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WORKSHOP REPORT - INTERACTIONS BETWEEN IBERIAN KILLER WHALES AND VESSELS: MANAGEMENT RECOMMENDATIONS

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WORKSHOP

INTERACTIONS BETWEEN IBERIAN KILLER WHALES AND VESSELS: MANAGEMENT RECOMMENDATIONS

Madrid, Spain, 6–8 February 2024

EXECUTIVE SUMMARY

In response to interactions between Iberian killer whales (*Orcinus orca*) and vessels, wherein the whales ram the rudder, often damaging and even breaking it, rendering the vessel unnavigable, an international workshop, involving killer whale scientists and management authorities, was held in Madrid, Spain, on 6–8 February 2024. The Workshop was sponsored by the Spanish and Portuguese governments, with the following Terms of Reference:

(1) Exchange knowledge regarding the interactions;
(2) Identify future research needs; and
(3) Develop advice and recommendations for the Moroccan, Portuguese and Spanish governments on how to manage these interactions.

The Workshop **recommended**, in the event of an encounter, that mariners move away from the whales as quickly as possible, at least 2 to 3km from the area in which the whales were encountered, either toward the coast (in the Gulf of Cádiz and Strait of Gibraltar) or toward an area where rescue can be expedited. Moving away is not guaranteed to end the interaction or prevent damage, but may reduce the latter's likelihood. Mariners should alert authorities as soon as an encounter begins, which should help with response time for a rescue if needed.

The Workshop also **strongly recommended** that mariners encountering Iberian killer whales do not use any measures to deter whales that would almost certainly harm the whales. The Iberian killer whales are Critically Endangered on the IUCN Red List and deterrence measures that might cause immediate harm or affect long-term survival or reproduction are illegal under European Union and national laws. Several of these harmful measures have been in use at some level since interactions were first reported in the summer of 2020, and the whales continue the interactions. Thus, they are not only ineffective but may be reinforcing the behaviour and increasing the severity of damage to vessels. Some of these measures are also dangerous for mariners (e.g. firecrackers and electrocution).

In summary, the Workshop **recommended** that mariners use only methods with no impact on the whales or the environment (e.g. moving away), until research and testing, scheduled to be undertaken as soon as possible, determine the effectiveness and safety of other potential measures discussed by the Workshop (see Annex 4 of the full report).

The Workshop also **recommended** that mitigation measures that produce sound/noise, should they be authorised, be used only when needed, rather than continuously. Continuous use of any such noise-producing measures may:

(1) Reduce their effectiveness (the whales may become habituated, as they have to many other human-caused sounds in their environment);
(2) Eventually serve to attract the whales, as they learn to identify the continuous sounds/noises with vessels and rudders; and
(3) Harm the whales and other marine life (including bluefin tuna and other commercially targeted fish), as it increases the level of 'noise pollution' in the Iberian marine environment.

The effort to manage the ongoing interactions between Iberian killer whales and vessels has been, to date, primarily undertaken by the individual national authorities responsible for maritime issues. The Workshop **recommended**:

(1) Increasing international collaboration and providing consistent advice and reporting systems throughout the region, including the development of a multi-faceted communications strategy; and
(2) Establishing a small, core, international advisory group with the ability to co-opt experts (including from IGOs such as the IWC and ACCOBAMS) as necessary to provide advice to authorities should they request it on scientific and technical matters, including, *inter alia*, reviewing mitigation protocols and research projects aimed at improving the scientific basis for advice.

The Workshop highlighted the importance of fully understanding the causes of death of killer whales from this Critically Endangered population. It **recommended** improving stranding responses throughout the population's range wherever needed, to maximise the number of complete, rigorous necropsies of any stranded killer whales found. The formation of a task force with specific expertise should be considered by the national authorities, with funding made available to allow rapid response to any killer whale strandings reported. The Workshop noted that ACCOBAMS and the IWC could provide general stranding response advice.

The Workshop **strongly recommended** that all existing datasets for Iberian killer whales—e.g. for photo-identification, sightings and genetics—be consolidated and that all researchers in the region work in close cooperation and communicate frequently regarding killer whale movements and behaviour. To assist in this, the Workshop further **recommended** that the governments of Spain, Portugal, Morocco and France (if needed) solicit research proposals (and provide funding where necessary) for the following:

(1) Analysis of existing killer whale genetic samples (improve understanding of killer whale movements in relation to prey);
(2) Analysis of AIS data to get a detailed analysis on distribution of AIS-equipped vessels (to get a better understanding of whale-vessel overlap); and
(3) Improvement of understanding of inter-individual behavioural variation and movement with relation to vessels.

Finally, the Workshop **recommended** that the development of a CMP (Conservation Management Plan) for this population be considered by range states and the IWC Scientific Committee, in cooperation and consultation with ACCOBAMS. National plans should be taken into account when developing this CMP.

1. INTRODUCTION

1.1 Opening remarks and introduction of participants

Interactions[1] between killer whales (*Orcinus orca*) found off the Iberian Peninsula and vessels have been documented since at least the summer of 2020 (Esteban *et al.*, 2022; de Stephanis, pers. comm.; see Item 2.4). In many instances, whales ram the rudder, often damaging and even breaking it, rendering the vessel unnavigable, and requiring a rescue by local coast guards (Fig. 1). Since 2021, interactions have resulted in the sinking of six vessels—four sailboats and two fishing boats[2]. These interactions appear to be solely attributable to the small Iberian population of killer whales (de Stephanis *et al*., 2008; Foote *et al.*, 2011; Esteban *et al.,* 2016a; Esteban *et al.,* 2016b, Esteban *et al.*, 2022), hereafter called Iberian killer whales.

These interactions have been discussed by the IWC (International Whaling Commission) SC (Scientific Committee) since 2021. Given the serious and persistent nature of these incidents, the SC agreed, during its 2023 meeting (SC69A), that an international workshop, involving killer whale scientists and management authorities, should be organised with some urgency to assist in assessing existing, and developing additional, mitigation measures for these interactions (IWC, 2024). A Steering Committee was established to organise the Workshop (Annex 1), which was held on 6–8 February 2024 in Madrid, Spain. The Workshop was sponsored by MITECO (the Spanish Ministerio para la Transición Ecológica y el Reto Demográfico)[3], together with Portuguese authorities and under the framework of LIFE-IP INTEMARES (the EU's financial instrument to support the Integrated Project Integrated, Innovative and Participative Management of the Natura 2000 Network in the Marine Environment)[4]. Logistical support was provided by Fundación Biodiversidad[5] and SEASHORE Environment and Fauna[6].

The Terms of Reference for the Workshop were to:

(1) Exchange knowledge regarding the interactions;
(2) Identify future research needs; and
(3) Develop advice and recommendations for the Moroccan, Portuguese and Spanish governments on how to manage these interactions.

The Workshop participants (Annex 1) were welcomed by Víctor Gutiérrez, Conservation and Restoration project manager at Fundación Biodiversidad, and by Spain's Commissioner to the IWC, Fernando Magdaleno, Deputy Director of Terrestrial and Marine Biodiversity at MITECO. They expressed their hope that the Workshop would produce constructive advice and recommendations for the relevant research, management and mariner[7] communities. Elvira García-Bellido, Head of the Marine Protected Species Unit of the Deputy Directorate on Terrestrial and Marine Biodiversity at MITECO, also welcomed the participants, describing the planning process for the Workshop.

1.2 Election of chair and appointment of rapporteur

Zerbini was elected chair and Rose was appointed rapporteur, with input from Donovan.

Zerbini provided a short overview of the structure of the IWC and the SC, and explained the process by which advice would be provided. The Workshop report, once agreed by all participants, will be reviewed at the 2024 IWC SC meeting (SC69B, to be held from 22 April–3 May in Bled, Slovenia). The SC may endorse the Workshop report and accept or modify the recommendations for inclusion in the SC report. The SC report will be considered at IWC69, the Commission's meeting in September 2024. The Commission is the decision-making body of the IWC and endorsement of recommendations in the SC

[1] In this context, the definition of 'interaction' is when a vessel encounters Iberian killer whales and the whales voluntarily approach the vessel, spending some period of time in close association with the vessel, *with or without* contact. The persistence and frequency of 'with contact' interactions distinguishes these encounters from those observed outside of the Iberian region.
[2] https://www.orcaiberica.org/en/interacciones-registradas
[3] Ministry for Ecological Transition and Demographic Challenge
[4] https://intemares.es/en/ and https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE15-IPE-ES-000012/integrated-innovative-and-participatory-management-for-n2000-network-in-the-marine-environment
[5] https://fundacion-biodiversidad.es/en/
[6] https://www.instagram.com/seashorefauna/?hl=en
[7] In this context, 'mariner' refers to members of the public aboard vessels involved in interactions, which are primarily recreational.

report will constitute formal advice to the relevant contracting governments.

1.3 Adoption of agenda

The agenda as adopted is provided in Annex 2.

1.4 Review of available documents

The formal presentations made during the Workshop are available upon request, as slide shows or written summaries, and the list of presentations (KW/MF24/01–21) is provided in Annex 3.

2. BACKGROUND

2.1 Biology, demography and status of Iberian killer whales

Esteban (KW/MF24/02) presented estimates of demographic parameters of the Iberian killer whale population between 2011 and 2023. The population is listed as Critically Endangered by the IUCN (International Union for Conservation of Nature)[8] due to low numbers, high neonate mortality and the status of its preferred prey, the Atlantic bluefin tuna (*Thunnus thynnus*), which was considered endangered in 2019 at the time of the Iberian killer whale's Red Listing[9]. Demographic research has involved photo-ID (photo-identification) from whale watching vessels and other platforms of opportunity. Abundance, survival, and reproductive and population growth rates were estimated through mark-recapture models. The abundance of Iberian killer whales was stable from 2011 to 2023, with an estimated 37 individuals in 2023. Survival rates for calves have increased since the early 2000s, but adult survival, particularly for females, has decreased. Reproductive rates were low, with an estimated inter-birth interval of 8.3 years (95% CI: 4.1–18.3 yrs). The overall population growth rate has been slightly positive (1.005 [95% CI: 0.964–1.045]). Esteban emphasised the need for long-term monitoring and highlighted that, although food shortages are no longer an issue after the recovery of bluefin tuna in the region, fisheries still pose a threat, through entanglements and fisher reactions to depredating whales (the whales depredating the longlines is an ongoing situation in Iberian waters; de Stephanis *et al*., 2008; Esteban *et al.*, 2016a—see also Item 4.1.1). In addition, a new potential threat is the use of electric currents (a 'tuna stunner') to stun fish on longlines, which could potentially electrocute the whales[10]. Several whales—four juveniles, five adults and two indeterminate—have stranded in the region between 2011 and 2023, although cause of death has been difficult to determine in most cases (see Items 2.3.3 and 5). The future of the population depends on survival and recruitment of juveniles and the survival of reproductive females. Continuous monitoring is crucial for conservation efforts.

In discussion, it was noted that, although attempts to make genetic matches between stranded individuals in this region have been made to assist in population modelling via known deaths, such efforts have not been rigorous, perhaps hindered by a lack of funding. Other data, such as stable isotopes, have not yet been collected, but would be helpful in assigning stranded animals to this population. Whilst recognising that the data were from platforms of opportunity, serious concern was expressed at the apparent decline in the number of reproductive females over the examined period. The overall lack of population growth is also a concern, although habitat carrying capacity is unknown.

In conclusion, the Workshop **agreed** that the low absolute abundance and the decrease in adult female survival rates were of serious concern, given the variety of direct and indirect threats facing the whales and their habitat. Aggressive responses by some mariners to interactions with Iberian killer whales (Items 2.4, 4.3 and Table 1) are a new, important threat that emphasises the need to find practical solutions to the issue as soon as possible. The Workshop also **stressed** the need to analyse the existing genetic material in a timely manner.

De Stephanis (KW/MF24/03) presented an overview of long-term studies of killer whales in the Gulf of Cádiz and the Strait of Gibraltar undertaken by CIRCE (Conservation Information and Research on

[8] https://www.iucnredlist.org/species/132948040/132949669

[9] The Atlantic bluefin tuna was downlisted on the Red List of the IUCN in 2021, from 'endangered' to 'least concern'—see https://www.iucnredlist.org/species/21860/46913402—after ICCAT (the International Commission for the Conservation of Atlantic Tuna) put measures in place to recover the species.

[10] Esteban noted that it is not clear if the new tuna stunner is used when killer whales are depredating the longlines, nor are the fishers who use them forthcoming about the voltage.

Cetaceans) since 1996. Approximately 1 000 000km of on-water effort have resulted in approximately 1000 sightings, and over 200 000 analysed dorsal fin photographs. The photo-ID catalogue, through 2023, contained 88 individuals, of which approximately 40 are believed to be alive (36 were sighted in 2023). Six Spot-6 satellite tags have been deployed. Sixteen biopsies have been collected for genetic, contaminants and diet analyses. Two major groups of killer whales have been identified. Little is known about one group (called 'Vegas'). The other is the population known as Iberian killer whales, which feeds exclusively on bluefin tuna. This population comprises about 30–40 individuals, according to mark-recapture analyses still under review, and has remained relatively stable over time. However, between 2005 and 2011, an alarming decrease in the availability of tuna was observed, followed by near-zero survival rates for calves (Esteban *et al*., 2016a). The killer whales are mainly found in waters between 30 and 200m in depth, with occasional observations in deeper waters, apparently linked to the presence of tuna fishing vessels (often associated with depredation). They are seen mostly between February and July in the waters off Barbate and environs (Fig. 2), dispersing from July to various other locations, including Belle Île in France, Brest, waters off Cap Breton, Galicia (northwest region of Spain), the entire Portuguese coast, and the Strait of Gibraltar. These killer whales previously employed a resistance-exhaustion (pursuit) foraging technique, chasing tuna at high speed to induce exhaustion to facilitate capture (Guinet *et al.*, 2007). More recently, observations indicate these pursuits no longer last for up to 30min, but rather only 2–3min.

In discussion, it was noted that the change in foraging strategy may be the result of bluefin tuna recovery—the increased presence of tuna could allow the whales to expend less effort than during the period 2005–2011, when there were fewer tuna. In addition, climate change could be playing a role, leading to these tuna being in the Gulf of Cádiz continuously rather than seasonally. This year-round abundance means that there appears to no longer be a need for the whales to pursue every fish encountered.

The Workshop noted that, although the presentations on demographics and population dynamics provided valuable background on the status of the population and added impetus to finding mitigation approaches that will not harm whales whilst safeguarding mariners, the details were not central to the ToR of the Workshop (Item 1.1). However, the Workshop **stressed** that the status of the Iberian killer whales was an important topic in itself, which warrants integration and consolidation of datasets (especially of photo-ID catalogues and genetic data) and combined modelling approaches. See Item 5.2.5 for further discussion and recommendations.

2.2 Interactions between killer whales and vessels

2.2.1 Iberian Peninsula

Esteban (KW/MF24/05) presented data on the most recent interactions between Iberian killer whales and vessels. At least 673 interactions have been documented since the first was reported in May 2020. Data sources were diverse; 19 vessels were directly inspected and crews completed 171 questionnaires. Since March 2023, an app has been available to report interactions, developed by the GTOA (Grupo de Trabajo Orca Atlántica). For the remaining vessels, there was no direct communication with the crew; instead, information was gathered from press releases, social media or competent authorities. Reported interactions occurred primarily (93%) on the Iberian Peninsula's Atlantic coast, but there were records in the surrounding areas (France to Morocco). Interactions lasted on average for 25 minutes, although some lasted for up to two hours. Interactions were reported throughout the year, but most (48%) were concentrated June–September. Whilst more recreational boats are at sea during this period, these are also the typical months when the Iberian killer whales are observed in the region. A few interactions were reported to occur at night, but most (78%) were during the day (10:00–20:00hrs). The vessels most frequently approached (80%) were medium-length sailboats (typically <12m, range 5–38m). However, fishing boats, RIBs (rigid-hulled inflatable boats) and motorboats were also approached. The whales focused most on spade rudders, found only on sailboats. Vessels involved in interactions were travelling an average of 6kn prior to the interaction, under sail and under power. Not all interactions have ended in vessel damage. Most of the damaged boats were sailboats, with some fishing vessels. RIBs and motorboats were usually undamaged; whale behaviour was similar with these types of vessels, but they

have no, or different types of, rudders and can move away at some speed. In total, 15 individual whales have been identified from photographs obtained during interactions. The animals were normally found in four separate groups, but sometimes they were observed together during interactions, mostly in the Strait of Gibraltar and Gulf of Cádiz.

In discussion, it was suggested that the use of vessels other than sailboats <12m for any vessel-involved experimental protocols might render interpretation of the results problematic. In response, it was noted that choice of vessel for the experimental protocols is important but must also incorporate practicality. Provided that the experiments are well-designed and with sufficient sample sizes, the results, analysed with appropriate statistical techniques, can provide valuable insights into the issue. Restricting the experimental procedure only to vulnerable vessels may reduce sample size and increase potential biases arising out of damage to the vulnerable vessels. Use of less vulnerable vessels might enhance identification of successful resolution strategies. An ideal approach might use multiple experimental strategies with respect to vessels. A pilot survey was suggested, for crews and individual mariners involved in interactions, in an effort to determine what triggers or discourages this behaviour. For example, when approached by whales, are the vessels using their depth sounders? If they are, might this sound be disruptive to the whales, leading to a reaction (see Burnham *et al.*, 2022)? No pattern is presently obvious.

A brief discussion followed, regarding the reliability of self-reporting by mariners, including, for example, whether mariners did or did not follow the suggested vessel response protocol devised by the relevant authorities and the GTOA[11] (hereafter 'response protocol'). GTOA representatives attending the Workshop felt overall that mariner self-reporting was reliable for the first two years, as mariners had an incentive to cooperate with authorities, as all parties worked to extinguish this behaviour. There are now different reporting apps and platforms, but, given the response protocol was not effective in all cases, mariners are not reporting as often. Information on interactions has therefore become more difficult to obtain. However, it is important that, with regard to mitigation actions, mariners report even when an action is *not* effective, to assist with refining mitigation guidance. It was noted that other aspects of the response protocol, such as the directive to take one's hands off the wheel if whales contact the vessel, help mariners avoid injury, but do not seem to be effective at stopping the interaction. It was also noted that, if some interactions without damage to the vessels are not reported, self-reporting could lead to bias toward more severe cases.

There was discussion of individual whale motivation for this behaviour, in which those familiar with the region noted that in the recent past, when bluefin tuna were at low numbers, the whales were preoccupied with finding and capturing sufficient prey. Now, with bluefin recovery, perhaps these whales, especially the juveniles, have more leisure to explore novel behaviours. Similarly, depredation may occur when prey abundance is low—this high-risk behaviour has the obvious reward of food when nutritional reserves are low. In other areas, such as the northeast Pacific, depredation is rare, but tends to occur in late winter, early spring, when the whales are food stressed (Ford, personal observation). Once salmon, the main prey of killer whales in the northeast Pacific, return to the region to spawn, depredation stops. It was suggested that depredation occurs when food sharing amongst the whales does not provide sufficient nutrition. Incentive for this risky behaviour may be high when fishing lines have caught large, high-fat-content prey.

It was noted that there were insufficient data to determine how interacting with vessels spread through the population. There seems to be no correlation between the individual whales that interact with vessels and the injuries they do or do not bear. In response to a question, it was noted that the whales target all types of rudders, including metal ones, which in some cases they have bent. To date, weather and water conditions do not seem to affect the likelihood of an interaction occurring, but are related to the problems a vessel may experience if an interaction occurs.

[11] https://www.orcaiberica.org/en/recomendaciones

There was further discussion about examining factors that may have influenced the redistribution of interactions or indeed may be triggering factors for the behaviour; for example, Galicia seems to have more interactions in some years than others. It would be valuable to assess what (if anything) changes in this area to explain these fluctuations in occurrence. Perhaps surrounding human activities influence the likelihood of an interaction occurring. It was also suggested that these changes might not be a case of spatial redistribution of interactions but rather a learning curve, such that mariners avoid interactions, reduce or avoid damage when interactions occur or even experience fewer interactions. It is key to understanding this situation to know what people are doing that may be influencing the whales in either direction (increased or decreased interactions or impacts). If these co-factors could be identified, effective mitigation measures might be more easily identified. It was noted that any analyses should take into account that, since March 2023, Spanish authorities no longer recommend stopping the boat, whilst at the same time most vessels had begun crossing Barbate Bay in shallow water, closer to the coast. These may have been factors in the reduction of interactions observed in the Strait of Gibraltar. Another potentially fruitful question is whether AIS data could help determine if interactions are highly correlated with boat distribution. Any correlation with prey density or with longline vessels actively fishing for tuna would also be helpful in designing effective mitigation strategies.

At this point, the concern was first raised that, if the Workshop makes recommendations for mitigation measures that do not work or at least do not work reliably or consistently, all of the Workshop's advice might lose credibility. It was noted that this is certainly a risk, but a directed, well-designed communications campaign (see Items 3.2, 4.4, 5 and Annex 4(A)[12]) could reduce this risk.

A discussion followed regarding the use of mitigation that could potentially be harmful to the whales, such as certain acoustic deterrents[13]. It was noted that some of these types of deterrents, such as oikomi pipes (metal pipes under the waterline that are struck to make a banging noise, used in some cetacean hunts to herd animals toward shore and which most cetaceans move away from; Items 2.3.2, 2.3.4, 4.1.3, 5 and Annex 4(B)) or TAST (targeted acoustic startle technology; Items 2.3.4, 4.2, 5 and Annex 4(B)), are unlikely to harm the whales' hearing. Other non-harmful acoustic devices, such as pingers (also known as acoustic deterrent devices or ADDs, a pinger is typically a small cylindrical device, often used in fisheries, which emits a sound and is meant to alert marine mammals, including cetaceans, to the presence of nets or lines)[14], are being tested, but the concern here is that the whales might habituate to such sounds (see, e.g. Tixier *et al.*, 2014). The concern was also raised that mariners, despite directives to the contrary, might use acoustic devices continuously or far more frequently than needed, potentially displacing killer whales from important feeding areas.

It was noted that, in some cases, whales had focused on sailboats towing dinghies and had contact with the dinghy, although some rudders were still damaged. The dinghy, in essence, served (at least temporarily) as a decoy or distraction. An obvious test would be to see if something similar, readily accessible, inexpensive and easy to carry on a sailboat, such as a buoy or fender, might distract the whales' attention away from the rudder (Item 4.5 and Annex 4(B)).

2.2.2 Caribbean Sea

Bolaños (KW/MF24/04) presented on interactions between killer whales and vessels in the Caribbean Sea. For the period 1851–2023, 405 records of killer whale presence in the Caribbean have been found in the literature and elsewhere (Bolaños-Jiménez *et al.*, 2023—the dataset has been updated since this publication to include 20 additional records). Some of the new presence records included interactions with boats and with FADs (fish aggregating devices). The locations of these six interactions included Colombia (n = 1), Venezuela (n = 3), the Dominican Republic (n = 1) and Puerto Rico (n = 1). These interactions involved close approaches by killer whales, including physical contact between the whales and the boat or engine; killer whales feeding around FADs at the same time that fishers were fishing; and

[12] The purpose and content of Annex 4 is fully explained in Item 4.5 and Annex 4.

[13] A 'deterrent' in this context is anything that causes a whale to move away from, or not to approach, an object (e.g. fishing line, net, vessel). This may be because the noise is aversive or simply because it alerts the animal to the object's presence.

[14] More powerful deterrents, classified as acoustic harassment devices, may cause pain or injury to marine mammals and are not under consideration here.

whale movements close enough to the boats to frighten the crew. In four cases, there was physical contact and the crew referred to these interactions as 'attacks'. Vessel types included one sailboat, one sport fishing boat, and four small, artisanal fishing boats (two of fibreglass and two of wood). A seventh case was reported that included damage to the rudder of a catamaran near Bequia, St Vincent and the Grenadines, but the crew could not positively identify the species involved. This is an emerging topic in this region, with only a few cases reported; therefore, information is insufficient to properly define these interactions. For now, it is advisable to prepare an educational campaign on safety at sea during these 'closer encounters', based on the model developed by the GTOA for the Iberian Peninsula.

In discussion, it was noted that the interactions observed in the Caribbean differ in degree from what is happening in Iberia. The frequency and percentage of interactions that involve physical contact are two orders of magnitude lower in the Caribbean. Nevertheless, the possibility of an interaction that damages vessels exists and mariners should be alerted. Bolaños noted that he had no hypothesis for why these physical interactions occur, but wondered if it was accidental, when whales were foraging in the area occupied by vessels. The researchers are developing an ethogram for the Caribbean interactions, to be presented at SC69B. The ethogram aims to describe the behaviours, recorded with good quality videos, seen during closer encounters in the Dominican Republic and Puerto Rico, in order to better understand the nature of the interactions. It was noted that it was important to record the type of vessel involved in these interactions, and what it was doing just prior to, and during, the interaction.

2.3 Overview of management actions to date by competent authorities

See Item 2.3.4 for discussion of the following three Items.

2.3.1 Spain

García-Bellido (KW/MF24/01) provided background on how Spanish authorities had been addressing vessel interactions off the coast of Spain, particularly in the Gulf of Cádiz and Strait of Gibraltar and off Galicia. The killer whale is included in various international and national conventions (e.g. CMS [Convention on Migratory Species]; ACCOBAMS [Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area]; the IUCN; the Barcelona Convention [the Convention for the Protection of the Mediterranean Sea]; OSPAR [the Convention for the Protection of the Marine Environment of the North-East Atlantic]). In EU legislation, this species is included in the Habitats Directive and Marine Strategy Framework Directive. At the Spanish national level, the Iberian killer whale is protected under Law 42/2007, on Natural Heritage and Biodiversity; the List of Wild Species under Special Protection Regime; Royal Decree 1727/2007, which establishes protection measures for cetaceans; Ministerial Order APM/427/2017, which approves protection measures; and the Conservation Plan for the killer whales of the Strait of Gibraltar and Gulf of Cádiz. Since interactions were first reported in 2020, MITECO has put in place various different collaborative and cooperative initiatives, at the international and national level. At the international level, MITECO notified the IWC Secretariat of these interactions in 2020 and asked for its advice. At the national level, MITECO proposed to MITMA (Ministry of Transportation) a limit on the navigation of sailboats <15m in length off Galicia. In addition, MITECO contracted a report from GTOA-CEMMA (Coordinadoria para o Estudo dos Mamíferos Mariños) to collect information about the interactions (e.g. types of vessels involved, locations), and also monitored for killer whales from sea plane overflights off Galicia.

García-Bellido (KW/MF24/08) further reported that, in 2021, MITECO proposed that MITMA limit the navigation of the same type of vessel, this time in the Gulf of Cádiz. MITECO also contracted GTOA-CEMMA to design a pilot project for the prevention and management of these interactions. It also launched a public contract for satellite tagging six killer whales during the next summer season. In 2022, MITECO contracted CIRCE to study the interactions and test mitigation in the Strait of Gibraltar and the Gulf of Cádiz. However, killer whales left this area in mid-July. For this reason, no tags were deployed and the pilot project could not proceed. In May 2023, the first satellite tagging was carried out. Maps showing areas of varying probability of an interaction with killer whales were designed and published by MITECO-MITMA, based on the telemetry data (see, e.g. Fig. 2).

Sánchez (KW/MF24/11), representing SEPRONA (the Environmental Protection Service) from the Guardia Civil in Spain, presented on SEPRONA's management actions. SEPRONA is the special body dedicated to enforcing environmental laws and inspecting and investigating environmental issues in the national territory of Spain. It includes UCOMA (Central Investigation Unit), which deals with coordination at the national level and with the most complex investigations affecting different provinces or with international connections. It also has Regional Units, which act as a first response to wildlife offences, animal abuse, food fraud, waste trafficking, illegal dumping and forest fires. Finally, the Guardia Civil has the Maritime Service, a special unit that deals with any kind of legal breach in Spanish waters.

Within this framework, a protocol for collaboration has been established between the Guardia Civil and MITECO, which aims to:

(1) Coordinate activities for marine biodiversity protection at a strategic level;
(2) Develop joint national plans and campaigns;
(3) Carry out training activities;
(4) Collaborate in stranding cases; and
(5) Exchange operational information for further criminal investigations.

In August 2023, a video recording an interaction between killer whales and a sailboat was circulated through social media. The crew of the vessel shot flares at the whales, which a recreational whale watching vessel observed and recorded. The rapid exchange of information between the Guardia Civil and MITECO led to the detection of the boat as it reached the port of Almerimar, in the province of Almeria. Therefore, the perpetrators were identified and a judicial file was opened. This enforcement action against the crew shooting flares is ongoing and an update will be provided at SC69B, if possible.

2.3.2 Portugal

Geraldes Dias (KW/MF24/09) presented a summary of actions undertaken by the Portuguese Navy. Given the increasing number of interactions between killer whales and vessels, the Navy established a working group with the Portuguese Maritime Authority and the ICNF (Institute for Conservation of Nature and Forests). This working group has undertaken several actions. It has:

(1) Established a procedure to issue navigational warnings that killer whales are present in an area;
(2) Ensured the readiness of operational teams at locations with a high probability of killer whale interactions, to support mariners;
(3) Facilitated rapid updates to the response protocol in the event of a killer whale encounter;
(4) Established an inter-ministerial framework to determine a course of action with an emphasis on navigational safety;
(5) Invested in the development of low-cost ADDs; and
(6) Developed specific geospatial information exchange tools.

In the future, these additional actions are planned:

(1) Collaboration between all interested parties to standardise practices and guidelines, so there is uniformity in the response protocol followed by mariners;
(2) Development of prototypes of oikomi pipes, to be distributed to Sines and Sesimbra Maritime Police, enabling operational teams to intervene in areas with the highest interaction rates; and
(3) Approval of legislation to better regulate and avoid the use of potentially harmful deterrent methods (e.g. firecrackers), which may be increasing uncontrollably.

Geraldes Dias also described the plan for testing oikomi pipes in Portuguese waters, to demonstrate proof of concept as an effective and non-harmful mitigation measure. He discussed the development of information workflow, as well as dashboards and apps for data input, output and sharing. The Navy is addressing some concerns to improve data integrity and completeness; i.e. using a standardised data model, developing standardised forms, reducing the number of data input methods, encouraging data sharing and using geospatial standards for data outputs.

Sequeira (KW/MF24/10) described measures taken by other Portuguese authorities. A technical workshop was held in Lisbon in March 2023, jointly organized by Portugal's ICNF and the Portuguese Navy to, *inter alia*:

(1) Provide updates on information collected from mariners involved in interactions;
(2) Collect information on actions taken by mariners involved in interactions;
(3) Discuss possible ways forward/solutions; and
(4) Develop recommendations for authorities, including
    (a) All killer whale sightings and/or interactions should be reported;
    (b) These data should be forwarded to the MRCC (Marine Rescue Coordination Centre) and an alert/notice to mariners should be issued immediately;
    (c) ICNF and the Portuguese Navy should work together to develop a research programme on acoustic deterrents and innovative mitigation methods; and
    (d) The response protocol should remain in place with minor revisions, including
        (i) Stop the engine (if sea state allows);
        (ii) Lower sails;
        (iii) Turn off all electronic equipment; and
        (iv) 'Play dead' (remain quiet and motionless).

2.3.3 Morocco

Masski (KW/MF24/12) reported that, prior to 2010, research on cetaceans in Morocco was limited, with scarce data from scientific cruises. To address this gap, a strandings database was compiled from various sources, documenting 205 events between 1980 and 2009, ranging from one to 32 strandings per year. However, this number was deemed an underestimate for Morocco's extensive coastline. The INRH (National Institute of Fisheries Research), charged with monitoring strandings, recognised the need for a national monitoring network to gather robust data. A three-year consultation with the government institutions began in 2015, accompanied by the development of identification guides and capacity-building efforts involving focal points identified in INRH research centres. This has led to increased awareness, reflected in an increase in the number of annual strandings reported, from 93 to 143 over the period 2015–2022. Additionally, necropsies were systematised in the Casablanca region. To expand these efforts, a necropsy capacity-building program was launched post-2018. ACCOBAMS supported these initiatives. Improving stranding detection efficiency remains a priority, alongside establishing a legal framework for strandings monitoring. Challenges persist in enhancing cooperation with academic institutions and NGOs, but such cooperation will undoubtedly contribute to improved monitoring.

2.3.4 Discussion of management actions

In discussion of Items 2.3.1–2.3.3, it was clarified that an exclusion zone off Galicia, based on where interactions had occurred, was effective, but would be difficult to implement throughout the entire Iberian region (which covers a vast area of maritime traffic). It was noted that AIS data would be helpful in monitoring exclusion zones, should they be established, although it was also noted that not all the boat types involved in these interactions have AIS systems on board. There was discussion about the pros and cons of exclusion zones; for example, if whale watching vessels are excluded, then opportunities to collect data from these platforms of opportunity, including photographs for the catalogues, could be lost. It was suggested that adaptive management, creating temporary exclusion zones, which are advisory rather than mandatory, could be attempted. Mariners would have strong incentive to avoid areas where the likelihood of an interaction is higher.

It was noted that several oikomi pipes have already been produced by the Portuguese Navy and are ready to be tested once the killer whales are again in Portuguese waters (Item 4.5 and Annex 4(B)). It was clarified that the pipes would first be tested for effectiveness before widespread deployment. If proven effective, they would initially be used by Portuguese enforcement officials, but could eventually be made more widely available. It was also clarified that data are being shared across national boundaries. Concern was expressed about the possibility that some mariners would gladly try the pipes, whilst others might not; Geraldes Dias replied that personal information would not be stored if and when the pipes are

distributed, to encourage mariner cooperation. Some concern was expressed at the potential misuse of acoustic devices and the need was stressed for appropriate testing and assessment of impacts on killer whale vital behaviour and distribution before competent authorities approve any such methods.

The Workshop **agreed** that effective efforts at addressing these vessel-whale interactions requires international cooperation, between such bodies as the IWC and ACCOBAMS (see Items 5.1.3 and 5.2), coordinating with national actions.

It was suggested that the directives in the response protocol to stop the engine/lower sails and 'play dead' may need to be revisited, at least in some areas (such as the Gulf of Cádiz, Item 2.4; see Item 5 for further discussion). It was further noted that, in 2022, ICNF issued a recommendation to whale watching companies not to approach killer whales in Iberian waters. In 2023, this was upgraded to an interdiction. In December 2023, Iberian killer whales were placed on the Portuguese Red Data List.

An acoustic device, known as TAST (Items 4.2, 5 and Annex 4(B)), originally developed by researchers at St Andrews University to deter killer whales from Norwegian purse seiners, will also be tested in Portuguese waters. It was suggested that any research protocol for TAST should be reviewed (by an advisory group; see Item 5.2.3) before field testing begins. The results obtained in the Norwegian fishery have been promising and the device is not harmful, making it a good candidate for testing with the Iberian killer whales. The need for caution before approving any acoustic devices was reiterated (and see Items 4.5 and 5).

It was noted that the team responding to strandings in Morocco comprises only four people. It was emphasised that necropsies should be undertaken by specialists to ensure consistency and comparability with results elsewhere. However, Masski explained that, in Morocco to date, necropsies are performed for ecological studies rather than for veterinary reasons and thus the Moroccan team can rarely provide a reliable cause of death. He also noted that the increase in reported strandings after 2015 was due to improved communication throughout the stranding network (i.e. probably a result of increased effort rather than increased strandings). Masski was encouraged to provide information on all Moroccan strandings data to the SC. There was a brief discussion of the ACCOBAMS Stranding Task Force, which is deployed when 'important' strandings occur within the ACCOBAMS region, noting that Morocco may wish to call upon this task force in the future (Item 5.2.4).

In light of the Critically Endangered status of this population, serious concerns were raised about the complete absence of conclusive results (or even presumptive diagnoses) for any of the four dead strandings found since the incidents began. Without complete necropsies conducted by veterinary pathologists, obtaining robust diagnoses is challenging if not impossible. This is particularly concerning given the reports of the use of dangerous 'deterrents' (e.g. firecrackers) used by some mariners during interactions (Table 1). Reliable information regarding cause of death could be critical in any criminal or court proceedings. To address these issues, the Workshop **stressed** the value of establishing a formal task force, comprising specialised experts, including accredited veterinary pathologists experienced with not only cetaceans in general but killer whales in particular. In addition, the identification of accredited laboratories for sample analysis is vital to provide competent authorities with swift access to experts and facilities, ensuring an effective response when dealing with any stranded killer whales (see Item 5.2.4).

2.4 Summary of mitigation research undertaken to date

De Stephanis (KW/MF24/06) presented on the history and behaviour of killer whales during the period 1998–2023, highlighting fluctuations in their population and changes in their interaction with vessels. Between 1998 and 2005, few calves were observed, with a marked decline in this age class between 2005 and 2011 (Esteban *et al.*, 2016a), linked to the scarcity of bluefin tuna. A 'baby boom' occurred in 2011, a year also marking a significant change in the whales' behaviour. Before 2011, Iberian killer whales were difficult to approach, likely due to negative interactions with fisheries in the 1980s and 1990s. However, since 2011, they are more approachable, which may be associated with the presence of juveniles without siblings and the increased number of whale watching vessels (versus fishing boats), as well as CIRCE's research vessel.

In discussion, it was noted that many killer whale (and other cetacean) populations engage in 'prop watching' behaviour (placing their head near the propeller wash); this behaviour should not be included in the definition of 'interaction'. It is possible contacting the rudder evolved from 'prop watching', but no other killer whale population has taken the 'next step', to damaging and destroying the rudder. The idea arose again, with wider agreement, that this behaviour may have evolved because the whales, for the first time in a couple of generations, are well-fed, have leisure time and experience reduced negative interactions with fisheries. However, it was also noted that the number of juveniles, which are typically the most curious and exploratory in killer whale populations, increased well before this behaviour arose. It was suggested that some level of playful interactions began earlier with young juveniles (ca. 2017), although these initial interactions did not result in rudder damage. This playful behaviour may have escalated as the animals grew older.

It was further noted that these same killer whales have associated with small-scale fishing vessels for decades in Morocco, without damaging them. It was suggested that perhaps the rudders of these Moroccan vessels are not as interesting to the whales.

Killer whales are known to play with other objects or animals in their environment to the point of damaging them (in the southern resident killer whale population of Washington, USA, which feed on salmon, individuals will 'play' with harbour porpoises to the point of killing them, which may be a similar escalation of an initially less harmful interaction), so this behaviour seems on that spectrum.

The question was raised as to whether the response protocol is effective. If it works sometimes (but not always), it seems imperative to assess what factors might influence this. For example, if fishing is occurring in an area, one strategy may be effective but another may not. At this point, it was noted that multiple mitigation measures and response strategies are likely to be necessary to effectively reduce the number of interactions in Iberia. The whales may habituate to any one method, whilst alternating methods may retain their effectiveness. There was general consensus that more research on the response protocol, its use, its effectiveness (or lack thereof) and what surrounding factors may influence any differences in effectiveness should be pursued. For example, if effort by the whale to reach a vessel is minimal, is an interaction more likely to occur? Do the animals actively seek vessel interactions or are they purely opportunistic? There are insufficient or no data at present to address these questions (and see below).

De Stephanis (KW/MF24/07) summarised the results from research conducted on mitigation measures to minimise killer whale-vessel interactions in the Strait of Gibraltar, under the LIFE-IP-PAF INTEMARES project (LIFE 15 IPE ES 012). The research considered three key strategies: (1) avoiding encounters with killer whales; (2) minimising damage in case of an interaction; and (3) extinguishing the behaviour. Heat maps were generated, using satellite tagging and mariner reporting of whale locations (Fig. 2). In the Strait, <1% of sailboats experience interactions; nevertheless, it is important to know where the animals are to seek alternative routes. These maps have proven effective, as encounter rates declined (based on mariner reports) between May 2020 and June 2023. Vessels moving closer to the coast, where water depth is shallower (avoiding deep water in the Strait, which whales prefer) has also reduced interactions.

De Stephanis further summarised that models have helped to better understand killer whale responses, suggesting that vessels traveling more than 2km from the original encounter location generally result in the killer whales discontinuing pursuit of the vessels, returning to the point where the interaction began. This is consistent with killer whales tending to remain within a 3km radius during short periods in the Strait, meaning that, in this area, it is more effective to move away from an interaction, as quickly as possible, at least 2–3km, than to stop the vessel (as the current response protocol suggests—see footnote 11). Moreover, moving away gives the whales less time to 'aim' for the rudder, which may reduce the force of impact. Apart from these measures, tests have been carried out with pingers and pilot whale playbacks, with mixed results. Pingers were not effective, as killer whales approached the device on all occasions. Pilot whale playbacks were more effective, but might cause killer whales to leave favourable foraging areas for up to several days. On the other hand, if they habituate to the playbacks, they might cease to respond to actual pilot whales. These two possibilities raise ethical and conservation concerns.

Finally, with regard to extinguishing this behaviour, de Stephanis (KW/MF24/18) described 'Orcamyst'. These are conical protuberances of 1.5cm on the hull and keel of sailboats, an innovative approach to deterring killer whales from interacting with vessels (Fig. 3). The whales typically ram the rudders at the base of the blade. The hypothesis is that these protuberances would alter the whales' perception of the rudder and thus their behaviour toward boats, eventually extinguishing these interactions. Preliminary results are promising. In conclusion, the measures presented seek to balance mariner safety with protecting the whales from harm, promoting coexistence.

In discussion, it was noted that additional detail regarding the methodology used in the Orcamyst study and the study's results would be helpful. It was clarified that the killer whales did break several experimental rudders. No data were collected on what the surrounding human activities were, so whether such activities influence the likelihood of an interaction is still not clear. It was suggested that any future research protocols investigating this situation should record potential influencing factors, especially human activities, in the surrounding area (see Item 2.2.1 and below).

A number of viewpoints were expressed that were taken forward into the discussion of immediate advice and future work under Items 3–5. Below is a summary of questions (several noted above) that arose during the discussion of presentations under Item 2 but were not necessarily answered at the Workshop:

(1) What is going on in the surrounding environment (a detailed list of parameters to look for)[15]?
(2) What, if anything, is the trigger for an interaction?
(3) Are there actions that can mitigate the severity of the interaction?
(4) If an interaction occurs, how can a mariner reduce the probability that their rudder will be damaged?
(5) In what season should a mariner sail?
(6) From the animal's point of view, what is the reward for this behaviour (i.e. with depredation, it is food. What is it when they approach and interact with vessels?)?
(7) Can the balance be changed, without causing harm, between what is gratifying to the animals and what is costly?

3. IDENTIFICATION OF PATTERNS IN, AND CONTRIBUTING FACTORS TO, INTERACTIONS, AND DISCUSSION OF POSSIBLE CAUSES

See Item 3.2 for discussion of the following three presentations.

3.1 Presentations

Ford (KW/MF24/13) presented on the cultural traditions, fads and idiosyncrasies of northeast Pacific killer whales, in an effort to offer insight into the Iberian killer whales' interactions with vessels. Killer whale behaviours are largely determined by social learning—these are best described as cultural traditions. Different populations often have distinct dietary specialisations that are maintained by cultural transmission, and these 'ecotypes' typically have a variety of persistent behavioural traditions that are related to their divergent foraging. Some populations may also develop unusual and temporary behavioural 'fads' and other idiosyncrasies that do not appear to serve any obvious adaptive purpose. Understanding the recent boat interactions by Iberian killer whales may benefit from an examination of such ephemeral traditions in other well-studied killer whale populations. In coastal waters of the Northeast Pacific, the salmon-feeding resident killer whale ecotype is split into two populations—northern and southern—which do not mix despite overlapping ranges. Although these two populations are similar ecologically and behaviourally, each has some unique traditions. Whilst some of these have persisted for at least 50 years (i.e. since annual field studies began), others suddenly developed but did not persist (fads). For example, the habit of carrying dead salmon on the whales' heads arose and spread widely amongst southern residents in the summer of 1987 but disappeared soon thereafter. It reappeared in the summer of 2008, but then disappeared once again. A similar case involving the brief appearance, disappearance, reappearance after 20 years and then disappearance of a behaviour

[15] Several parameters related to questions 1–3 were provided to MITECO by GTOA-CEMMA, as a starting point for the contracted study conducted by CIRCE (this Item).

occurred in northern residents, with the ritualised ramming or butting of heads between pairs of subadult and adult males. It may be that the current fixation of Iberian killer whales with boats, and particularly their rudders, is such an ephemeral fad and that, should it suddenly cease, it might reappear at a later date.

Guinet (KW/MF24/15) presented on behavioural transmission in killer whales. This occurs through two processes. Vertical transmission (from the mother or experienced individuals to the young in a group) is probably the mechanism for risky or complex behaviours that take some time to learn, e.g. acoustic repertoire, foraging locations and foraging techniques (such as the intentional stranding observed in Crozet killer whales; Guinet *et al.*, 1995). Horizontal transmission (imitation within a group) is an efficient mechanism for rapidly propagating new but less complex behaviours, such as fads, depredation or probably the vessel interactions seen in Iberian killer whales. Neophobia (fear of the new) and neophilia (innovation) are both seen in killer whales throughout the world. The balance between these two varies amongst individuals according to their age, sex and personality. Juveniles tend to exhibit a higher degree of neophilia than adults, but personality leads to large differences in their openness to new experiences (curious versus cautious). If neophilia is high in some individuals within a small population, then diffusion of innovation is also likely to be high.

Guinet speculated that killer whale-boat interactions are probably self-reinforcing, perhaps originating as 'trophy games' by bold individuals and then spreading through horizontal learning. Operant conditioning using reinforcement (positive and negative) (Skinner, 2014) could be critical in maintaining, modifying or extinguishing these behaviours, suggesting strategies that could assist in reducing their frequency. The least reinforcing scenario, i.e. when there is no response to, or no opportunity for, a behaviour (Skinner, 2014), should decrease or extinguish this undesired behaviour. However, this will require consistent application amongst all mariners. Such strategies to reduce the 'reward' killer whales perceive from this behaviour include, *inter alia*, (1) avoiding areas or seasons of high(er) encounter probability (Item 2.3.4 and Annex 4(A)), and (2) making rudders less attractive through physical modifications (Item 2.4 and Annex 4(B)). A multidisciplinary and ethical approach to the complex issue of understanding and managing interactions between killer whales and vessels is needed, recognising the importance of cultural transmission, behavioural plasticity and operant conditioning principles.

Deecke (KW/MF24/19) presented on understanding how specific behaviours arise in wildlife. The work of Tinbergen (1963) provides a useful approach to understanding proximate (repertoires of individuals over their life span) and ultimate (repertoires of populations and species over evolutionary time) aspects of behaviour. Proximate aspects are mechanisms (stimuli and processes that trigger and control behaviour) linked to development (ontogenetic change), whereas ultimate aspects consider function (fitness consequences of behaviour) and evolution (phylogenetic and evolutionary change). This framework has been useful in understanding and resolving a range of human-wildlife conflict and can be applied to the Iberian killer whale situation. Sound is a primary sensory system of odontocetes, and thus acoustic stimuli (e.g. engine noise, depth sounders) likely play a role in initiating and shaping these interactions. However, other sensory cues such as vision (e.g. shape and colour of the hull or rudder), touch (e.g. propeller wash, texture of the hull and rudder) and olfactory and electromagnetic cues also need to be considered. In addition, the factors that control the motivation for individuals to initiate and persist with such interactions need to be identified.

With respect to developmental aspects, present knowledge (see Item 2.2.1) suggests a bias toward juvenile individuals. Questions of function need to consider the fitness consequences of boat interactions, both in terms of survival (probability of injuries or death, reduction in foraging success) and reproductive success (loss of calves, reduction in mating opportunities). Potential or actual fitness consequences of proposed mitigation measures are particularly important. Evolutionary aspects include the interactions of killer whales with other cetacean species, e.g. frequent interactions with long-finned pilot whales (*Globicephala melas*; see KW/MF24/16, Item 4.1.2). These may have selected for specific personality traits in Iberian killer whales, and behaviour patterns involved in interactions with large whales (e.g. biting of pectoral fins and flukes) may have been transferred onto boats. The acoustic similarity of many depth

sounders to odontocete echolocation should also be considered here. A full consideration of the mechanistic, developmental, functional and evolutionary aspects of the interactions of Iberian killer whales with vessels may help identify knowledge gaps on which to focus future research, but also inform effective decision-making in the short-term.

3.2 Discussion

Discussion of these three presentations focussed on the killer whales' likely motivation(s) for the interactions and how this and knowledge of general killer whale behaviour might provide insights into potential mitigation strategies (Item 4) in the light of the need for timely advice. It was noted that the behaviour was first reported after the lockdown (arising from the COVID-19 pandemic). The Workshop considered the hypothesis that a change in the Iberian soundscape may have triggered the behaviour to be difficult to assess. It was noted that GTOA-CEMMA (KW/MF24/05) and CIRCE have done preliminary analyses of AIS data, to examine potential correlations amongst changes in vessel traffic and the emergence of the behaviour—results will be forthcoming.

In light of the available observations and reports on the interactions (Item 2.2.1) and the presentations here, the Workshop **concluded** that there was no evidence that the interactions between Iberian killer whales and vessels are aggressive on the whales' part (Item 5.1.1). The behaviour has more in common with fads seen elsewhere and seems associated with play or socialising, perhaps encouraged by the recent increased abundance and availability of prey—reducing the time needed for foraging—and by the reduction in negative interactions with fisheries. The use of words such as 'aggression' or 'attack' to describe such interactions is thus inappropriate. Despite this, the Workshop **recognised** that this behaviour is often frightening for mariners and results in actual damage to rudders and even the sinking of vessels on occasion. Whatever the motivation of the whales, it is therefore imperative to provide timely advice to mariners on actions they might take to avoid interactions or minimise the impact should they occur. This is a major conclusion of the Workshop (Item 5.1.1) and the Workshop **agreed** that it is essential to develop a professionally elaborated strategy to communicate this to the media and public (Items 4.5, 5.1.3 and Annex 4(A)).

Further discussion of mitigation measures can be found under Item 4.5. The general lessons learned from the presentations and discussion under the present Item are summarised below:

(1) In the longer-term, the objective of mitigation approaches is to assist in eliminating or at least minimising the 'satisfaction' or reward the whales obtain from this behaviour, in an effort to extinguish it. The most effective way to minimise satisfaction is, of course, to keep whales and vulnerable vessels away from each other and the Workshop **agreed** that this should be the primary mitigation approach (Items 4.4, 5.1.3 and Annex 4). This, whilst unlikely to be completely achievable, can be maximised by providing advice to mariners on areas/times to avoid based upon our best knowledge of Iberian killer whale geographical and temporal distribution (see Item 5.1.3 and Annex 5)[16]. However, recognising that these are highly mobile animals in a changing environment, the Workshop **agreed** that there must be advice to mariners on strategies to follow when interactions occur, which prioritise the safety of mariners and the welfare of the whales, whilst minimising the whales' satisfaction (see Items 4, 5, Fig. 4 and Annex 4).

(2) Whales are complex wild animals and thus can be unpredictable, at least from a human perspective. For example, the same individuals may exhibit different behaviours under different conditions and different individuals may exhibit different behaviours under the same conditions—thus no advice can be perfectly effective. In addition, experience elsewhere has shown that fads may reappear, sometimes after a long absence. Therefore, any effective advice may not be permanently so. A more reasonable objective of mitigation measures and advice is to considerably reduce the probability of unfavourable encounters and improve the safety of mariners. Proper recording of interactions (positive or negative) will allow suggested mitigation measures to be evaluated and improved. Importantly, any measures that may potentially adversely affect whales (e.g. acoustic devices, modifications to rudders; see Annex 4) from this

[16] If available, this may be supplemented by near real-time information on whale occurrence (Item 4.5)

Critically Endangered population must be in accord with legislation and ethical guidelines and thoroughly evaluated in well-designed scientific experimental situations (Items 4 and 5).

(3) Knowledge of killer whales' sensory capabilities, their neophobia and neophilia and an understanding of transmission mechanisms can assist in designing mitigation approaches that reduce or eliminate the satisfaction individuals gain from interacting with vessels and their rudders. As elaborated under Items 2.4, 3.1 and 4, this may include rudder modifications (to either protect it or make it unpleasant to a whale), distractions (e.g. providing a stimulus away from the vessel more attractive to a whale than the rudder—the whales have been seen playing with rudder pieces once it breaks and leaving the vessel) or deterrents (a stimulus, perhaps acoustic, that has a stronger negative component than the attraction of the rudder, provided it has no lasting adverse effects). Given the whales' motivation is not related to survival or reproduction, perhaps mildly uncomfortable deterrents would work.

(4) Interactions have been reported since 2020; therefore, it is essential to provide clear, updated, practical advice now (within current legal guidelines), specifying any limitations such as those in (2), whilst simultaneously undertaking research to improve this advice, including the development and testing of new mitigation measures (see Items 4 and 5 and Annex 4).

(5) Changing mariners' behaviour, whilst not necessarily easy, is probably easier, especially in the short-term, than changing whales' behaviour. Mariners have a strong economic and safety incentive to do something effective, as they wish to avoid vessel damage or sinking. It is essential that the advice provided by authorities (see Item 5.1.3 and Annex 4(A)) is communicated in a professional, clear manner, using as many educational and informational tools as possible. This advice should target all relevant stakeholders, including mariners crewing potentially vulnerable vessels, holiday companies, harbourmasters and on-water officials (who need to learn and understand what is happening and what they are enforcing and why).

4. MANAGEMENT AND MITIGATION

4.1 International experience relevant to killer whale deterrence

4.1.1 Depredation and deterrence in the Southern Ocean

Tixier (KW/MF24/14) presented on killer whale depredation and mitigation in the Southern Ocean. Through an international cross-sectoral collaboration, an inter-disciplinary research project has been implemented to assess, understand and mitigate killer whale depredation on catches by the toothfish (*Dissostichus* spp.) longline fisheries operating in southern Chile, the southwest Atlantic, South Georgia and Marion/Prince Edward, Crozet, Kerguelen and Heard/McDonald islands. From long-term observation and photo-ID data collected by fishery observers, paired with tracking, isotopic and acoustic data collected during dedicated trips, the results showed that (1) killer whale depredation levels vary spatially, affect a considerable number of longlines (up to 40% in some areas) and result in the removal of >180 tons of fish per year at Crozet and (2) the behaviour was initiated by at least three distinct killer whale ecotypes ('regulars', Type-B2 and Type-D). At Crozet, the extensive photo-ID data collected since the 1980s indicated large intra-population heterogeneity in the depredation behaviour, with about 22% (5/23) of the known groups involved in >70% of depredation events. Toothfish is an important natural prey item for these killer whales, which likely co-occur with the fishery in areas of high toothfish densities.

At South Georgia, telemetry data showed that killer whales can follow fishing vessels for distances >100km. Vessels' acoustic signatures and the way fishers use their engine probably influence the whales' ability to detect vessels. From these findings, recommendations were made to fishers on how to adjust their fishing practices to minimise both the likelihood of depredation occurring (e.g. avoiding areas of high depredation risk, reducing the noise they produce) and the number of fish removed when depredation cannot be avoided (e.g. reduce the soaking and hauling times, move distances >100km). Whilst the testing of technological solutions to depredation has shown limited effectiveness, efforts continue with fish protection devices and acoustic systems providing real-time information on the presence of whales. In parallel, a project has recently started on understanding and potentially changing fishers' perceptions of killer whales, in an effort to increase acceptance of this 'cost of doing business'.

In discussion, potential lessons from managing depredation were noted for the Iberian situation, recognising that these interactions differ from depredation, primarily with respect to understanding the whales' motivation (food is an obvious motivator, but the motivation to ram rudders is less clear; see Items 2.2.1 and 3.2) and the extensive commercial element of a high seas fishery (as opposed to private mariners), with an established regulatory framework. Managing private owners and crews is more challenging (see Items 3.2 and 5).

The issue of whales detecting and following the fishing vessels by sound was raised in the context of whether it might provide insights into the Iberian situation. It was clarified that the characteristic(s) of the sounds made by fishing vessels that might be attracting whales in the Southern Ocean are not well understood, although work is ongoing both in terms of sound propagation modelling and experimental studies (use of acoustic tags on whales to measure received levels is difficult as a practical matter in these seas). There is evidence that whales can detect such vessels at distances of up to 30km; however, some sound characteristics can travel up to 100km from the source, at levels killer whales may hear. These fishing vessels are completely different from the vessels involved in the Iberian killer whale interactions. The fishers believe back-hauling the lines is the 'dinner bell'. It was suggested that PAM (passive acoustic monitoring) for whale vocalisations might be used to alert fishers, but this depends on the whales being vocally active, which is not always the case here or elsewhere. It was noted that southern resident killer whales in the Northeast Pacific pass hydrophones about 30% of the time without being detected.

4.1.2 Killer whale and long-finned pilot whale interactions in Iceland

Samarra (KW/MF24/16) presented on interactions[17] between killer whales and long-finned pilot whales in the Westman Islands of Iceland, and the possible role of acoustic cues in the context of whether this might prove useful in developing acoustic deterrents for Iberian killer whales. Sightings of pilot whales became more frequent from 2014 in the Westmans (Selbmann *et al.*, 2022). Interactions between the two species have also been observed in the coastal waters of Norway and in the Strait of Gibraltar. Interactions were common (70% of observation time) in Icelandic waters when both species were in the same area. As has been reported in other North Atlantic areas, the interactions appeared to be antagonistic. Off the Westmans, the killer whales often avoided pilot whales by moving away (68% of the time), sometimes fleeing at high speed (28%), with both species porpoising. Interactions could be complex, involving several approaches but also tolerance. The hypothesis that the relative group sizes of the two species may play a role in triggering different types of responses by killer whales requires additional data to be properly tested. The factors driving these interactions are unknown, but may involve anti-predator mobbing behaviour by pilot whales, as described for the Strait of Gibraltar (de Stephanis *et al.*, 2014). Killer whales appear to detect pilot whales acoustically at large distances and respond to their approaches before they can be detected visually, suggesting that acoustic cues play an important role in these interactions. To test this, playback experiments are being conducted, with pilot whale sounds recorded during natural approaches being directed to suction cup-tagged killer whales. Preliminary results suggest killer whales may avoid pilot whale sounds, but further analyses are underway.

In discussion, it was noted that the Westman Island killer whales are mostly herring feeders, but that mixed-diet ecotypes (killer whales that feed on fish and marine mammals) may also occur there. A 1987 observation of aggressive behaviour by killer whales and a probable kill of a pilot whale reported off Iceland (Donovan *et al.*, 1989) more likely involved an ecotype that at least occasionally feeds on mammals. The intermittent but increasing occurrence of pilot whales off the Westman Islands (there have been some pilot whale mass strandings in other Icelandic regions) may be associated with an increase in mackerel abundance. If pilot whales are focussing on mackerel, then it is unlikely there is competition for prey with killer whales feeding on herring. In further discussion of the potential value of playing pilot whale sounds to deter killer whales, Samarra reported that the limited playback experiments thus far have not induced porpoising in killer whales, although they moved away. Habituation was not tested, as the researchers tried not to do playbacks with the same whales more than once.

[17] In this context, 'interaction' means when the two cetacean species are in the same area and approach or move away from each other or otherwise behave in response to the other's presence (versus show no reaction to the other's presence).

4.1.3 Killer whale deterrence in the face of oil spills in Washington, USA

Noviello (KW/MF24/17) presented on efforts in Washington, USA, to prepare for deterring killer whales from oil spills in state waters. For over 15 years, the oil spill team of the WDFW (Washington State Department of Fish and Wildlife) has worked with the US National Oceanic and Atmospheric Administration, the US Coast Guard and SeaDoc Society/University of California at Davis to develop a plan to use active deterrence to keep endangered southern resident killer whales (SRKWs) away from oil spills. A variety of potential deterrence techniques were evaluated; low flying helicopters, underwater firecrackers and oikomi pipes were preapproved for use during oil spills. Following lessons learned during the August 2022 diesel oil spill from a sunken fishing vessel in central SRKW territory[18], where killer whales were observed to dive under the pipes and remain submerged for a long distance, rather than turning around as desired in an oil spill situation, a SRKW Task Force is identifying ways to improve the efficacy of deterrents and actively look for more effective methods that would solve logistical issues for rapid deployment and reduce the risk of habituation. Better trained, equipped and strategically deployed deterrence teams, along with new methods such as underwater playback of a deterrence signal, are being considered. For the specific problem of Iberian killer whales damaging vessels, low flying helicopters appear impractical for a variety of reasons, including cost, availability and the hazards of low flight near sailboats with tall masts. Underwater firecrackers are not recommended because of the risk of injury to the whales (see Items 2.3.4, 5.2.2 and Table 1). In the northeast Pacific, they are not recommended within 50m of the whales and it is likely that boats attempting this method in Iberia would have whales closer than that distance. Noviello suggested several possible deterrence methods for Iberia, including authorising at-risk vessels to use oikomi pipes, hull mounted or towed ADDs or the louder and more invasive acoustic harassment devices (see footnote 14, Item 4.5 and Annex 4(B)), as well as the possible creation of a low-cost system to play back a repertoire of deterrence signals, including, *inter alia*, pilot whale calls.

In discussion, Noviello noted that only limited research had been undertaken to date on the most effective size/diameter/material of oikomi pipe. The WDFW has used pipes that are 8 feet (2.5m) in length and he noted that the pipes used in drive hunts in Japan are longer still. The WDFW does intend to test different sizes/types of pipes, which the Portuguese Navy is also doing (Item 2.3.2). The shortest effective length would be the most practical for private mariners.

In further discussion about possible mitigation measures, the concept of the hukilau—a series of weighted, vertical lines hanging in the water column, used for fishing in Polynesia—was raised (Items 3.1, 5, Annex 4(B) and Fig. 5). Whales will not swim through these lines in situations where an effort is being made to herd the animals in a particular direction (e.g. when they are entrapped near shore and will not head toward open water without assistance; Jourdain *et al.*, 2021). The Workshop **agreed** that hukilaus could potentially be deployed from vessels on demand (or even, with some innovation, continuously, at least when under sail) and might prove effective at deterring killer whales from interacting with a vessel's rudder. See Item 4.5 for further discussion on this point.

In closing, concern was expressed that the whales might be permanently excluded from areas where deterrents are in regular use. However, the intent is to use approved methods only when whales have already approached a vessel, not continuously in an effort to exclude whales from the vessel's vicinity. This is as much because continuous use might lead to habituation as because it might lead to total exclusion of the whales.

4.2 Identification of possible new mitigation measures

Götz (KW/MF24/20) presented on a new ADD. ADDs often lose effectiveness over time, as habituation, a decrease in responsiveness to the signal, can be a significant problem in contexts where food motivation is involved (Götz *et al.*, 2010; 2013). TAST[19] provides an alternative by activating the acoustic startle response, which is mediated by an autonomous reflex arc in the brainstem. In experimental studies, repeated elicitation of the startle reflex led to an increase in flight and avoidance behaviour in the

[18] https://www.fisheries.noaa.gov/feature-story/coordinated-response-protected-southern-residents-sunken-ship-leaking-oil
[19] Targeted acoustic startle technology, https://genuswave.com/technology/

majority of tested seals (Götz *et al.*, 2011; 2015). This approach only requires low noise doses by using brief, isolated sound signals emitted at low duty cycles. Target-specificity can be achieved by choosing a frequency band in which hearing sensitivity of a species is higher than in non-target species (Götz *et al.*, 2016).

The method has been successful in keeping seals away from fish farms, whilst not adversely affecting the behaviour and distribution of harbour porpoise (Götz and Janik, 2015). In long-term trials, it has reduced farmed salmon depredation by seals by 91–97% and, in inshore gillnet fisheries, it led to a 74% increase in catch in protected nets (MMO, 2020). The startle reflex can also be elicited in odontocetes by using a different, mid or high-frequency signal that falls in a frequency band where these species are either equally sensitive or more sensitive than seals (Götz *et al.*, 2020). TAST can therefore be used in applications where odontocetes are the target species and successful deterrence has been demonstrated in several species in the wild using a duty cycle as low as 0.6% (Hiley *et al.*, 2021). In the latest series of experiments, TAST deterred killer whales from purse seine nets, resulting in a >92% reduction of surface activity close to the net. TAST constitutes a novel approach for deterring animals from confined areas whilst minimising noise and limiting effects to a small area where received levels are above the startle threshold. TAST is in production for pinniped and odontocete applications. New devices with smaller transducers are currently in development.

In discussion, it was clarified that sound propagation of the startle signal is still being quantified. It is likely the signal level drops below the startle threshold within 80m. There was discussion about the reliability of determining the underwater positions of a cetacean based only upon surface activity. Götz reported that one whale was tagged and that animal did move out of the area after being exposed to the signal, which was consistent with the surface activity data. In Norway, where testing will continue, more tags will be deployed. A question arose about use of the system (which is hull-mounted) when a vessel is underway. In reply, it was noted that the 'tow fish' is exposed to bubbles from the propeller, which affects sound propagation, but under sail, it would be less of a problem. The researchers will seek to quantify this and might test the system in Portugal first from a power boat (see Items 2.3.2 and 2.3.4).

Götz explained that the cost per unit will be determined by the manufacturer once a commercial prototype is developed and production costs can be estimated, but the aim is to develop a model that is affordable to mariners. An advantage of the system is that it can be used only when needed, and it might reduce the reward/satisfaction of 'playing' with rudders and contribute to elimination of the behaviour over time even without it being present on all vessels. The whales targeted in the initial testing of the device began to avoid the research boat, which is of course the goal in Iberia. Ultimately, effectiveness and cost will determine its acceptance by the mariner community. Götz emphasised that habituation is unlikely with this device, as the response to the signal is involuntary. The possibility of hundreds, if not thousands, of vessels potentially carrying the device and targeting a very small population of whales was raised. It was clarified that the intended use would be 'as needed', not continuous, meaning any particular individuals would only be exposed during an approach to a vessel. An alternative might be to use them continuously but at a very low duty cycle, e.g. 5%. As for other 'active' mitigation measures, controlling or restricting their use may provide a formidable regulatory challenge and requires careful consideration.

The Workshop noted the potential advantages of the TAST approach over other acoustic deterrent/harassment approaches and looked forward to the results of further testing, recognising the importance of investigating the implications of the widespread use of *any* acoustic devices in the region before making recommendations on their broader use (e.g. by mariners) in this context.

4.3 Mariners' actions to date

The Workshop **recognised** that mariners are already using deterrent methods in an effort to stop whales from interacting with their vessels, mostly without success (based on data through early 2024[20]). The Workshop **stressed** that most of these methods are illegal under EU law, as they have high potential to harm these Critically Endangered whales, as well as unproven. The Workshop **agreed** that any

[20] See https://www.orcaiberica.org/en/interacciones-registradas.

communications plan must emphasise the illegality and unproven nature of non-approved mitigation measures. To date, mariners are known or believed to have used a number of methods (with at least one crew, which fired flares at killer whales, under investigation by Spanish authorities; Item 2.3.1), as presented in Table 1.

4.4 Evaluation of feasibility and effectiveness of mitigation measures

The Workshop **agreed** that providing clear advice on mitigation strategies involving wild, unpredictable animals is difficult, especially where there are data gaps. As noted under Item 1.1, these interactions were first reported in 2020. It is therefore essential to provide clear, updated, practical advice now (within current legal guidelines), specifying any limitations and uncertainties, such as those described in Item 3.2(2). This should occur simultaneously with research to improve this advice, including the development and testing of new mitigation measures (see Items 4 and 5 and Annex 4).

The Workshop **reiterated** that the most effective mitigation measure is to keep whales and vulnerable vessels away from each other. It reemphasised its discussions and conclusions on this provided under Item 3.2(1) on how this can best be achieved with a combination of spatial and temporal analyses of past data from a variety of sources (see Item 5.1.3, Annex 4(A) and Annex 5). Near real-time data of sightings should be transmitted where available; PAM may also assist in identifying hotspots. Advice on hotspots to mariners must be clear and emphasise useful navigation features such as depth, as well as geographic location, where possible. The importance of an effective communications plan directed to key stakeholders (Item 3.2(5) and Annex 4(A)) is also reemphasised here. Any plan should include a process for explaining, wherever the interaction frequency declines, *why* it has declined, where appropriate—i.e. it is not random but due to changes in mariner behaviour or the effective use of mitigation measures.

Any mitigation advice requires changes to mariners' behaviour (either voluntarily, or, if deemed necessary, by regulation). Competent authorities should be involved in determining and communicating a mitigation measure's effectiveness (or lack thereof), overseeing its implementation. This includes being part of any communications campaign. They are also responsible for enforcement if mariners use unapproved, potentially harmful mitigation measures (Item 4.3 and Table 1).

The Workshop **recognised** that the data from the Gulf of Cádiz are more extensive than from other locations. Therefore, the existing data analyses, and the general distribution of the whales away from the coast, are sufficient to provide reliable advice to mariners (Item 4.5, Annex 4(A) and Fig. 2) on how to considerably reduce the likelihood of interactions. However, other areas along the coast of the Iberian Peninsula have fewer data and developing reliable advice on geographical and temporal hotspots is more difficult and, until further data become available and the analyses outlined in phase (2) of Annex 5 are completed, use of tools such as smartphone apps and maritime communications networks to provide reliable, near real-time whale sightings could help vulnerable vessels seek alternative routes around whale hotspots (Item 4.5 and Annex 4(A)). However, whilst the behaviour persists in the population, interactions will occur and advice must be provided.

In the light of discussions under Items 2.4 and 3.2 and some of the measures already being used by some mariners (Item 4.3 and Table 1), the Workshop **stressed** that any rudder modifications must be carefully evaluated to ensure that they do not directly harm whales. In addition, it was noted that mariners would probably be reluctant to use methods that might permanently affect the handling of the vessel. The Workshop **agreed** that there was thus merit in developing approaches that modified the rudder (or the area around the rudder) as needed, rather than permanently.

With respect to the use of sharp objects (such as knives and spikes—see Item 4.3 and Table 1), the Workshop noted that they have the potential to harm individual whales, perhaps seriously. This is illegal under EU and national laws. Therefore, if rudders are to be modified, small protuberances would be more appropriate; any modifications to rudders should be designed to ensure that they are not injurious but merely uncomfortable. However, it was also noted that any measure related to modifying the rudder could encourage mariners to attempt harmful modifications, such as knives. It was emphasised that killer whales do not tend to hurt themselves; they are careful animals that in some populations perform risky

foraging behaviours (Item 3.1) mastered after long developmental periods. Pointed (not sharp) conical protuberances on the rudder are a passive modification that offers the whales a choice to interact or not; this may be sufficient to extinguish the behaviour by decreasing the reward (satisfaction) associated with these interactions. This is likely to be facilitated by the fact there is no food (or energy) reward associated with this behaviour. Further field testing of Orcamyst (Item 2.4) will be undertaken in the coming season, after development of stringent experimental protocols. It was **agreed** that any mitigation measure that has the potential to harm or displace whales will need careful testing following rigorous research protocols, to ensure that any approved methods are consistent with the law, effective and not harmful (Item 4.5).

In an ideal world, there would be a simple strategy for mariners to follow when killer whales interact, which would avoid vessel damage and harm to the whales. Unfortunately, there appears to be no such panacea, as discussed under Item 3.2. There are no unequivocal data to show that, for example, staying still or moving away is the 'better' strategy to avoid rudder damage. What is better may vary with, *inter alia*, geographical location and the behavioural state of individual animals. What seems clear is that, from a safety perspective, it is broadly better to be within easier reach of rescuers should rescue be needed. Thus, depending on conditions, moving towards shore or a port is a reasonable strategy. This means that mariners should be advised to alert competent authorities immediately when an interaction begins. The value of developing a system for standard incident reporting is discussed under Items 4.5 and 5.1.3. In the Gulf of Cádiz, the evidence is that killer whales are not found in shallow waters close to the coast (Item 2.4), so advice to move to the coast is particularly pertinent. There is evidence that killer whales will not continue with an interaction more than 2–3km from where it starts in the Gulf of Cádiz, so again moving away at least this distance has some merit, although for slow-moving vessels, this can be sufficient time for damage to occur.

The Workshop **agreed** that advice for mariners must always explain its limitations; this is developed further under Item 5.1.3. Emphasis must be placed on both the safety of the mariners and the safety of these Critically Endangered animals.

It was noted that in Portugal, authorities advise mariners that any guidance is not always effective and to check before leaving port for information on killer whale sightings. Also, mariners are told that if they see killer whales, they should immediately alert the authorities.

4.5 Overview of mitigation measures discussed at the Workshop

Annex 4 is a comprehensive presentation of the mitigation measures the Workshop considered and discussed. Where research/testing is required, detailed research proposals/protocols should be reviewed by an advisory group (Items 2.3.4 and 5.2.3) and then submitted to relevant funding and permitting agencies. These protocols should include needed sample sizes and statistical power analyses, to ensure results are robust. Mariners must have trust in any results arising from mitigation research. Annex 4(B) lists *potential* mitigation measures to be tested; the list is *not* of recommended measures (see Item 5). In all cases, potential measures must be properly authorised by the competent authorities before use. Where mariners are to be selected for participation in a study, selection criteria should be specified and mariners should be required to sign waivers, in case of vessel damage when testing a mitigation measure.

As discussed during the Workshop, the potential mitigation measures in Annex 4 are presented in two broad categories—(A) those that avoid interactions altogether (the preferred option; see above) and (B) those that may deter the killer whales once an interaction starts. There was consensus (with some caveats) on all of these potential mitigation measures, with some already being tested and others soon to be tested. A small number of these measures were considered for the first time at the Workshop.

The two proposed measures related to avoiding an interaction combine advice on time/area avoidance maps with a communications campaign (Annex 4(A)). Maps could include general areas to avoid, based on long-term occurrence and movement patterns of whales (Fig. 2 and Annex 5), where possible supplemented with near real-time updates from scientists, mariners and telemetry data (with safeguards) (Item 2.3.1 and Annex 5). It is essential to integrate all available information when developing and revising

existing maps (see Fig. 2) and the Workshop **welcomed** the news that two main data holders who have been studying and observing, *inter alia*, the movement patterns and distribution of Iberian killer whales (GTOA and CIRCE) have agreed to share (and consolidate—see Items 2.1 and 5.2.5) their data as input for updating general heat maps of probability of occurrence. There is a two-phase proposal for analysing these data with a goal of producing a first set of maps to be considered at SC69B (Item 2.3.1 and Annex 5). Tixier and Guinet added that it may be possible to infer whale movement patterns by analysing the large body of telemetry data from bluefin tuna in the area; they are making analysis of these data a priority in the coming year.

Further discussion noted that, whilst PAM can be an effective and non-invasive way to monitor for whales—with some evidence that the Iberian killer whales have become more vocal in recent seasons—there is a significant cost to setting up a sufficient array. Therefore, the value in the context of killer whale interactions will need to be carefully evaluated by competent authorities. It was also noted that citizen reporting as a monitoring method could result in incorrect species identification, but this was deemed a low and acceptable risk. Regardless, communications networks in the region should be a priority for condensing and improving (there are many sources of information currently available online and elsewhere regarding Iberian killer whales, including several that are dubious), to ensure the most accurate and most readily accessed information on whale presence and likelihood of interactions is available to mariners and on-water officials. Fundamentally, the success of any mitigation will be dependent on an accurate and effective communications effort, making a multinational communications plan/campaign essential to this effort (Items 2.2.1, 3.2, 4.4 and Annex 4(A)). It was noted that other jurisdictions where human-wildlife conflict is an issue, such as in South Africa with sharks and beach-goers, have their own communications plans; the communications experts contracted to produce the Iberian killer whale communications plan should consider these other situations in their final work product.

After considerable discussion, the Workshop evaluated mitigation measures that could be implemented once vessel-whale interactions occurred (mariners frequently do not see the animals before an interaction starts). Eight potential measures were identified and these were considered to be feasible and likely enough to be effective to be suitable for further testing (Annex 4(B)). Some of these measures have been used successfully in other contexts (e.g. fisheries), with killer whales or other cetacean species. Several measures are acoustic in nature, but not all. The Workshop **agreed** that, if and when noise-producing mitigation is authorised for use by competent authorities, mariners should be advised to use such measures only as needed, rather than continuously, to avoid introducing more disruptive anthropogenic noise into Iberian killer whale habitat than is already present. In reviewing whether to authorise the use of any acoustic devices in Annex 4(B), competent authorities should take into consideration the likelihood that mariners would use them continuously rather than in accordance with advice.

The Workshop **agreed** that hukilaus (Items 4.1.3, 4.4 and Fig. 5) should be tested. This is an inexpensive, simple potential mitigation measure that, when a vessel is under sail, could even be deployed continuously with appropriately shaped weights (Fig. 5), with no impact on the environment. (Any instructions for deploying a hukilau must minimise the possibility of lines becoming entangled in the propeller or lifting the upwind weights out of the water during normal vessel heel when under sail.) Whilst there is some potential for habituation, the risk could depend on how long their use is necessary before the behaviour is extinguished in the population. The hukilau would only need to surround the stern (Fig. 5), as the keel prevents the whales from approaching via the bow. During the research testing phase, hull-mounted cameras could record the whales' reaction to the lines. Factors that could be varied to determine maximum efficacy in this context are, *inter alia*, material used for the vertical lines, vertical length of line and horizontal distance between lines. Funding is already available for testing Orcamyst in the Gulf of Cádiz, and the hukilau can be added to this work. De Stephanis, Guinet and Tixier (Annex 1) volunteered to develop a research proposal by the end of March 2024.

The Workshop also **agreed** that TAST (Items 2.2.1, 2.3.4 and 4.2) should be tested; such testing is already funded and will be undertaken in Portuguese waters this coming season. It has minimal impact on the

whales and the environment, despite its acoustic nature, yet has very low potential for habituation, given it evokes an autonomic response, over which the animal has little control.

The first potential mitigation measure listed once an interaction occurs was moving the vessel away from the whales to within 2km of shore in the Gulf of Cádiz, and in general towards the closest port, after contacting competent authorities. Some concern was expressed that this is a significant change from the current Portuguese response protocol directive to stop the boat (Item 2.3.2). Additional data are needed to demonstrate that this mitigation action will be successful. It was noted that, should testing of some additional mitigation measures (e.g. the hukilau) reveal them to be effective, then the advice may be to stop so they can be deployed. It was clarified that moving toward shore should, for now, be specific to the Gulf of Cádiz and the Strait of Gibraltar, where the majority of the mitigation measure research is being conducted and where coastal characteristics differ from, for example, the coasts of Portugal and Galicia. Two other potential acoustic measures to test are oikomi pipes (Items 2.3.2 and 4.1.3) and pilot whale playbacks (Item 4.1.2). Both are acoustic deterrents, but with minimal impact on the environment. The potential for habituation to these two measures is difficult to assess at present, but would be minimised if they were used only when needed.

Three additional potential mitigation measures considered in Annex 4(B) were decoys (e.g. dinghies or buoys), rudder modifications and pingers. Any decoys have a high potential for habituation but are inexpensive and easy to test. Modifying the rudder to make it less attractive to the whales might be effective, but mariners are often reluctant to modify their vessel's below-the-waterline features, due to increased drag, and could utilise modifications that prove harmful to the whales. Although pingers are effective with some cetacean species in some fisheries, potential for killer whales to habituate to these devices is high. Once again, concern was expressed at the potential misuse of acoustic mitigation measures and the need to assess impacts on killer whale behaviour and distribution before regional authorities approve such methods.

In further discussion, the idea of a docent/warden programme, to assist with enforcement of mitigation measures and their implementation, was raised. Such programmes are used successfully in other parts of the world, such as British Columbia, but this was deemed an impractical idea for the hundreds of kilometres of coastline occupied by the Iberian killer whale population.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Interactions are not aggression

The singular **agreement** amongst the experts at this workshop is that the interactions between Iberian killer whales and vessels are *not* aggressive. The interactions have more elements consistent with fad behaviour or play/socialising than aggression. The use of such terms as 'attack' to describe these interactions is thus inappropriate, misleading and should cease.

Despite this, the Workshop recognised that this behaviour is often frightening for mariners and results in actual damage to rudders and even the sinking of vessels on occasion. Whatever the motivation of the whales, it is therefore imperative to provide timely advice to mariners on actions that they might take to avoid interactions or minimise their impact should they occur, whilst ensuring the welfare of the whales (see Items 3.2 (1), 3.2(4) and 5.2)

5.1.2 Status

Iberian killer whales are Critically Endangered (Item 2.1). There are probably less than 40 individuals in the population and there is evidence of a decrease in adult female survival. Aggressive responses by some mariners to interactions with Iberian killer whales that may result in injury and/or death are a new, important threat to the survival of this population that emphasises the need to find practical solutions to the issue as soon as possible.

5.1.3 Best advice

The Workshop **stressed** that it would be best to avoid these interactions—travel around rather than through killer whale hotspots, for example—than to mitigate them once they start. This should be the

primary mitigation approach (and see Item 3 for a discussion on how this may also assist in extinguishing the behaviour). Whilst avoidance of hotspots is the most effective approach, the Workshop emphasised that killer whales are highly mobile animals living in a changing environment; thus, predicting where they will be cannot be 100% successful (Item 3.2 (1)).

The Workshop **agreed** that an effective communications campaign, targeting all key stakeholders, including mariners, rescue services, harbourmasters, on-water officials and national authorities (see Item 3.2 (5)), is essential to ensure the Workshop's recommendations are effectively understood, followed and monitored (Item 5.2.3 and Annex 4(A)). The goal is not only to extinguish this behaviour in the Iberian killer whales, but to modify human behaviour. Consequently, it is important that all guidance and advice for mariners and authorities be straightforward and readily understood. International cooperation, within the affected region (Spain, Portugal, Morocco and, to a lesser degree, France), as well as between IGOs such as ACCOBAMS and the IWC, will be essential moving forward.

Mariners need to be prepared for an interaction in these waters, including knowing that they may need to be rescued. The Workshop **agreed** that widespread cooperation and reporting from mariners is essential to management efforts going forward. On-water officials also need to understand the situation clearly, to ensure appropriate action and consistent messaging when they enforce mitigation or rescue mariners. Therefore, any ongoing or final mitigation measures should be chosen and implemented in consultation with mariners and on-water officials, through 'town hall' meetings, public hearings or other avenues, as mariners need to inform authorities of, and these authorities need to understand, their limitations and needs.

In addition, the *effectiveness* of all guidance and advice directed at mariners—and even mandatory actions expected of them—is, at this time, uncertain. These recommendations are the Workshop's *best advice*, but the level of their effectiveness cannot be determined at this time. Despite preliminary research, the science—of *why* the whales are pursuing these interactions, *what factors* in the environment are associated with, or triggering, the interactions, and *which mitigation measures* will be effective at minimising the opportunities for, and risks associated with, these interactions—is not complete and there remain a number of uncertainties about how to *effectively* avoid, mitigate and/or extinguish this behaviour.

There is not at present, or likely to be in the future, a single solution to this issue. It is likely that multiple mitigation measures will need to be used in sequence or in tandem to effectively extinguish this behaviour or deter the whales from vessels. The Workshop **agreed** that current measures used by mariners, legal and illegal, have been ineffective. It was suggested that this may be because the whales do not make a direct association with the mariners' action (e.g. shooting a flare) and the rudder. These actions may also be reinforcing the behaviour rather than deterring it. Ultimately, this behaviour may disappear, as fads have in other populations, but it may also reappear at some point in the future. These are intelligent, socially complex, innovative wild animals and science cannot predict their behaviour with certainty.

Figure 5 is a schematic of the best advice for mariners developed during the Workshop, based upon the data and experience examined under Items 2–4 (see these items for details and rationale). Annex 4 summarises potential mitigation measures to be tested, whilst Table 1 summarises measures that are currently in use (Item 4.3), emphasising those that should *not* be used.

5.2 Recommendations

5.2.1 Future work

The Workshop **agreed** that there are three primary areas for future research on the vessel-killer whale interactions issue:

(1) Obtaining better data related to interactions via improved reporting by mariners and by developing an approach to try to ensure thorough, prompt necropsies of stranded animals to determine cause of death;
(2) Improving primary advice on areas to avoid by integrating the available data (see the two-phase approach outlined in Annex 5) and obtaining new data via observations (e.g. by scientists,

mariners, citizen scientists); and
(3) Testing potential mitigation measures using agreed rigorous research protocols.

In addition, the Workshop **stressed** the need for a comprehensive population assessment workshop to update the present status of the Iberian killer whales and to evaluate its likely trajectory under realistic scenarios. This could feed into the possible development of a joint IWC/ACCOBAMS Conservation Management Plan (Item 5.2.5) that, *inter alia*, will include discussion of the whale-vessel interaction issue, along with other actual and potential threats.

Finally, the Workshop **stressed** the need for:

(1) Continued and strengthened international cooperation on this issue by the range states;
(2) Prompt action to develop an effective, professional, multi-faceted communications plan and reporting system; and
(3) Development of a small, core, international advisory group with the ability to co-opt experts as necessary to provide advice to regional authorities, should they request it, on scientific and technical matters, including, *inter alia*, reviewing mitigation protocols and research projects aimed at improving the scientific basis for advice.

5.2.2 Immediate mitigation advice

Attention: CG, public

*The Workshop **recommends**, as the highest priority, the outline of advice and reporting provided in Fig. 4, where mariners should avoid times/areas of highest probability of killer whale presence, based on maps provided by competent authorities.*

*In the event of an encounter, the Workshop **recommends** mariners move away from the whales as quickly as possible, at least 2 to 3km from the area in which the whales were encountered, either toward the coast (in the Gulf of Cádiz and Strait of Gibraltar) or toward an area where rescue can be expedited. Moving away is not guaranteed to end the interaction or prevent damage, but may reduce the latter's likelihood. Mariners should alert authorities as soon as an encounter begins, which should help with response time for a rescue if needed.*

*In terms of additional mitigation, the Workshop **strongly recommends** that mariners encountering Iberian killer whales do not use any deterrence measures that would almost certainly be harmful to the whales (Item 4.3 and Table 1). The Iberian killer whales are Critically Endangered on the IUCN Red List and deterrence measures that might cause immediate harm or affect long-term survival or reproduction are illegal under EU and national laws. Several of these harmful measures have been in use since 2020 at some level and the whales continue the interactions; thus, they are not only ineffective but may be reinforcing the behaviour and increasing the severity of damage to vessels. Some of these measures are also dangerous for mariners (e.g. firecrackers and electrocution).*

*In summary, the Workshop **recommends** that mariners use only methods with no impact on the whales or the environment (e.g. moving away, Annex 4(A)), until research and testing determine a method's effectiveness and safety. To stand any chance of being effective, measures must be field-tested. Several will be tested in the 2024 season (spring–autumn), with the others to be tested as soon as possible.*

*The Workshop also **recommends** that all mitigation measures that produce sound/noise (Annex 4(B)), should they be authorised, be used only when needed, rather than continuously. Continuous use of any such noise-producing measures may:*

(1) Reduce their effectiveness (the whales may become habituated, as they have to many other human-caused sounds in their environment);
(2) Eventually serve to attract the whales, as they learn to identify the continuous sounds/noises with vessels and rudders; and
(3) Harm the whales and other marine life (including bluefin tuna and other commercially targeted fish), as it increases the level of 'noise pollution' in the Iberian marine environment.

5.2.3 Advisory Group

Attention: CG, S, SC, IGO (e.g. ACCOBAMS)

The effort to manage the ongoing interactions between Iberian killer whales and vessels, wherein the whales sometimes contact these vessels and, in 20–40% of these cases, damage them, has been, to date, primarily undertaken by the individual national authorities responsible for maritime issues. Noting the success of this international workshop, the Workshop ***recommends****:*

(1) Increasing international collaboration and providing consistent advice and reporting systems throughout the region, including the development of a multi-faceted communications strategy; and
(2) Establishing a small, core, international advisory group with the ability to co-opt experts (including from IGOs such as the IWC and ACCOBAMS) as necessary to provide advice to authorities should they request it on scientific and technical matters, including, inter alia*, reviewing mitigation protocols and research projects aimed at improving the scientific basis for advice. Ideally, all proposals for research related to extinguishing and mitigating the interactions between Iberian killer whales and vessels should be reviewed by the Advisory Group before the research proceeds.*

The Workshop ***agreed*** *that all the participants at the Workshop were prepared to assist the Advisory Group on individual issues if requested.*

As a priority, the Workshop ***recommends*** *the implementation (with funding) of the two-phase proposal to undertake an integrated analysis of the available data to update the 'hotspot' mapping provided in Annex 5.*

5.2.4 Stranding response and post-mortems

The Workshop highlights the importance of fully understanding the causes of death of killer whales from this Critically Endangered population. It ***recommends*** *improving stranding responses throughout the population's range wherever needed (Item 2.3.4), to maximise the number of complete, rigorous necropsies of any stranded killer whales found. Every effort should be made to ensure that necropsies are undertaken as soon as possible. The formation of a task force with specific expertise, such as specialists in veterinary and forensic pathology and experience with cetaceans and ideally with killer whales, should be considered by the national authorities, with funding made available to allow rapid response to any killer whale strandings reported. Similarly, one or more accredited laboratories should be identified for sample analysis with funding made available to ensure that the samples are processed in a timely manner.*

The Workshop ***recognises*** *that capacity and geography differ in the various jurisdictions, as does the legal framework for post-mortem investigation. These differences must be taken into account when developing a killer whale stranding response strategy, which should include the facilitating of obtaining permits where necessary. In Spanish coastal areas, MITECO will provide, in addition to a regional stranding network, a unit of veterinary forensic pathologists, if needed, for cases occurring within territorial waters. The Workshop noted that ACCOBAMS and the IWC were also able to provide general stranding response advice.*

5.2.5 Demographics, conservation and management

Attention: SC, R, CG

The Workshop ***recommends*** *the convening of an international Iberian killer whale assessment workshop, where further discussion of the demographics of this population should focus on,* inter alia*, population modelling and genetics analysis (Item 2.1).*

Before this occurs, the Workshop ***strongly recommends*** *that all existing datasets for Iberian killer whales—e.g. for photo-identification, sightings and genetics—be consolidated and that all researchers in the region work in close cooperation and communicate frequently regarding killer whale movements and behaviour.*

*To assist in this, the Workshop further **recommends** that the governments of Spain, Portugal, Morocco and France (if needed) solicit research proposals (and provide funding where necessary) for the following:*

(1) Analysis of existing killer whale genetic samples (improve understanding of killer whale movements in relation to prey);
(2) Analysis of AIS data, at least for those vessels that carry AIS systems, to get a detailed analysis on distribution of vessels (and combine the previous two analyses to get a better understanding of whale-vessel overlap); and
(3) Improvement of understanding of inter-individual behavioural variation and movement with relation to vessels.

The Advisory Group is willing to assist in this if requested.

*Finally, the Workshop **recommends** that the development of a CMP (Conservation Management Plan) for this population be considered by range states and the IWC Scientific Committee, in cooperation and consultation with ACCOBAMS. National plans should be taken into account when developing this CMP.*

6. ADOPTION OF THE REPORT

It was **agreed** that the draft workshop report would be consolidated by the rapporteur and shared with the Workshop steering committee and participants for adoption via e-mail. The report was adopted by correspondence on 12 April at 14:00 hours EDT.

In conclusion, García-Bellido and Zerbini thanked the Workshop participants for their thoughtful input. The Workshop thanked Zerbini for acting as chair and Rose for rapporteuring. It was also **agreed** that a press release should be prepared and issued as soon as possible after the Workshop concludes. Zerbini then closed the Workshop.

7. CITED LITERATURE

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Table 1. Illegal and legal deterrents already in use, or believed to be in use, by mariners in the waters of the Iberian Peninsula, in an effort to deter killer whales from vessels/rudders

ILLEGAL (due to risk of injury to the whales and/or of damage to the environment)	LEGAL
Tossing firecrackers into the water near or on the whales (currently the option most frequently reported in the media and to authorities)	Dumping sand over the side—this was effective when reported, possibly as the sand obscured the rudder, acoustically and visually, from the whales
Throwing heavy lengths of chain at the whales	Attaching small protuberances to the vessel's rudder (these only become a violation should they cause injury to a whale)
Pouring gasoline, chlorine or bleach over the side, all of which could affect/damage the whales' respiratory system if inhaled	
Firing flares	
Dropping seal bombs over the side (these are essentially small explosives that can damage marine mammal hearing or injure them if the device explodes in close proximity to an animal)	
Attempting to strike the whales with a 'weapon', such as a gaffe or boat hook	
Throwing rocks	
Pouring waste/grey water over the side	
Electrocution (which is also highly risky for mariners)	
Using an airhorn from the deck	
Banging two pipes together on the deck	
Utilising pingers	
Attaching knives or spikes to the vessel's rudder	
Reversing the engine (this would be illegal if the whales are next to the propeller when it reverses, as there is a high potential for injury)	

Figure 1. An Iberian killer whale interacting with the rudder of a sailboat near the Strait of Gibraltar. Photos by R. de Stephanis.

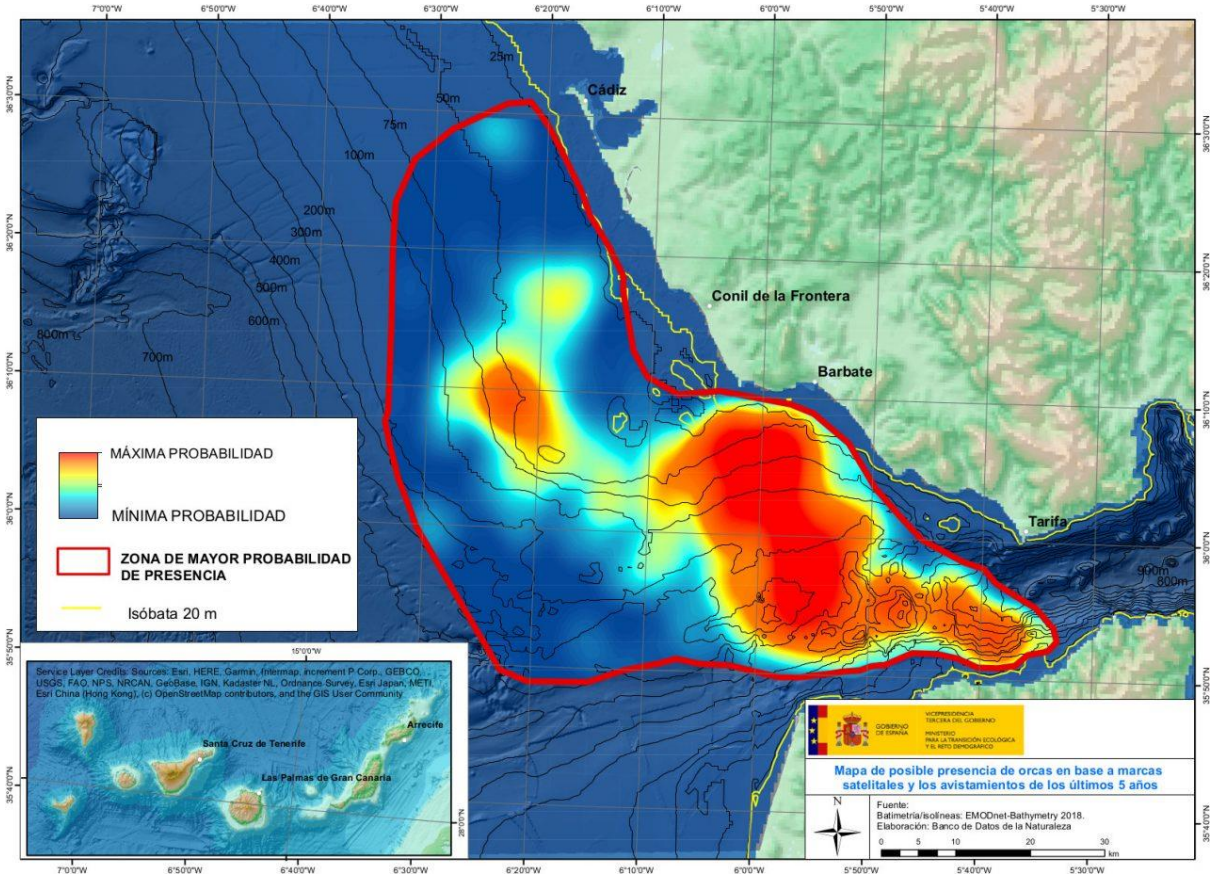

Figure 2. Heat map of waters off Barbate, Spain, and near the Strait of Gibraltar, indicating areas of minimum to maximum probability of a vessel encountering Iberian killer whales (and therefore, minimum to maximum probability of vessels having an interaction with killer whales).
Image courtesy of R. de Stephanis.

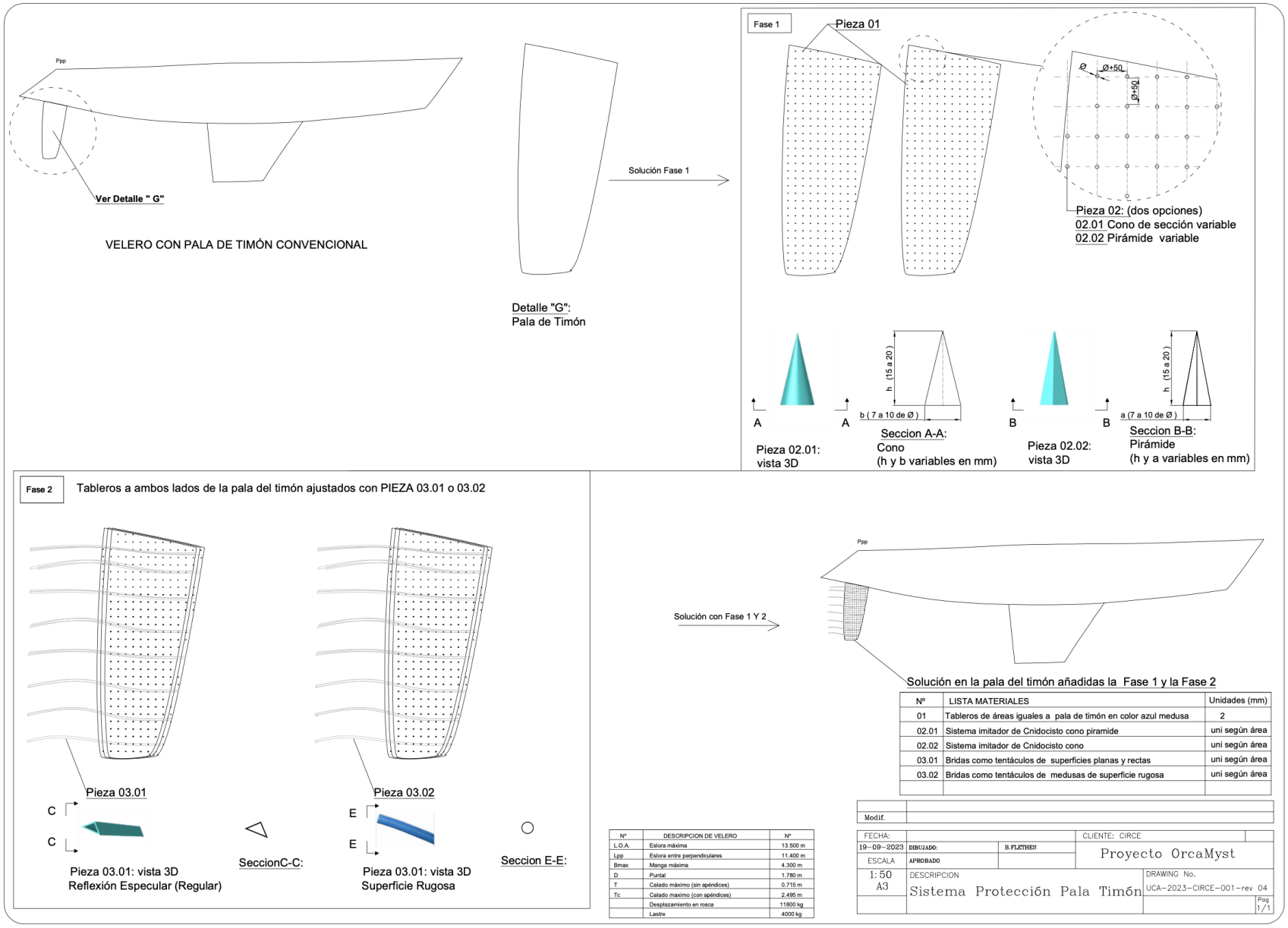

Figure 3. Orcamyst (Item 2.4), a rudder modification designed to alter killer whale perception of the rudder and therefore their behaviour toward it. Images courtesy of R. de Stephanis.

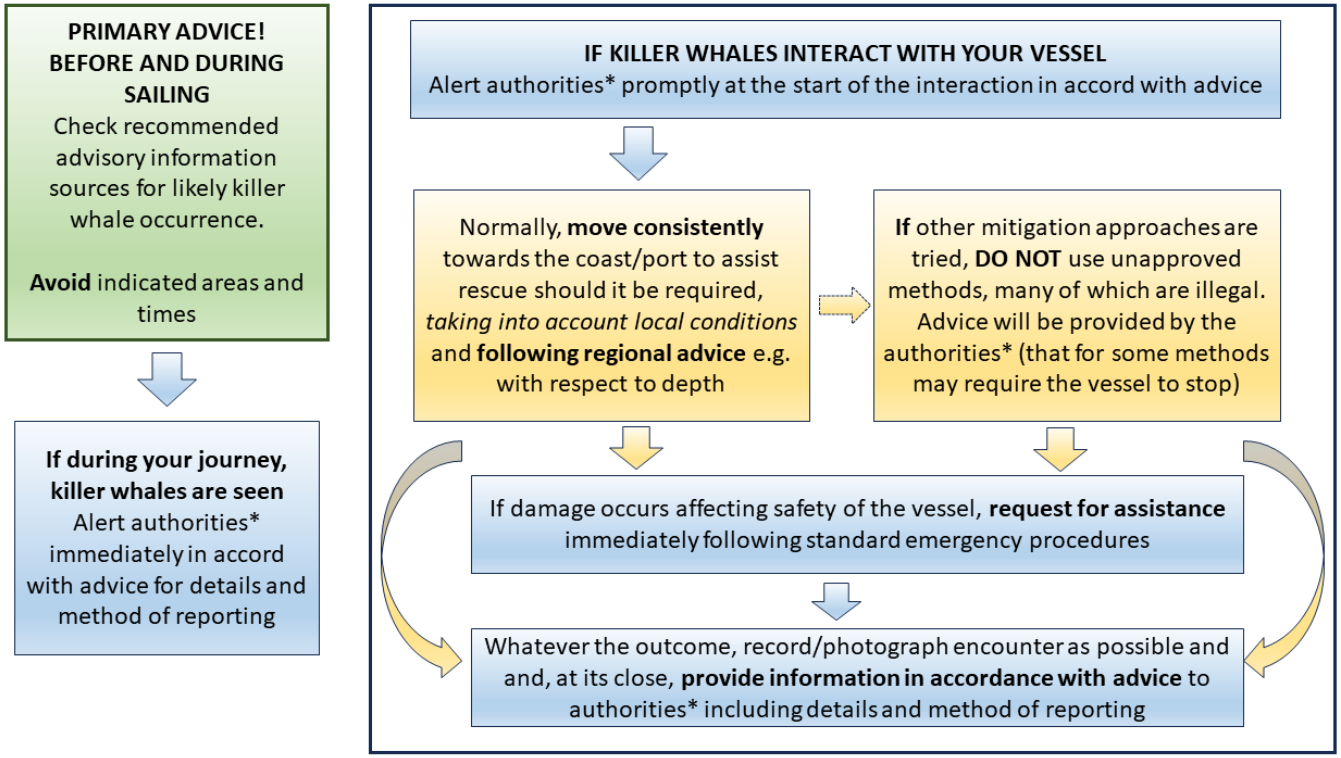

Figure 4. Schematic of reporting and mitigation advice for mariners developed during the Workshop.
Green box: primary advice. Blue boxes: reporting by mariners. Yellow boxes: mitigation once an interaction occurs.
A professionally developed communication and reporting strategy for all stakeholders is required, which is consistent across the region.

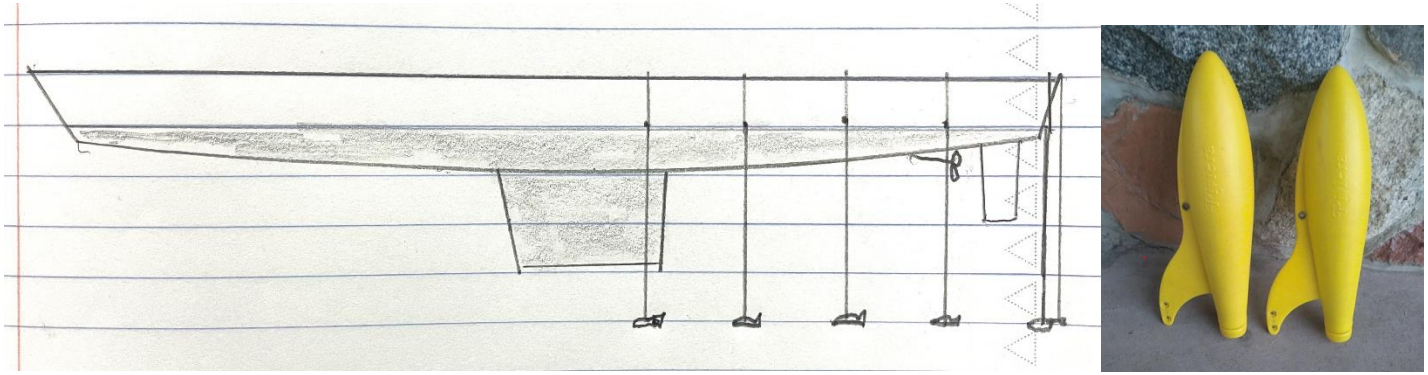

Figure 5. Possible design of hukilau vertical lines deployed to prevent whales accessing the rudder, using torpedo-shaped weights (pictured weights are approximately 2.7kg each) that could potentially be utilised when under sail or even when under power, without entangling the lines in the propeller.
Images courtesy of D. Noviello, J. Ford and J. Foster.

Annex 1

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StCm = Steering Committee

Annex 2

AGENDA

Interactions between Iberian Killer Whales and Vessels:
Management Recommendations
6–8 February 2024
Madrid, Spain

1. Introduction
   - 1.1 Convenors' opening remarks and introduction of participants
   - 1.2 Election of chair and appointment of rapporteur
   - 1.3 Adoption of agenda
   - 1.4 Review of available documents
2. Background
   - 2.1 Brief overview of management actions to date by competent authorities
   - 2.2 Summary of interactions between killer whales and vessels
   - 2.3 Summary of research undertaken to date
   - 2.4 Discussion of management actions
3. Identification of patterns in, and contributing factors to, interactions, and discussion of possible causes
4. Management and mitigation
   - 4.1 Summary and discussion of international best practices regarding killer whale deterrence
   - 4.2 Identification of possible mitigation measures
   - 4.3 Evaluation of feasibility and effectiveness of mitigation measures
   - 4.4 Discussion of potential implementation of mitigation measures
5. Recommendations

Annex 3

LIST OF PRESENTATIONS

KW/MF24/	Name	Title
01	García-Bellido	Brief overview of management actions to date by competent authorities in Spain
02	Esteban	Update on the demographic parameters of Iberian killer whales
03	de Stephanis	Understanding orcas: population dynamics and behaviour
04	Bolaños	Close encounters between orcas and man-made objects in the Caribbean Sea
05	Esteban	Update on the interactions between killer whales and vessels along the Iberian Peninsula
06	de Stephanis	Orca-boat interactions: analysis of causes and temporal evolution* [rudder damage?]
07	de Stephanis	Origins and aims: introduction to the 'Orcas and Boats' project
08	García-Bellido	Interactions between killer whales and vessels in Spanish jurisdictional waters: what has been done from MITECO
09	Geraldes Dias	Actions developed by the Portuguese navy
10	Sequeira	Update on progress in Portugal
11	Sánchez	The role of the Guardia Civil
12	Masski	Cetaceans of the Moroccan coast: stranding monitoring and research
13	Ford	Traditions, Innovations, Fads and Other Cultural Quirks in Northeastern Pacific Killer Whales
14	Tixier	Using knowledge on killer whale ecology and behaviour to mitigate conflicts with humans: the case of killer whale depredation on fisheries catches in the Southern Ocean
15	Guinet	Cultural vertical and horizontal transfer of behavioral traits and operational conditioning in orcas: the Crozet Islands case
16	Samarra	Killer whale interactions with pilot whales: the role of acoustic cues
17	Noviello	Experience with planning for and attempting to deter killer whales from approaching oil spill
18	de Stephanis	Nautical Innovation: Anti-Orca Rudder Prototype
19	Deecke	Niko knows best: A framework for understanding the proximate and ultimate aspects of human-killer whale conflict
20	Götz and Janik	The targeted acoustic startle technology (TAST): a sustainable approach to managing human-wildlife (marine mammal) conflict
21	de Stephanis	Demonstrative action for testing techniques to minimize episodes of orca interactions with sailboats within the framework of the LIFE-IP-PAF INTEMARES project (LIFE 15 IPE ES 012)

Annex 4. Compilation of potential mitigation measures for interactions between Iberian killer whales and vessels discussed during the Workshop. Where more testing/research is required, detailed research proposals or protocols, including sample sizes and statistical power analyses, should be required. The use of any of these measures must be properly authorised by competent authorities[21]
(A) Measures to avoid interactions; (B) Measures once interaction occurs

(A)

MEASURE	DESCRIPTION	CONSEN-SUS (if no, why)	ACTORS	TIMELINE (FUNDING)	MONITORING EFFORTS	CAN WE ENFORCE IT? HOW?	PROS	CONS
Time/area avoidance	Items 2.3.1 and 2.3.4: Mariners are advised to navigate outside/around designated areas where there is high risk of interaction with killer whales; develop a series of maps with whale 'hotspots' updated in near real-time, as much as possible (regardless, on a known schedule), which are readily accessible to mariners online or via other means	YES	Regional authorities to be designated as responsible for making maps available and updating them as necessary	Immediately or continue ongoing notifications (funding implications dependent on which methods used to make and update maps)	Rigorous monitoring of whale locations is needed to make this measure effective, through visual observations, citizen reporting or PAM	Intermittently, when regional authorities are on the water and can intervene when avoidance areas are not being observed	Easy to implement (time/area closures are already effectively used in other contexts); no impact on whales	Longer trips for mariners; must consider vessel safety; not a guarantee of avoiding interactions, but rather minimising risk of one
Communications plan/campaign	Items 2.2.1, 3.2, 4.4: Regional authorities contract with communications specialists to develop a multi-tiered, multilingual, transnational communications plan to educate, and provide consistent messaging to, all interested parties, including regional authorities, enforcement officials, mariners, researchers, media and the general public. This plan should include methods for improving existing communications networks through which mariners and on-water officials report whale sightings and mitigation measure outcomes, to maximise accurate information flow	YES	Regional authorities to develop and implement, in multinational cooperation	Immediately, with a view to having a communications plan in place by the beginning of the interaction season—spring 2024, at latest (funding required for contract)	Effective metrics to measure the efficacy and reach of the plan are essential and the plan should include these in detail; surveys of mariners and on-the-water enforcement officials can assist with this monitoring; the communications plan should emphasise that even negative results (when mitigation does not work) should be reported	N/A	An effective communications strategy is essential to the effort to mitigate/end these interactions	Funding required to contract with communications specialists; some delay until communications plan is prepared

[21] Annex 4 is *not* a list of recommendations (see Item 5). It is a list of potential mitigation measures to test.

(B)

MEASURE	DESCRIPTION	CONSEN-SUS (if no, why)	ACTORS	TIMELINE (FUNDING)	MONITORING EFFORTS	CAN WE ENFORCE IT? HOW?	PROS	CONS
Hukilau	Items 4.1.3, 4.5: Multiple weighted, vertical lines placed around vessel or rudder—in other contexts, killer whales are reluctant to move through such vertical lines (passive measure, with whale choosing its response)	YES	This workshop to develop initial protocol; researchers and selected mariners to test	Immediately (some funding implications for research/ testing)	Report research results; be clear for which vessel types it is or is not effective	N/A	TBD via field testing, but an inexpensive, non-harmful, simple tool; in other contexts, effective at herding cetaceans, including killer whales	TBD, but potential whale entanglement; potential damage to vessel by incorrect use of line; possible habituation
TAST*	Item 4.2: 'Startle device' developed for use in certain fisheries—relies on autonomic reflex (active measure, to deter whales)	YES	Researchers to continue testing	Immediately (testing already funded)	Report research results	N/A	TBD via field testing, but non-harmful; high potential for being effective; habituation unlikely	Potentially expensive
Response protocol – vessel movement	Item 4.4: Existing protocol provides guidance to mariners—add directive to move closer to shore in Gulf of Cádiz (passive measure, with whale choosing its response)	YES	Competent authorities to revise existing protocol	Add movement directive to existing response protocol immediately, being specific about location (no funding implications)	Coast Guard reports; self-reporting by mariners	N/A	Effective in Gulf of Cádiz and Strait of Gibraltar – 'closer to shore' should be made as specific as possible in any directive (e.g. 'within xkm of shore' or, where it makes sense, 'into xm depth)	Not necessarily feasible elsewhere, particularly on Portuguese coast—vessel safety must be considered
Oikomi pipes*	Items 2.3.2 and 4.1.3: Long, metal pipes held over the side and struck to produce banging sound below the waterline; in other context, highly effect at herding cetaceans (active measure, to deter whales)	YES, with caveats (see cons)	Researchers and Portuguese Navy to continue testing	Ongoing (testing already funded in Portugal)	Report test results	Intermittently, when regional authorities are on the water when an interaction occurs	Disturbs but does not injure whales; in other contexts, highly effective at herding cetaceans	Some potential for habituation or prolonged displacement
Pilot whale playback*	Item 4.1.2: Pilot whale calls transmitted underwater as whales approach—in other contexts, killer whales move rapidly away from	YES, with caveats (see cons)	Researchers to test	Immediately (funding implications minimal, as some testing is already ongoing)	Report research results	N/A	Disturbs/deters but does not injure killer whales	Potential for habituation (if actual pilot whales are never otherwise detected); mariners would have to

	these calls (active measure, to deter whales)							acquire transmission system; potential for changing movement patterns of killer whales and even excluding them from habitat; potential for impact on pilot whales in the area
Decoy, e.g. dinghy, buoy	Item 2.2.1: Decoy dropped into the water/trailed behind vessel, to distract whales' attention (passive measure, with whale choosing its response)	YES	Researchers to test	Immediately (funding implications minimal)	Self-reporting by mariners; report research results	N/A	Completely non-harmful; inexpensive; readily available—has worked in some instances already in Iberia	High potential for habituation
Modify rudder	Item 4.4: Surface of rudder modified to render it unattractive to the whales (passive measure, with whale choosing its response)	YES, with caveats (see cons)	Researchers to develop protocol and test	Immediately (some funding implications for research)	Report research results	To some extent – permanent modifications can be examined by authorities in port	TBD via field testing, but could modify the behaviour of the whales to the point of extinguishing the behaviour	TBD via field testing, but option could encourage mariners to attempt harmful, illegal modifications, such as spikes or knives; modifying the rudder may cause drag, which mariners might not adopt readily
Pingers*	Item 2.4: Marine mammal acoustic deterrent devices used in multiple fisheries (active measure, to deter whales)	YES, with caveats (see cons)	Researchers to test	Immediately/ ongoing (some funding implications for research)	Report research results	Intermittently; when regional authorities are on the water when an interaction occurs	TBD via field testing, but could deter whales from approaching vessels	Did not work in field-testing in Gulf of Cádiz; widespread use could result in displacement of whales; high potential for habituation in killer whales

*Acoustic

Annex 5

DESCRIPTION OF DATA STREAMS REQUIRED TO DETERMINE AREAS WHERE THERE IS A HIGHER PROBABILITY OF KILLER WHALE OCCURRENCE IN IBERIAN PENINSULAR WATERS (DATA REQUIRED FOR 'HOTSPOT' MAPS)

There are three available data sources that can provide insights into the primary mitigation approach to minimise interactions (Annex 4(A)), i.e. to provide advice to mariners on areas/times where they are most likely to encounter killer whales (thus are areas to avoid). Note that this is different from methods providing real-time information to mariners on actual occurrence.

The most effective way to improve probability maps is to maximise the amount of data from the different data sources, understand their strengths and weaknesses, and then integrate them to provide the best advice possible. It requires the data holders to agree to provide information, with appropriate safeguards, for common analyses that maximise sample size. It will require a degree of innovative temporal and spatial modelling, incorporating both anthropogenic and natural explanatory variables. This must include a robust examination of uncertainty and how to present this to mariners and regional authorities, including on-water officials.

This Annex has been developed to assist and encourage potential data holders to submit any relevant data that they may have. Collaboration and data sharing are essential to the protection of both mariners and whales. It is important to recognise that for each case there may not be a full suite of accompanying data. This does not prevent the data contributing to the analysis, provided the minimum amount of information is available (indicated by asterisks in the text below). However, the more information that can be provided, the more robust and useful the analyses will be.

(1) Whale-vessel interactions

The information provided here is valuable for many reasons but is inevitably biased in terms of developing whale density maps. To understand and allow for this, in analyses and modelling, will require additional information on both general whale and vessel occurrence. These will come from other datasets (e.g. maritime traffic/AIS information, whale information from (2) and (3) below) and are not the responsibility of the data provider/ mariner.

(a) Record identifier;
(b) Vessel length in metres (if available);
(c) Vessel type (if available);
(d) Vessel purpose (if available);
(e) Day, month and year of the interaction*;
(f) Time of day of the encounter (hh:mm);
(g) Duration of the encounter in minutes (if available, can be approximate);
(h) Latitude and longitude (ideally in decimal degrees) of the encounter*;
(i) Behaviour of the vessel prior to the encounter (e.g. drifting, sailing under power, without power);
(j) If travelling, course and origin that day;
(k) Confidence in species identity (high, medium, low);
(l) Number of individuals seen in the interacting group;
(m) Photographs or video relevant to the encounter;
(n) Had other whale groups been seen during the trip that did not interact with the vessel?;
(o) Information on whether the interaction resulted in physical contact between the animals and the boat*;
(p) Information on whether contact resulted in damage to the boat;
(q) Were other vessels in the area and (if available) number, type and/or activity?; and
(r) Comments: any other information the provider feels might be relevant.

(2) Sightings data (opportunistic or systematic)

Sightings data from anywhere throughout the region are essential to developing (ideally) seasonal density maps of whales[22]. These are also biased to a greater or lesser extent and this bias will be accounted for in any analyses. It is important to know whether the data are from opportunistic vessels (reports from mariners), semi-systematic (e.g. from vessels such as whale watching vessels that operate regularly in a relatively fixed area, with a specific searching strategy and ideally some measure of approximate effort) or systematic data (obtained from a scientific survey following pre-designed track lines and collecting distance/angle data). In the case of semi-systematic or systematic surveys, a description of the general approach and methods accompanying the data submission will be valuable. In addition to evaluating possible biases (e.g. due to presence only data, lack of effort data, lack of information from all times of the year), spatial modelling will be the primary analytical technique, with a variety of explanatory variables (including those from outside the datasets, e.g. oceanography, productivity, prey).

(a) Sighting identifier;
(b) Survey type (opportunistic, semi-opportunistic, systematic);
(c) Survey/sightings platform (e.g. airplane, helicopter, vessel);
(d) Effort data available (including GPS tracks);
(e) Day, month, year and time of the sighting*;
(f) Latitude and longitude (in decimal degrees) of the sighting*;
(g) Species*;
(h) Number of individuals seen (group size)*;
(i) Photo-identification data available Y/N;
(j) Information on whether the group seen corresponded to the Iberian killer whale population (group type);
(k) Water depth in metres at the location of the sighting; and
(l) Comments: any other information the provider feels might be relevant.

If from a systematic study, the full datasets, including effort, weather, angle and distance to sighting, should be provided, as well details of any associated publications

(3) Movement data from (a) telemetry (Argos locations) or (b) resightings of individually identified animals

Information on movements is a key component of developing and understanding seasonal whale densities and routes, and interpreting data obtained under (1) and (2) above. The most comprehensive data, because they are continuous and longer-lasting, come from satellite telemetry. The key question these data are meant to address is where the animals go—what their preferred habitat is.

Whilst providing unique insights and multiple positions, such data come from a relatively small number of animals so questions of 'representativeness' can arise. It is advantageous in this case that the sex, age and even relatedness of many of the Iberian animals is known. This may be less of a problem where animals remain in stable groups and where even a small number may still comprise a relatively large proportion of the total population. There are international guidelines for the use of such tags, including on small populations, where the health and survival of each individual can be critical to the population's persistence. Any tagging done with Iberian killer whales must follow these guidelines and the selection protocol should be reviewed by an ethics committee.

Integrating these data with the data collected under (1) and (2) presents an interesting modelling challenge but the improvement in advice on minimising interactions will be considerable.

[22] Similar information to that required to develop whale density maps will be required for shipping, but that is outside the scope of this document.

Telemetry data

(a) Animal identifier or PTT ID associated with the satellite transmitter*;
(b) Day, month, year and time of the location of tagging and each Argos location*;
(c) Latitude and longitude (in decimal degrees) of the location of tagging and each Argos location*;
(d) Location quality associated with each Argos location (e.g., 3, 2, 1, 0, A, B, Z); and
(e) Tagged individual age and sex if available.

Resighting data

(a) Animal identifier (ideally based on a single consolidated catalogue identifier)*;
(b) Age and sex of the individual (if available);
(c) Day, month, year and time of the resighting*; and
(d) Latitude and longitude (in decimal degrees) of the location of each resighting*.