels, it was noted that displacement could have quite a significant impact for some species if the area in question is optimised for what they need, and if animals have learnt how to use a particular area.

Bejder was asked about the impetus for the policy change described in Monkey Mia. He indicated that this was prompted by a decline in numbers and reproductive decline in females that had been subjected to long-term exposures.

Iñíguez was asked for more detail on the zoning strategy that he reported had been used in Península Valdés and whether there was evidence of whales using respite areas. He confirmed that a zone was designated for whale watching, along with a corridor for ships to enter the harbour. These together occupied approximately one third of the space combined and the remaining area of the gulf was set aside as respite for whales. It was, however, unknown whether whales preferentially use this area.

In response to a question on whether the greater impact would come from smaller boats or fewer people, or fewer larger boats, Bejder suggested that fewer large boats would be better than many small ones in some ways but that acoustic impacts of large boats might be greater. Iñíguez reported that in Península Valdés, cooperation between operators (e.g. filling the boat of one operator before another took any passengers) to reduce numbers had worked to decrease numbers of boats but that it took a long time for operators to meet agreement on this sort of practice. In this context the importance of self-regulation by operators was noted, but that this can be a long process of cooperation with local communities.

It was asked whether there was an evidence that growth in whale watching was resulting from a switch from consumptive to non-consumptive use. Iñíguez reported some anecdotal evidence of this for fishing communities (fishers spending six months of the year fishing and the other six months as whale watching operators).

6.4 Marine litter excluding ALDFG
Andrew Butterworth gave a presentation on the non-entanglement impacts from marine debris, particularly plastics. He reported that plastics are a major component of persistent marine debris - polypropylene, polyethylene, nylon, polystyrene, polycarbonate and polyvinyl chloride are very durable, are close to the density of seawater, and are easily carried by currents. Tracing of barcodes shows that plastic can be found 10 years later and 10,000km away from its country of origin. Literature review suggests that ingestion of debris has been documented in 48 (56%) of cetacean species. Butterworth outlined published explanations for why marine species ingest marine debris which include: (i) they are opportunistic feeders, ingesting debris encountered in the environment; (ii) they ingest debris because it resembles their prey; (iii) they ingest prey with debris in their gastrointestinal tract; and/or (iv) they ingest debris accidentally during predation, or through curiosity or play. He then went on to discuss: (a) published example cases where the volume of debris consumed may have resulted animal welfare impacts, for example, if the larynx is obstructed, or if digestion compromised; and (b) cases where ingestion of plastic micro-particles is reported, with the possibility that ingested debris (particularly degraded plastics) may be a potential cause of toxicity in cetaceans. In conclusion, he suggested that the incidence rate of ingestion events, which severely compromise the animals is likely to be low (when compared for example to entanglement), and that the potential welfare impact from toxins derived from ingested plastics is unclear and represents a knowledge gap. However, the presence of marine debris in the sea does appear to have the potential to be one of the anthropogenic hazards for cetaceans.

6.4.1 Discussion on marine litter
During the discussion Jepson noted that media reports on marine debris ingestion contrast with the results from the UK strandings programme, for which there is only one record of death as a result of marine debris ingestion from over 3,500 cetacean necropsies conducted during a 25-year period. Although marine debris ingestion was found in a small number of UK examined strandings, in many cases it was thought to have been incidentally ingested during a live stranding event. Deaville further suggested that although it was important to note the presence of marine debris, pathological impact had to be demonstrated for the ingestion to be considered to be a causal factor in the animal's death. Other participants noted that more records of death from marine ingestion debris do exist from other parts of the world. Deaville suggested that it was important to record negative as well as positive data, to help build up a broader picture of where debris ingestion might be an issue (in relation to species and regions) and where it is not, highlighting potential knowledge gaps on this topic.

6.5 Matters related to habitat degradation
Mark Simmonds provided brief introductions to a range of issues under this agenda item: climate change, chemical and noise pollution, and prey depletion. He asserted that the potential links between climate change and welfare concerns for marine mammals requires a novel approach. A recent literature review considering climate change and marine mammals showed that a growing proportion of publications make links between observed changes in the field and climate changes, with much literature focused on the Arctic region (Nunny and Simmonds, 2016). (None of this literature considers any welfare implications.) Linkages have been made between observed and predicted changes in the physical environment (e.g. loss of ice cover and changes in water circulations) and habitat and species-level changes (e.g. decline in primary productive leading to changes in prey availability) (see Simmonds (2016, figure 3.15.9). The literature indicates that declines in prey availability, access and quality were perhaps the primary concerns for cetaceans but loss of habitat, displacement and the potential for increased competition further to range changes was also highlighted. Changes in human behaviour in response to the climate change could also impact them (for example increasing activities in Arctic waters such as fishing, boat traffic and fossil fuel exploration) and may even be the most immediate impacts in some cases (Alter *et al.*, 2010). Climate change might cause some benefits for some populations - for example in terms of enhanced feeding opportunities in waters that might not have previously been hospitable to them - at least initially. However, overall, Simmonds suggested that climate change might be expected to enhance many significant welfare concerns that affect wild cetaceans.

Chemical pollution has been recognised as a threat to cetaceans and especially those at the apex of marine food chains. Special note was taken of the meticulous investigations into the 2010 *Deepwater Horizon* event in the Gulf of Mexico linking health concerns in dolphins, including loss of calves, to exposure to this major oil spill event. In particular, Schwacke *et al.* (2014) recently reported that dolphins within the Barataria Bay, Louisiana region demonstrated a high prevalence of advanced lung disease, blood values consistent with hypoadrenocortism or inflammation, poor body

condition, and overall a guarded to poor prognoses for survival. Most recently, Colegrove *et al.* (2016) revealed that from 2011 to 2013, during the northern Gulf of Mexico UME [unusual mortality event], 'bottlenose dolphins were particularly susceptible to late-term pregnancy failures and development of in utero infections including brucellosis.'

Simmonds also drew attention to the recent work by Jepson *et al.* (2016) and Murphy *et al.* (2015) on organochlorine pollutants, showing that health concerns (i.e. immunosuppression and reproductive suppression) continue in the North Atlantic region caused by the persistence of PCBs. Pathological findings were consistent with immunosuppression and increased susceptibility to disease included macro-parasitic and bacterial pneumonias, high lung and gastric macro-parasite burdens, and generalised bacterial infections (septicaemias). From a conservation perspective the implications for some populations are severe and there will be associated welfare concerns.

As an introduction to noise pollution, Simmonds referred to the summary made by Todd *et al.* (2015). They note that the ocean is a very noisy environment, with both natural and anthropogenic sources contributing significantly to background noise levels. If noise levels are sufficiently elevated at an animal's most sensitive hearing frequencies this can result in TTS or PTS (temporary or permanent threshold shift). Lower intensity sounds could invoke behavioural reactions, including avoidance or vocalisation alterations. Masking is also a concern, and can reduce the ranges at which marine mammals communicate. Todd *et al.* (2015) add that military SONAR has been correlated with mass stranding events.

In terms of observed effects of marine noise pollution, Simmonds noted that TTS had been extensively studied in several species; localised avoidance have been observed; changes in other behaviour e.g. dive times and calling have been observed; stress responses are expected and there is some evidence of this; impulse trauma has been observed; strandings observed and also noise–associated *in vivo* gas bubbles in tissues. There was no time to explore these issues in depth, but Simmonds noted that chronic embolisms in tissue might well be very painful and, in support of this, showed images from the post mortem of a Risso's dolphin (*Grampus griseus*) examined in the UK by the Cetacean Strandings Investigation Programme, showing a grossly distended spleen.

Finally, Simmonds presented Fig. 1, which shows a series of potential causes and consequences of issues relates to prey quantity, quality and abundance and the welfare concerns that may result. Simmonds noted that the IWC already had work streams looking at some of these issues and that this was primarily through the work of the Scientific Committee and predominantly from a conservation perspective. He suggested that prey depletion and chemical and noise pollution stood out as potentially having significant, related welfare concerns.

6.5.1 Discussion on matters related to habitat degradation
Discussion on the 2010 *Deepwater Horizon* event in the Gulf of Mexico noted the importance of the research programme that has taken place there, which provided a hugely valuable set of evidence on the impacts of such events.

Questions on PCBs focused on the likely geographical extent of PCBs and whether the impacts described (for killer whales in the Atlantic) were likely to be confined to the Northeast Atlantic area. Jepson confirmed that the Northeast Atlantic has the highest recorded levels in the world - up to 6.5 times levels in the Southern Resident killer whale population in the North Pacific which was previously considered to be the highest. There are very high levels of PCBs in killer whales from the Arctic to the Antarctic, with the highest levels in industrialised regions, indicating that there are likely to be significant PCB related impacts throughout their range. There are geographical hotspots including the Mediterranean Sea in Europe and the River Yangtze in China, one of the most polluted rivers in the world, home to the Yangtze finless porpoise and previously home to the now extinct baiji. Thus it was noted that the problem is not confined to Europe and was likely to extend to other species feeding at similar trophic levels as killer whales, including false killer whales and bottlenose dolphins. Work was needed to fill in data gaps for these species.

There was some discussion on prey depletion and the potential for this to occur as a result of climate change. Prey depletion had been studied in other species (e.g. Oozthuisen noted that there had been studies in South Africa on impacts of overfishing on penguins) and the workshop noted that more studies relevant to cetaceans would be useful- including in relation to cumulative impacts from climate change. Some participants expressed a view that this could be more significant than currently realised.

7. INTRODUCTION OF A WELFARE ASSESSMENT MODEL AND ITS APPLICATION
7.1 Comparative assessment of welfare threats
Following on from the presentation of the Five Domains model for the assessment of welfare threats (Item 5.2) participants agreed that it would be useful to consider further the potential usefulness of this framework to the consideration of non-hunting cetacean welfare threats. It was thus agreed that the workshop would establish five break-out groups to test the framework against a set of threats to cetacean welfare, using the proforma in Appendix 1. Each group discussed each welfare threat against four of the Five Domains (Nutritional, Heath, Behavioural and Psychological - leaving out the Environmental domain on the basis that this was thought more relevant to captive animals) in the framework in qualitative terms and in relation to both acute and chronic impacts. Each individual was then asked to complete the proforma by scoring each welfare threat for both acute and chronic impacts against each domain in the model, using a score of 0-3 (0=no impact; 1=minor impact; 2=moderate impact; 3=severe impact). These scores were then collated and combined in an effort to explore the utility of the framework for comparative assessment of welfare threats.
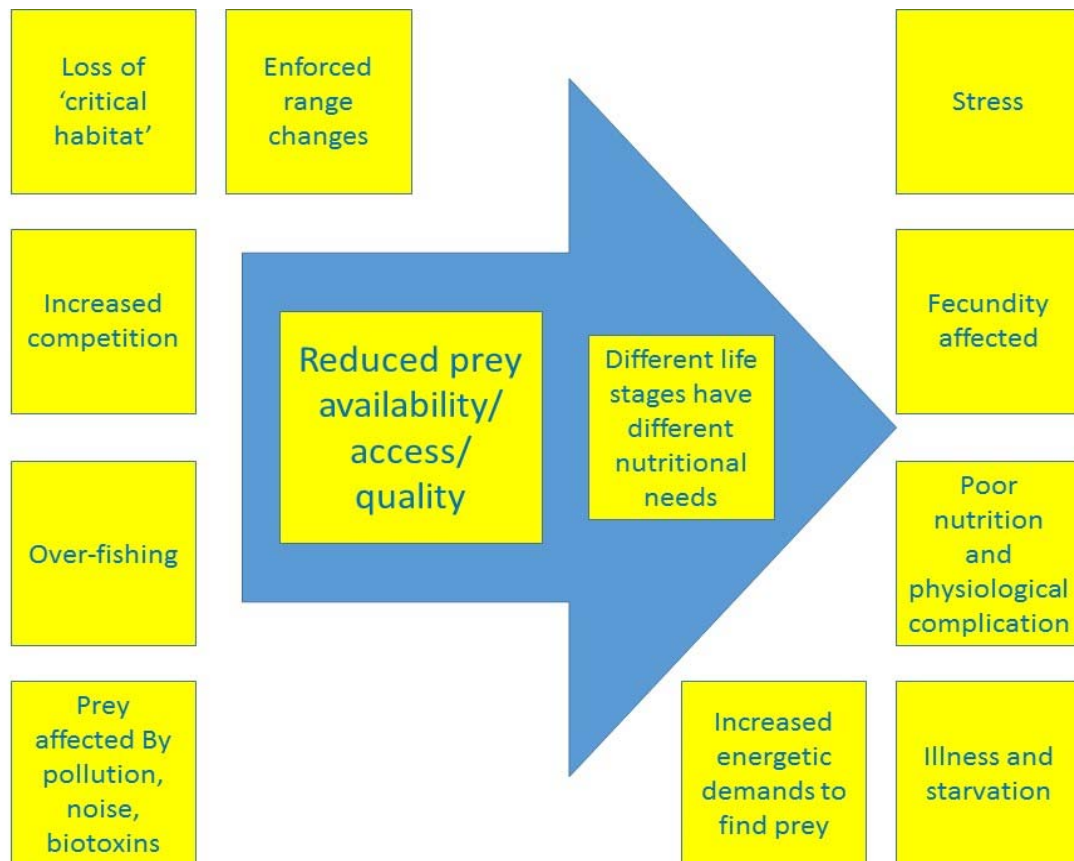
Fig 1. Potential causes of changes in prey quantity, quality and abundance and implications for cetacean welfare.

Following this exercise, Rendell presented briefly on the collated results from the individual scoring exercise. 84% of people rated entanglement the highest welfare threat, with lots of variation in what threats were ranked in second and subsequent places. Whale watching was rated lowest by 53% of participants. Despite the lack of information on prey depletion as a welfare threat there seemed to be a view that this was an important issue, with 21% of participants rating this as the second most severe threat. Following brief discussion of these results, the Workshop agreed that, rather than undertake in-depth analysis of this very exploratory exercise, it should reflect on some more general experiences in undertaking this exercise, and on use of the Five Domains model. This discussion led to a number of generic observations on applicability of the Five Domains model to the assessment of welfare threats to wild cetaceans. These are summarised in Item 7.1.1 below.

7.1.1 Observations on the applicability of the Five Domains model to the assessment of welfare threats to wild cetaceans

Overall, the groups had positive experiences with working with the Five Domains model and found it relevant to apply in the consideration of non-hunting cetacean welfare threats. There had been some challenges in terms of definitions-particularly of acute vs. chronic impacts. For example, some groups defined 'acute' as 'quick, lethal impact' whilst others defined this more on a time-series in terms of immediate impact or impact within a few hours- regardless of whether this was a lethal impact or, in fact a 'good' outcome (e.g. brief entanglement, panic and then escape). Participants agreed that clearer definition of terms would have aided the assessment.

There was some discussion on the Psychological Domain. The Workshop noted that Domains 1 to 4 are all measurable by normal scientific methods. There may of course be practical difficulties in obtaining data on some aspects, but these raise technical not fundamental problems that could in time be solved. Domain 5 is the one that is not directly measurable but requires an analogical leap based on similarities between mammalian brains. The fifth welfare state is seen as an overall integration of the other domains

Groups had found it hard to make a generalised assessment for each threat. There could be such a spectrum of impacts that assessments could vary quite significantly between a 'worse-case scenario' or situation with 'highest numbers of animals affected' *vs* a case of more moderate impact. Strength of threat could also vary significantly e.g. amplitude or frequency of noise. There would also be variations in extent and significance of impact depending on the species

(including large *vs* small cetaceans). Thus a case by case approach could be much more useful than trying to make a generalised assessment.

In addition, it was noted that some welfare threats (e.g. pollution and disease; marine litter ingestion and chemical pollution; noise and whale watching) can be interconnected so assessing them separately can be difficult and not always as useful.

Groups noted that impacts of some threats were directly observable (e.g. entanglement, ship strike) whereas others were not directly observable (chemical etc.). In addition, there were a range of evidence gaps, particularly for certain threats, that made the assessment difficult. There had thus been discomfort in the application of a single uncertainty score for each threat. In this context groups had found it easier to assess welfare threats which cause trauma and injury and thus have clear welfare effects. Others causing loss of health, e.g. pollution, prey depletion, had been more difficult. It was agreed that it would be useful to try to capture evidence gaps in more detail.

There was some further discussion on use of terminology. Terms such as 'fear' and 'panic' can perhaps be observed and quantified more easily in some animals (e.g. captive farm animals) but this is more difficult in wild animals. It was also agreed that there was a need for more understanding of the baseline behaviour of wild animals in order to better understand human impacts.

There was some discussion on whether it was possible to consider the positive welfare states that humans can bring to cetaceans. This was considered in the Five Domains model but not considered for this exercise and some participants asked for more consideration of whether this should be included.

Some groups would have found it helpful to have a bigger range for scoring in the assessment.

In conclusion, the Workshop agreed that the model was limited in its use for an overall comparative and generalised assessment of different welfare threats; and that it would potentially be much more useful to consider its applicability to different case studies and scenarios. This could potentially also include assessment of the human response to welfare situations e.g. strandings response and various decisions (e.g. euthanasia) associated with this. Clearer definitions (e.g. chronic *vs* acute) would also be helpful.

The group noted that some elements of the assessment had been opinion based due either to lack of evidence or difficulties in assessing or relating the domains to wild animals. There was a need to accumulate an evidence base to test expert opinion against other measures e.g. stress studies. It was also agreed that this assessment was essentially a 'point in time' assessment but that in longer-lived animals, quality of life over time might be more important.

7.2 Applying the Five Domains model to cetacean welfare scenarios
During the previous discussion participants had expressed interest in exploring the use of the Five Domains model further through its application to some specific scenarios, framed with a clear description of species, impacts, definitions and timelines. The Workshop agreed to split into different groups to define and explore scenarios related to entanglement; pollution; whale watching and ship strikes. Mattila, Jepson, Bejder and van der Hoop agreed to chair these groups. Some worked examples from this exercise are in Appendix 2. Feedback from the groups working on particular scenarios is summarised below.

7.2.1 Whale watching
Feedback from this group reiterated that the framework would not be useful to compare whale watching with other threats, and that the exercise had been focused on how it could be used to inform whale watching activities. The group had included both scientists and managers and there had been useful discussion on how this assessment tool could be used by both disciplines. The group identified different stressors from whale watching activities and tried to quantify welfare impacts associated with each of these stressors - for each stressor taking a best and worse-case scenario. The group attempted to align with existing approaches to identify exposure and impacts of whale watching as developed by IWC and other organisations. These are typically evaluated in four different scenarios: (i) resident coastal population; (ii) migration; (iii) feeding; (iv) breeding. For the purpose of this exercise a best- and worst-case scenario was developed with the worst-case scenario being a resident coastal population repeatedly exposed to stressors. Using this approach, the group had developed a more context-specific approach, which they thought was critical. The approach mainly looked at short-term responses but had a column for cumulative responses in the longer term. Results for this followed a similar pattern to short-term responses but with less confidence in the numbers. Information on the long-term and cumulative impacts of whale watching on cetacean welfare was identified as a knowledge gap.

During the discussion, the Workshop noted that the development of a more context-specific approach had been important. The introduction of multiple stressors had been useful and might be useful to work through for the other welfare threats. An advantage of using the tool in the whale watching context was that it pushed for good welfare, which would also push towards the industry behaving more responsibly and more sustainable practices in the long term. It was also noted that it might be possible to use the tool to help compare two scenarios, e.g. a comparison between two different whale watching proposals. This led to some discussion on who should use the tool. Some participants expressed concern that it could be open to misuse by less responsible operators and that appropriately trained experts should be involved in the assessment.

However, it was noted that the results from using the framework could be useful for communicating threats to local communities and industry.

In conclusion, the Workshop noted that if this tool were to be used for whale watching it needed to include multiple stressors and should be used against the four categories of animals (above) defined in the literature. It was also noted that this tool could be considered by the IWC whale watching standing working group in its work to further develop the whale watching handbook.

7.2.2 Ship strikes
The group defined four cases. They reported that confidence in their assessment had been high – they were dealing with very specific cases, with existing evidence and analysing in the context of this evidence. This had also helped to define acute vs chronic impacts. In each scenario they were retrospectively reviewing cases where the eventual outcome was known. This had led to a discussion on the best point in time to make a welfare assessment. In a chronic case then there may be healing over time so the assessment would be very different depending on which stage the framework assessment was completed. The group had concluded that the assessment needed to be done at the final end point. But there were obvious limitations with this and in many cases this would not be possible.

This exercise had led to a broader discussion on the use of the tool to review management approaches for ship strikes. The group had noted that some mitigation measures designed to prevent strikes, e.g. traffic separation should lead to positive conservation and welfare outcomes but had queried whether mitigation designed to reduce mortality from a conservation perspective e.g. slowing down might result in an increased number of non-lethal strikes and potentially an increased problem from a welfare perspective. A recommendation on this can be found in Item 8.2.

7.2.3 Entanglement
The group had looked at four different cases: (1) a small cetacean entangled in a net; (2) a large whale with a minor entanglement, which was shed; (3) a large whale in severe entanglement where it was not possible to intervene; and (4) a large whale with a lethal entanglement that was released. An "acute" impact was defined according to the time taken for an animal to drown and anything over a longer timespan was defined as "chronic". The group had encountered similar issues with timescale as the ship strikes group and noted the likelihood of being forced to rate at the point of observation.

The group had noted that the original Five Domains model had a large glossary of effective state definitions and that it might be possible within this to find better descriptors for wild cetaceans. It was also thought a five-point scoring scale might have helped.

In discussing the case of the released animal, it was noted that its welfare did not improve straight away, and indeed open wounds persisted for the rest of its life. Thus the tool could be useful in assessing when to intervene.

There was some discussion on the scoring scale. The group had suggested that a five-point scoring scale might have helped. However, it was noted that fewer point scales may be more appropriate in a data poor scenario.

The Workshop noted that the Global Entanglement Network have an assessment tool for judging when to intervene and this framework could potentially help with this discussion. A recommendation on this can be found in Item 8.2.

7.2.4 Chemical pollution
The group had explored several scenarios involving PCBs (pilot whales in the Mediterranean with moderate exposure and killer whales in the Mediterranean with high exposure), as well as an oil spill (bottlenose dolphin in the Gulf of Mexico). For PCBs, it was determined that given the impacts came from bioaccumulation then there were no major acute effects. Discussion had focused around immunosuppression and reproductive suppression including increases in abortions and mortality of live born calves. It was noted that, for these scenarios, impacts on some domains were secondary in affect, e.g. once an animal is diseased (as a result of immunosuppression) then nutrition and behaviour (for example) might start to be more affected.

Chronic impacts considered in one scenarios included a case of death within days/months of a calf as a result of toxicity from the high levels of PCBs in milk. In this scenario it had been noted that a measure of the welfare status of a female could improve following offload of PCB burden to her calf (which can be up to 90%) but that reduced welfare could be observed in a grieving response.

For oil spills the group had used 'short' (period of oil spill itself) and 'long-term' impacts rather than acute and chronic. Inhalation and ingestion led to both short and long-term effects, with long-term effects also being observed on health and reproduction. During its discussions the group had noted the importance of the research programme on impacts of the 2010 *Deepwater Horizon* event in the Gulf of Mexico. This assessment would not have been possible without it.

Finally, the group noted that, although fairly good data existed for the scenarios used, there are significant data gaps for other species.

There was some discussion on the welfare impacts of calf mortality. It was noted that there was evidence of grieving behaviour demonstrated by mothers losing their calves (Reggente *et al.*, 2016; Simmonds, 2006).

7.3 Assessing welfare over time and cumulative impacts

The Workshop concurred with an observation by Butterworth that although the Five Domains tool presents positive and negative welfare states in binary format for ease of presentation and understanding, the reality is that animal welfare is on a continuum. Taking this into account, it was noted that ostensibly minor welfare burdens on individuals whose welfare is already compromised in other ways could reduce their overall resilience beyond their coping capacity, and that assessment of cumulative impacts was therefore important.

Earlier discussions had noted that it would be useful to consider further means of mapping welfare over a lifetime- moving from assessment of instantaneous welfare state to an assessment of overall quality of life (Yeates, 2011); and help with the examination of long-term cumulative impacts. Christine Nicol presented a model developed by Wolfensohn *et al.* (2015), which was developed to try to capture the long-term impacts on primates of being kept in laboratories for long periods. The model requires consideration of how long an animal is likely to suffer impacts from a particular welfare event. This is plotted out to look at the impact of this event over a lifespan and it provides a useful visual presentation of how welfare is affected over time. The time interval between data capture points can be decided by the average life span of the animal. Nicol suggested that this model could be modified and used to consider cetacean welfare and it most likely to be useful for particular scenarios and for the assessment of best practice. The Workshop noted a key limitation for wild animals, in that often, it is only possible to get one observation but it was acknowledged that it might be possible to make some judgment on the length of time that impacts would be suffered for compared to the lifetime. Nicol further added that there were some developing measures, such as telomere shortening that could, from one observation or biopsy sample, be developed as indicators of stress over time. Johnson offered some further observations on when different types of models might be useful. If assessing at the policy level (i.e. significance of threat and whether to take action or not) then a point in time assessment might be sufficient; but making a decision about a particular animal and whether to intervene or not (and how) e.g. a stranded or entangled animal requires some assessment of what it likely to happen to that animal in the future.

7.4 Development of a cetacean welfare assessment framework

Overall, the Workshop concluded that the Five Domains model had performed fairly well in application to the wild animal context and in the assessment of cetacean welfare threats. It was therefore considered appropriate to explore the possibility of adapting this model towards the development of a cetacean welfare assessment framework, designed for the assessment of non-hunting welfare threats.

A small group led by Bass was asked to undertake some work in the margins to develop a draft framework. The Workshop briefly discussed which of the (original) Five Domains should be included in this framework and agreed that all Five Domains should be considered. Though the Environmental Domain had been excluded from the initial testing of this framework (Item 7.1.1), it was considered that there would be some human impacts on the environment of wild animals that could be considered within this domain. The group was also asked to consider how positive welfare states of cetaceans could be reflected in the framework. A draft framework was subsequently developed by the group and modified on the basis of plenary discussion.

The draft proposed Cetacean Welfare Assessment Framework agreed by the Workshop is in Annex E. Recommendations on the further development and application of a cetacean welfare assessment framework, including on application of welfare expertise and evidence gaps can be found in Item 8.1. Recommendations on how development and application of the proposed cetacean welfare assessment framework could help to further strengthen the consideration of welfare within existing IWC programmes can be found in Item 8.2.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Development and application of a cetacean welfare assessment framework

The Workshop **agrees** that, despite some limitations in its application to wild animals, the use of the *Five Domains model for assessing welfare status* has been relevant and useful as a tool to help consider non-hunting threats to cetaceans, particularly for defined case studies and scenarios (Item 7.1 and 7.2). It **agrees** that a cetacean welfare assessment framework (adapted from the Five Domains model, and further developed by the IWC), designed for the assessment of non-hunting welfare threats, would be useful for a range of potential applications. These could include: (1) the review of welfare threats to inform the case for (or against) action; (2) informing the development of policy and mitigation strategies, including to ensure that welfare issues are appropriately addressed in conservation strategies; and (3) the development of response and rescue guidelines.

On this basis, the Workshop **recommends** that the IWC endorse the further development and application of the draft Cetacean Welfare Assessment Framework in assessing non-hunting threats to cetacean welfare and promote its use beyond the IWC (Item 7.4).

The Workshop **recommends** that further work on the assessment framework be taken forward, in particular to: (1) continue to adapt the Five Domains model for wild cetaceans; (2) address how best to assess welfare impacts and changes in welfare status over time; (3) define and incorporate potential stressors and include accepted best practice/limits (e.g. for whale watching and noise); (4) determine the most appropriate scale for scoring severity; (5) address how best to

incorporate a consideration of cumulative, in-combination effects and long-term impacts; and (6) identify any further improvements that can be made.

The Workshop thus **recommends** that Terms of Reference be drafted to guide further work to refine the assessment framework and that its refinement and application be progressed through the existing IWC Intersessional Working Group on Welfare with the aim of submission to IWC67 in 2018 for endorsement. The Workshop **recommends** that the Intersessional Correspondence Group on Welfare and the IWC Secretariat ensure that appropriate experts are engaged in the continued development and application of the assessment framework.

8.1.1 Application of welfare expertise
The Workshop **emphasises** that appropriately trained experts should be engaged in the assessment of welfare threats (Item 7.2.1). It, however, **agrees** that the results from application of the assessment framework could be useful in engaging local communities and industry in the development of mitigation options and best practice guidelines (Item 7.2.1).

The Workshop **recommends** that care be taken to ensure that the practical application of the assessment framework be assisted by appropriately trained experts, including animal welfare experts and cetacean experts and that the conclusions be shared with local communities in order to facilitate education and promote best practice.

8.1.2 Evidence gaps
The Workshop **agrees** that the assessment of welfare threats is more feasible where there is a strong evidence base. It a**cknowledges** that it was more difficult to assess the significance of, and develop appropriate mitigation strategies for threats, species and areas of the world for which there was more limited data and **agrees** that further work was necessary to address evidence gaps (Item 7.1.1).

The Workshop therefore **recommends** that consideration be given to progressing further work where uncertainty may reduce the confidence in the application of the proposed assessment framework including in relation to prey depletion, chemical pollution, anthropogenic sound, marine litter and biotoxins.

The Workshop also **recommends** that a process be established that allows for the continued re-assessment of welfare threats as knowledge and understanding improves.

8.1.3 Precautionary principle
The Workshop **notes** that it is appropriate, in some cases not to wait until the full scientific evidence is available before taking mitigation action and thus notes the value of application of the precautionary principle when assessing animal welfare and providing mitigation advice to avoid potentially poor welfare situations.

The Workshop **recommends** that in cases where the welfare implications of certain activities are only poorly understood, management of a particular activity or threat should be precautionary and adopt a risk-based approach based on best available scientific knowledge.

8.2 Strengthening the consideration of welfare across IWC work programmes
In reflecting on the use of the Five Domains model to consider welfare threats the Workshop **notes** the potential application of the tool in the development of the whale watching handbook (Item 7.2.1); and the potential for its integration into the assessment tool used by the Global Entanglement Network (Item 7.2.3). The Workshop **notes** synergies, as well as potential conflicts between conservation and welfare (Items 4.1 and 5.2), including in the context of ship strikes (Item 7.2.2). The Workshop **concludes** that the application of the Five Domains model had been valuable in order to consider welfare threats addressed by existing IWC work programmes.

The Workshop thus **agrees** that the development and application of the proposed cetacean welfare assessment framework could help to further strengthen the consideration of welfare within existing IWC programmes. The Workshop **emphasises** that this would require a greater understanding of the welfare implications for individual animals over time (including wound healing, wound progression and times to death); and of the welfare implications of disruption of normal behavioural routines and social behaviours. The Workshop **emphasises** the need for improved data collection associated with welfare threats and in particular the importance of the IWC ship strikes database in this regard (Item 6.2.1).

Thus, the Workshop r**ecommends** that the assessment framework be submitted to the Scientific Committee and other relevant IWC committees and working groups for further scrutiny and comment, and eventual transmission to the IWC Commission for endorsement.

The Workshop further **recommends** that application of the assessment framework be considered by the IWC entanglement expert group for its utility and potential addition to the existing entanglement intervention framework to enhance welfare considerations in the decision-making process.

The Workshop **recommended** that the IWC give further consideration to identifying any conservation strategies that may inadvertently compromise individual cetacean welfare and to seek solutions that optimise both welfare and conservation goals. The Workshop **recommends** the encouragement of monitoring of wound healing, wound progression, and time to death in cetaceans in the wild that have incurred vessel-strike or entanglement injuries, in order to provide greater understanding of the welfare implications for individuals.

The Workshop **recommended** that IWC Contracting Governments ensure national ship strike data, including non-lethal incidents, are submitted to the IWC Ship Strike Database and that the IWC promote the importance of submission of this data directly to the IWC database in order to develop understanding of the welfare risk to cetaceans.

The Workshop **emphasises** that, of the threats considered by the Workshop, entanglement in fishing gear is the most significant threat to wild cetacean welfare. Thus the Workshop **recommends** that IWC Contracting Governments and the IWC Secretariat place a high priority on developing effective entanglement mitigation and prevention measures, and until such time as that is developed, continue support for the palliative care offered by further developing the Global Whale Entanglement Response Network and database.

The Workshop **agrees** that more work is needed on the implications of entanglement and bycatch for small cetaceans and thus the Workshop **recommends** that the IWC conducts a detailed consideration of the welfare implications of entanglement and bycatch for small cetaceans.

8.3 Additional and emerging threats to cetacean welfare
During the Workshop participants were asked to identify any additional to cetacean welfare threats that were relevant to the work of the IWC including existing threats not sufficiently discussed at the Workshop and new and emerging threats.

The Workshop **notes** other issues of concern including biotoxins from harmful algal blooms, which may be human induced; the consequences of the repeated entrapment and release of dolphins in tuna purse seine nets; habitat loss from human activities such as mining and animal welfare implications of swim-with cetacean programmes. The Workshop **agrees** that several of these issues presented opportunities for engagement with other intergovernmental organisations (e.g. in the case of mining, with UN bodies responsible for seabed stewardship).

8.4 Engaging with other organisations and experts
The Workshop **notes** (Item 4.3) that there are a range of other international organisations engaged in efforts related to animal and cetacean welfare including OIE, OECD, FAO, EU, NAMMCO and CITES and **agrees** that it would be useful for the IWC to engage with these organisations.

In addition, the Workshop **acknowledges with gratitude** the contribution of animal welfare experts to the Workshop and **agrees** that the IWC should continue to engage these experts as this work progresses. It is noted that this is in line with action already agreed under the Welfare Action Plan (Action 4.1 *Establish and maintain appropriate and constructive links with organisations considering animal welfare, including the hunting of terrestrial animals*; Action 4.2 *Request that Contracting Governments provide information on animal welfare science experts for inclusion in the IWC external contacts database*).

The Workshop thus **recommends** that the IWC Secretariat proactively engages with organisations with a welfare remit and experts to share information and facilitate the use of existing welfare principles, standards, and definitions as appropriate, for example with the OIE, NAMMCO, and CITES.

In addition, the Workshop **recommends** that IWC Contracting Governments identify national experts in the assessment of welfare for inclusion on the list of welfare experts to be compiled under the IWC Welfare Action Plan.

8.5 Cost implications
The Workshop **emphasises** that further work to deliver the welfare action plan, and to take forward recommendations from the Workshop would have cost implications and **agrees** that it would be useful to establish these costs in order to inform budgeting processes and potential fundraising.

The Workshop **recommends** that the Secretariat provide clear cost estimates for work necessary to facilitate the delivery the IWC Welfare Action Plan, starting with the completion of the welfare assessment framework

The Workshop further **recommends** that the IWC gives consideration to the establishment of a dedicated funding stream to help progress the assessment and mitigation of non-hunting threats to cetacean welfare.

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Annex A

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Annex B

Agenda

1. Welcome and introductions

    1.1 Opening remarks

    1.2 Appointment of rapporteur(s)

    1.3 Available documents

2. Workshop aims (objectives, and focus)

    2.1 Overview

    2.2 Relationship with the IWC Welfare Action Plan

    2.3 Expected workshop outcomes and production of report

3. The regional and international context

    3.1 Understanding what we mean by 'animal welfare'

    3.2 National perspectives

    3.3 International organisations perspectives on animal welfare

4. Assessing welfare threats to wild cetaceans at the individual and population level.

    4.1 Assessing welfare status – physical, physiological, and behavioural impacts indices.

    4.2 Separating human–induced poor welfare from natural welfare challenges

5. Summary of non-hunting threats to cetacean welfare

    5.1 Entanglement in active gear and ALDFG (abandoned, lost and discarded fishing gear)

    5.2 Ship strikes

    5.3 Whalewatching

    5.4 Marine litter excluding ALDFG

    5.5 Matters related to habitat degradation

        5.1.1 Chronic and acute noise

        5.2.2 Chemical pollution (other than marine litter)

        5.2.5 Prey depletion i.e. from overfishing

        5.2.7 Climate change

6. Comparative assessment of welfare threats: discussion and group exercise

7. Reflections on day 1 – what have we missed?

8. Conclusions and recommendations

    8.1 Identification of priority advice and evidence gaps

    8.2 Recommendations (including, timescales, funding, responsible actors and collaboration)

        8.2.1 With respect to evidence/advice gaps

        8.2.2 With respect to mitigation actions

        8.3.3 With respect to updating the IWC Welfare Action Plan and a communication strategy

9. Next steps and close of workshop

Annex C

List of Documents

IWC/M16/CW/GEN

01. Information for Participants

02. Participant List

03. Draft Annotated Agenda

04. Final Agenda

IWC/M16/CW

01. Rendell, J. Non-hunting threats to cetacean welfare: identifying key issues and addressing knowledge gaps.

IWC/M16/CW/ForInfo

01. International Whaling Commission. 2016. Report of the IWC Workshop on Euthanasia Protocols to Optimise Welfare Concerns for Stranded Cetaceans, 11-13 September 2013, London, UK. *Chair's Report of the 65th Meeting of the International Whaling Commission* 2014.

03. IWC Secretariat. 2014. Addressing welfare within the IWC - Intersessional Working Group on Welfare Summary Recommendations. Paper IWC/65/WKM&AWI05rev2 presented to the 65th meeting of the International Whaling Commission, Portoroz, Slovenia, September 2014.

04. Hunt *et al.* 2013. Overcoming the challenges of studying conservation physiology in large whales: a review of available methods. *Conservation Physiology* 1: 24pp.

05. Moore, M.J. 2013. Welfare of whales by-caught in fishing gear or struck by vessels. *Animal Welfare* 22: 117-121.

06. Moore, M.J. and van der Hoop, J.M. 2012. The Painful Side of Trap and Fixed Net Fisheries: Chronic Entanglement of Large Whales. *J. Marine Biol.*

07. Rolland *et al.* 2012. Evidence that ship noise increases stress in right whales. *Proc. R. Soc. B* 279, 2,363-2,368.

08. Van Der Hoop *et al*. Assessment of Management to Mitigate Anthropogenic Effects on Large Whales. *Cons. Biol.* 27(1): 121-133.

11. D.J. Mellor and N.J. Beausoleil. 2015. Extending the Five Domains model for animal welfare assessment to incorporate positive welfare states. *Animal Welfare* 24: 241-253.

12. D.J. Mellor and N.J. Beausoleil. 2016. Updating Animal Welfare Thinking: Moving beyond the Five Freedoms; towards A Life Worth Living. *Animals* 6: 20pp.

13. Mellor, D.J. The 5 Domains Model.

16. Simmonds *et al*. Marine Noise Pollution: Increasing Recognition but Need for More Practical Action.

17. Jepson *et al*. PCB pollution continues to impact populations of Orcas and other dolphins in European waters.

18. Ayres *et al*. Distinguishing the Impacts of Inadequate Prey and Vessel Traffic on an Endangered Killer Whale (*Orcinus orca*) Population.

19. Ayres *et al*. Forecasting the consequences of climate-driven shifts in human behaviour on cetaceans.

Annex D

The 5 domains model

Extracted from Mellor and Beausoleil *Extending the five domains model for animal welfare assessment to incorpoate positive welfare states.* Animal Welfare 2015, **24**: 241-253

Physical/Functional Domains

Survival-Related Factors						Situation-Related Factors	
1: Nutrition		**2: Environment**		**3: Health**		**4: Behaviour**	
Restrictions on:	*Opportunities to:*	*Unavoidable/imposed conditions:*	*Available conditions:*	*Presence of:*	*Little or no:*	*Exercise of 'agency' impeded by:*	*'Agency' exercised via:*
Water intake	Drink enough water	Thermal extremes	Thermally tolerable	Disease: acute, chronic	Disease	Invariant, barren environment	Varied, novel, engaging
Food intake	Eat enough food	Unsuitable substrate	Suitable substrate	Injury: acute, chronic;	Injury	(ambient, physical, biotic)	environmental challenges
Food quality	Eat a balanced diet	Close confinement	Space for freer movement	husbandry mutilations		Inescapable sensory impositions	Congenial sensory inputs
Food variety	Eat a variety of foods	Atmospheric pollutants: CO₂,	Fresh air	Functional impairment:	Functional	Choices markedly restricted	Available engaging
		ammonia, dust, smoke		due to limb amputation,	impairment		choices
		Unpleasant/strong odours	Pleasant/tolerable odours	or lung, heart, vascular,		Constraints on environment-	Free movement
Voluntary overeating	Eating correct quantities	Light: inappropriate intensity	Light intensity tolerable	kidney, neural or other		focused activity	Exploration
Force-feeding		Loud/otherwise unpleasant noise	Noise exposure acceptable	problems			Foraging/hunting
				Poisons	Poisoning	Constraints on animal-to-	Bonding/reaffirming bonds
		Environmental monotony:	Normal environmental			animal interactive activity	Rearing young
		ambient, physical, lighting	variability	Obesity/leanness	Body condition		Playing
					appropriate		Sexual activity
		Unpredictable events	Predictability	Poor physical fitness:	Good fitness level	Limits on threat avoidance,	Using refuges, retreat, or
				muscle de-conditioning		escape or defensive activity	defensive attack
						Limitations on sleep/rest	Sleep/rest sufficient

Affective Experience Domain

5: Mental State							
Negative	*Positive*	*Negative*	*Positive*	*Negative*	*Positive*	*Negative*	*Positive*
Thirst	Wetting/quenching pleasures of drinking	*Forms of discomfort:* Thermal: chilling, overheating	*Forms of comfort:* Thermal	Breathlessness	Comfort of good health and high	Anger, frustration	Calmness
Hunger (general)	Pleasures of different tastes/smells	Physical: joint pain, skin irritation	Physical	Pain: many types	functional capacity	Boredom, helplessness	Engaged, in control
Hunger (salt)	Pleasure of salt taste	Physical: stiffness, muscle tension		Debility, weakness		Loneliness, isolation	Affectionate sociability
	Masticatory pleasures	Respiratory: e.g. breathlessness	Respiratory	Sickness, malaise			Maternally rewarded
Malnutrition malaise	Postprandial satiety	Olfactory	Olfactory	Nausea		Depression	Excitation/playfulness
		Auditory: impairment, pain	Auditory	Dizziness		Sexual frustration	Sexual gratification
		Visual: glare/darkness eye strain	Visual			Anxiety, fearfulness, panic, anger	
Bloated, over full	Gastrointestinal comfort			Physical exhaustion	Vitality of fitness	Neophobia	Secure/protected/confident
Gastrointestinal pain		Malaise from unnatural constancy	Variety-related comfort			Exhaustion	Likes novelty
							Energised/refreshed

Welfare Status

Annex E

Draft IWC Cetacean Welfare Assessment Framework

The Draft Cetacean Welfare Assessment Framework was proposed by the IWC Workshop to Support the Consideration of Non-Hunting Aspects of Cetacean Welfare, 3-4 May 2016. The Workshop agreed in principle that the Mellor and Beausoleil (2015) 'Five Domains Model' originally proposed by Mellor and Reid (1994) represented a useful framework through which it was possible to consider and describe the welfare of wild cetaceans in a standardised format. It was also successfully tested by the workshop as an assessment tool, through which it is possible to conduct basic appraisal and scoring of human-threat induced negative welfare states in wild cetaceans.

Within the framework Domains 1-4 list factors affecting cetacean welfare which could, potentially, be observable and/or measurable. Domain 5 takes aspects from each of these domains and infers the mental states that the animal may experience as a result of external stresses and challenges. These words are, necessarily, a surmised interpretation of cetaceans' mental states based on our own human emotional experiences. All negative domain states (listed under the red text headings) should be interpreted to mean negative states beyond animals' normal coping capacity. It is expected that a number of the factors listed are likely to be of considerably greater significance to some cetacean species, for example the complexity of, and reliance on, social groupings in certain species, and the role of social experience in early life development and learning.

Glossary of terms
Agency exercised/impeded: the ability of an animal to initiate, execute, and control its own volitional actions.

Resilient behaviour: the resilience of a behaviour refers to its susceptibility to disruption under challenging conditions. High resilience behaviours (e.g. feeding) will continue to be shown for as long as possible but low resilience behaviours (e.g. play) may be forfeited when other challenges arise. The loss of low resilience behaviours is thus a useful early marker of other challenges (e.g. Littin *et al*., 2008).

Energetic requirements: the amount of energy that is needed by an animal for cell metabolism, muscular activity, and growth.

Conspecifics: member of the same species.

Neophilic: pleasurable interest in novel conditions or objects.

References
Littin, K., Acevedo, A., Browne, W., Edgar, J., Mendl, M., Owen, D., Sherwin, C., Würbel, H., and Nicol, C. Towards humane end points: behavioural changes precede clinical signs of disease in a Huntington's disease model. *Proc. R. Soc. B*. 2008; 275: 1856–1874.

Mellor, D. J. and Reid, C. S. W. 1994. Concepts of animal wellbeing and predicting the impact of procedures on experimental animals. In R. M. Baker, G. Jenkin, and D. J. Mellor (eds.), *Improving the well-being of animals in the research environment* (3-18). Glen Osmond, Australia: Australian and New Zealand Council for the Care of Animals in Research and teaching.

Mellor, DJ., and Beausoleil, NJ. 2015. Extending the 'Five Domains' model for animal welfare assessment to incorporate positive welfare states. *Animal Welfare*. 24(3), 241-253.

An adapted version of the 5 domains model (Mellor and Reid, 1994) to guide the assessment of wild cetacean welfare as affected by human activities

Survival-related factors (potentially observable)

1. Nutrition
Restrictions on:
- Prey intake/ availability/ ability to forage, leading to energetic deficit
- Prey variety
- Prey quality (e.g. prey containing contaminants)

Opportunities to:
- Eat enough prey to meet energetic requirements
- Eat good quality prey

2. Environment
Exposure to:
- Water-borne irritants and/or toxins damaging to health
- Loud/otherwise unpleasant noise
- Other disturbance preventing optimal habitat use
- Constriction and/or confinement (e.g. entangling materials)
- Thermal stress

Available conditions:
- Noise exposure non-harming
- Contaminant exposure levels non-harming
- Availability of suitable habitats for feeding, breeding, migrating
- Full and free mobility within environment

3. Health
Presence of:
- Disease
- Injury
- Functional impairment
- Poor body condition (e.g. emaciation)
- Harmful toxin levels
- Dehydration
- Energetic burden
- Compromised respiration

Little or no:
- Disease
- Injury
- Physical impairment
- Body condition compromise
- Harmful toxin levels
- Dehydration
- Energetic deficit
- Respiration compromise

Situation-related factors (potentially observable)

4. Behaviour
Exercise of agency impeded by:
- Limitations on communications and/or interactions with conspecifics
- Loss of/separation from key members of social group
- Physical or sensory impositions interfering with ability to perceive and/or navigate environment
- Limitations on sleep/rest
- Limits on avoidance of potential threats (including predators)
- Aversive response to novel conditions
- Other alterations/limitations in behaviour that could reduce the animal's health and survival chances
- Altered activity budget, loss of low resilience behaviours

Agency exercised through:
- Congenial sensory inputs
- Free movement and habitat choice
- Sufficient opportunity for sleep/rest
- Ability to communicate and engage in social interactions (e.g. play, reproduction, mother-calf bonding, cultural transmission)
- Ability to avoid potential threats (including predators)
- Neophilic response to novel conditions

Affective experience (non-observable, interpreted via domains 1-4)

5. Mental state
Negative
- Pain from external body damage
- Pain resulting from internal disease, injury or presence of foreign matter
- Hunger
- Malaise due to disease, malnutrition and/or debilitating injury
- Anxiety/fear/panic (e.g. in response to constriction, confinement, sensory deprivation, physical disturbance)
- Isolation, loneliness, grief
- Physical exhaustion

Positive
- Comfort of good health and high functional capacity
- Postprandial satiety
- Maternally rewarded
- Calmness
- Control in behavioural choice
- Social and sexual gratification
- Excitation/playfulness
- Energised

Physical/Functional Domains

	Survival-Related Factors					Situation-Related Factors	
1: Nutrition		**2: Environment**		**3: Health**		**4: Behaviour**	
Restrictions on:	*Opportunities to:*	*Unavoidable/imposed conditions:*	*Available conditions:*	*Presence of:*	*Little or no:*	*Exercise of 'agency' impeded by:*	*'Agency' exercised via:*

Water intake
Food intake
Food quality
Food variety
 	
Voluntary overeating
Force-feeding
	Drink enough water
	Eat enough food
	Eat a balanced diet
	Eat a variety of foods
	
	Eating correct quantities
		Thermal extremes
		Unsuitable substrate
		Close confinement
		Atmospheric pollutants: CO$_2$,
		  ammonia, dust, smoke
		Unpleasant/strong odours
		Light: inappropriate intensity
		Loud/otherwise unpleasant noise
		
		Environmental monotony:
		  ambient, physical, lighting
		
		Unpredictable events
			Thermally tolerable
			Suitable substrate
			Space for freer movement
			Fresh air
			
			Pleasant/tolerable odours
			Light intensity tolerable
			Noise exposure acceptable
			
			Normal environmental
			  variability
			
			Predictability
				Disease: acute, chronic
				Injury: acute, chronic;
				  husbandry mutilations
				Functional impairment:
				  due to limb amputation,
				  or lung, heart, vascular,
				  kidney, neural or other
				  problems
				Poisons
				
				Obesity/leanness
				
				Poor physical fitness:
				  muscle de-conditioning
					Disease
					Injury
					
					Functional
					  impairment
					
					Poisoning
					
					Body condition
					  appropriate
					Good fitness level
						Invariant, barren environment
						  (ambient, physical, biotic)
						Inescapable sensory impositions
						Choices markedly restricted
						
						Constraints on environment-
						  focused activity
						
						Constraints on animal-to-
						  animal interactive activity
						
						Limits on threat avoidance,
						  escape or defensive activity
						Limitations on sleep/rest
							Varied, novel, engaging
							  environmental challenges
							Congenial sensory inputs
							Available engaging
							  choices
							Free movement
							Exploration
							Foraging/hunting
							Bonding/reaffirming bonds
							Rearing young
							Playing
							Sexual activity
							Using refuges, retreat, or
							  defensive attack
							Sleep/rest sufficient

Affective Experience Domain

	5: Mental State						
Negative	*Positive*	*Negative*	*Positive*	*Negative*	*Positive*	*Negative*	*Positive*

Thirst
 	
Hunger (general)
 	
Hunger (salt)
 	
Malnutrition malaise
 	
Bloated, over full
Gastrointestinal pain
	Wetting/quenching
	  pleasures of drinking
	Pleasures of different
	  tastes/smells
	Pleasure of salt taste
	Masticatory pleasures
	Postprandial satiety
	
	Gastrointestinal comfort
		Forms of discomfort:
		Thermal: chilling, overheating
		Physical: joint pain, skin irritation
		Physical: stiffness, muscle tension
		Respiratory: e.g. breathlessness
		Olfactory
		Auditory: impairment, pain
		Visual: glare/darkness eye strain
		
		Malaise from unnatural constancy
			Forms of comfort:
			Thermal
			Physical
			
			Respiratory
			Olfactory
			Auditory
			Visual
			
			Variety-related comfort
				Breathlessness
				Pain: many types
				Debility, weakness
				Sickness, malaise
				Nausea
				Dizziness
				
				Physical exhaustion
					Comfort of good
					  health and high
					  functional capacity
					
					Vitality of fitness
						Anger, frustration
						Boredom, helplessness
						Loneliness, isolation
						
						Depression
						Sexual frustration
						
						Anxiety, fearfulness, panic, anger
						Neophobia
						Exhaustion
							Calmness
							Engaged, in control
							Affectionate sociability
							Maternally rewarded
							Excitation/playfulness
							Sexual gratification
							
							Secure/protected/confident
							Likes novelty
							Energised/refreshed

Welfare Status

Appendix 1

Day 1 delegate exercise form

		Entanglement - Acute	Entanglement - Chronic	Ship Strikes - Acute	Ship Strikes - Chronic	Whale Watching - Acute	Whale Watching - Chronic	Marine Litter - Acute	Marine Litter - Chronic	Noise - Acute	Noise - Chronic	Chemical Pollution - Acute	Chemical Pollution - Chronic	Prey Depletion - Acute	Prey Depletion - Chronic
Nutritional domain	Food limited in quantity or quality. **Severity of welfare impact: 0 = none, 1 = minor, 2 = moderate, 3 = severe**														
Health domain	Disease, injury or impairment. **Severity of welfare impact: 0 = none, 1 = minor, 2 = moderate, 3 = severe**														
Behavioural domain	Behavioural expression restricted **Severity of welfare impact: 0 = none, 1 = minor, 2 = moderate, 3 = severe**														
Psychological domain	Negative states including: pain, hearing discomfort, panic, fear, exhaustion, hunger. **Severity of welfare impact: 0 = none, 1 = minor, 2 = moderate, 3 = severe**														
	Number of animals affected: 0 = none, 1 = few, 2 = many, 3 = most														
	Overall Confidence: 1 = Low, 2 = Medium, 3 = High														

Physical/Functional Domains							
Survival-Related Factors						*Situation-Related Factors*	
1: Nutrition		2: Environment		3: Health		4: Behaviour	
Negative	*Positive*	*Negative*	*Positive*	*Negative*	*Positive*	*Negative*	*Positive*
Restricted water & food; poor food quality	Enough water & food; balanced and varied diet	Uncomfortable or unpleasant physical features of environment	Physical environment comfortable or pleasant	Disease, injury and/or functional impairment	Healthy, fit and/or uninjured	Behavioural expression restricted	Able to express rewarding behaviours

Affective Experience Domains					
5: Mental State					
Negative Experiences			*Positive Experiences*		
Thirst	Breathlessness	Anger, frustration	Drinking pleasures	Vigour of good	Calmness, in control
Hunger	Pain	Boredom, helplessness	Taste pleasures	health & fitness	Affectionate sociability
Malnutrition malaise	Debility, weakness	Loneliness, depression	Chewing pleasures	Reward	Maternally rewarded
Chilling/overheating	Nausea, sickness	Anxiety, fearfulness	Satiety	Goal-directed	Excited playfulness
Hearing discomfort	Dizziness	Panic, exhaustion	Physical comforts	engagement	Sexually gratified

Welfare Status

Figure 1. An abbreviated version of the Five Domains Model. It summarises survival-related and situation-related factors and their associated physical/functional domains, and provides examples of negative or positive affects assigned to the mental domain. The overall affective experience in the mental domain equates to the welfare status of the animals. For full details see [37].

Appendix 2

Scenario exercise – whale watching

	Acoustic component		Proximity	Duration of interaction	Time between interactions	Number of vessels	Vessel behavior around animals	Cumulative long-term impact over lifetime
	Best / worst	Best / worst	Best / worst	Best / worst	Best / worst	Best / worst	Best / worst	Best / worst
Food limited in quantity or quality. **Severity of welfare impact: 0 = none, 1 = minor, 2 = moderate, 3 = severe**	1 3	1 1	1 3-5	1 4	1 4.5	1 4.5	1 4.5	>1 >3
Disease, injury or impairment. **Severity of welfare impact: 0 = none, 1 = minor, 2 = moderate, 3 = severe**	0 5		0 4.5	0 4	0 4	0 4	0 4	
Behavioural expression restricted **Severity of welfare impact: 0 = none, 1 = minor, 2 = moderate, 3 = severe**	2 4		1 4	1 4	1 4	1 4	1 4	
Negative states INFERRED including: pain, hearing discomfort, VIGILANCE panic, fear, exhaustion, hunger. **Severity of welfare impact: 0 = none, 1 = minor, 2 = moderate, 3 = severe**	1 4		1 4.5	1 3	1 5	1 4.5	1 4.5	
Number of animals affected: 0 = none, 1 = few, 2 = many, 3 = most	3		3	3	3	3	3	
Overall Confidence: 1 = Low, 2 = Medium, 3 = High	1	.	3	3	3	3	3	

Appendix 3

Application of the Five Domains assessment to ship strikes scenarios - Report from Workshop breakout group

The group assessed four vessel-strike cases with different temporal scales, trauma types, cetacean and likely vessel sizes. Evaluation is based on the total amount of information at the time of assessment: based on the final observed state rather than the initial observed state. A follow-up analysis of two cases at multiple time points is also included. See Figure 1 for a schematic representation of these four cases in a coordinate system for comparison.

1. North Atlantic right whale NY-2680-2001 Eg
- Scenario: large whale, likely large vessel, sharp trauma. Diagnosed cause of death from necropsy: vessel strike with 12 propeller gashes along the left side of the animal, likely involving something like brain trauma + exsanguination. Assumed time to death: minutes to less than one hour.
- Nutritional domain: 0
- Health domain: 3 – significant, severe injury, albeit with sensation for only minutes to tens of minutes.
- Behavioural domain: Not Applicable – likely no expression of any natural behaviour and no time to really exhibit any natural behaviour, simply progression to death.
- Psychological domain: 3 – debilitation, pain, panic, fear, exhaustion. Slow process of bleeding out, likely a traumatic death.

2. Bottlenose dolphin FB78 e.g. Wells et al. 2008
- Scenario: small cetacean, likely small vessel, sharp trauma. Animal survived 23+ years beyond initial wound observation.
- Nutritional domain: 1 – not an extrinsic factor of limited food quantity or quality, but a temporary loss of appetite likely at initial event. Assessed later in time, 0.
- Health domain: 1.5 – dorsal fin trauma is in the same direction as the vasculature vs. against the direction, limiting the potential of bleeding; dorsal fin is a cartilaginous tissue; likely some impact on thermoregulatory ability.
- Behavioural domain: 1 – may impact swimming ability and potential competitive ability, behavioural adjustment due to hydrodynamics.
- Psychological domain: 1 – initial acute phase likely traumatic, may have consistent pain associated with wounds, but unknown.
- Prevalence: this is of high prevalence in small coastal species, but likely low in oceanic species.

3. North Atlantic right whale Eg 2425
- Scenario: large whale, likely smaller vessel, sharp trauma. Decline observed 5 months after initial incident was documented.
- Nutritional domain: 2 – Photographs show decline in body condition
- Health: 3 – Decline in body condition and change in colour. Evidence of proliferation of orange cyamids indicative of poor health. Loss of part of caudal fin.
- Behavioural: 2 – Loss of fluke likely impacts natural locomotion.
- Psychological: 3 – Declining condition, pain, discomfort, anxiety likely result in poor psychological state.

4. Fin whale VAQS-2005-1017
- Scenario: large whale, large vessel, blunt trauma. Animal brought in to port on ship's bow with broken vertebral column.
- Nutritional: 0
- Health: 3 – severe injury with broken vertebral column and massive internal hematoma
- Behaviour: 3 – no option for free movement as entirely restrained on the bow of a vessel
- Psychological: 3 – Pain, discomfort, panic, restraint in moments that animal was alive.
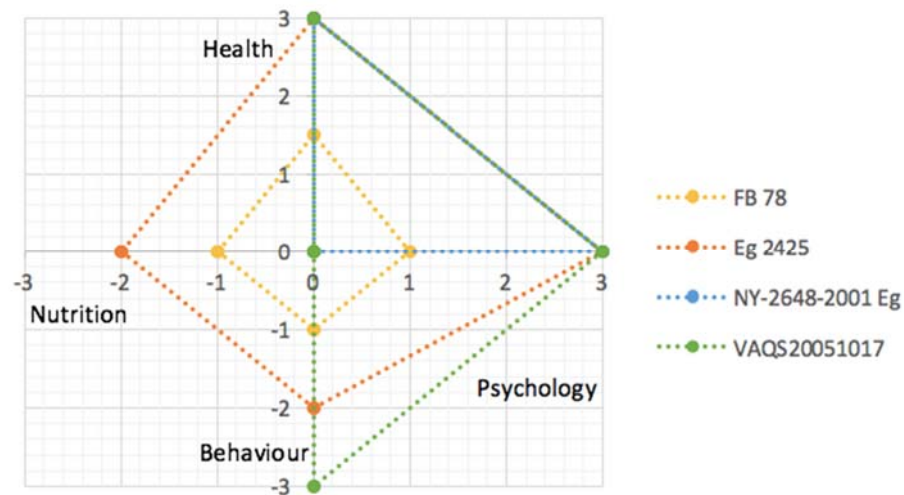
Fig. 1. Evaluation of four vessel-strike cases in the coordinate system of four specified welfare domains.

Based on available information, we were able to use this tool on two cases at multiple time points. Note that for FB78, the welfare of the animal improved through time from the acute event and over time through healing (welfare area decreased; Fig 2), while the welfare of Eg 2425 decreased (i.e. the welfare area increased; Fig 3).
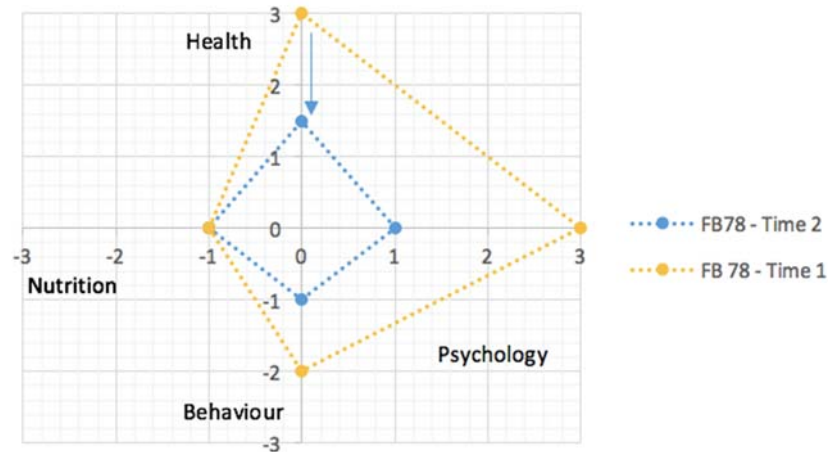

Fig. 2. Evaluation of vessel struck bottlenose dolphin FB78 at two time points. Time 1 is the initial observation of the wound on 2 July 1983; time 2 is an observation 22 years later on 8 February 2006.
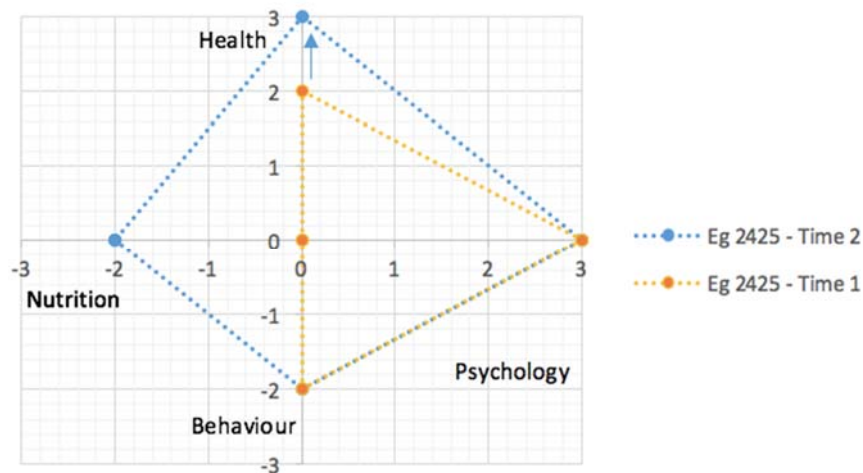

Fig. 3. Evaluation of vessel struck North Atlantic right whale Eg 2425 at two time points. Time 1 is the initial observation of the wound on 10 March 2005; time 2 is an observation 5 months later on 4 September 2005.