

Cetacean euthanasia: Addressing the strandings ‘taboo’

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ABSTRACT

Live cetacean stranding response can include euthanasia decisions, which are influenced by multiple complex factors, such as interacting welfare, governance, logistical and sociocultural considerations. This study aimed to examine how euthanasia is conducted during cetacean strandings, identify barriers to its implementation, and explore potential improvements. To do this, we applied two methods: (1) an online survey (n = 48; 22 countries) and (2) an in-person workshop (n = 30; 15 countries) to gain insight from stranding responders on how euthanasia is conducted at live stranding events. We used thematic analyses to investigate participant responses. Our findings indicate that effective euthanasia decision-making during cetacean strandings depends fundamentally on national law, the availability of appropriately trained personnel, and suitable logistical resources (e.g., appropriate equipment and chemical agents), yet is frequently constrained by systemic governance fragmentation, uneven regional capacity, and inconsistent resource allocation. These structural and operational limitations can delay or complicate time-sensitive animal welfare decisions. Strengthening national and regional stranding networks through sustained investment in training, resource provision, clear governance pathways, and coordinated information-sharing is therefore essential to enable timely, consistent, transparent, and animal welfare-centred outcomes, while also enhancing operational effectiveness and maintaining public confidence in live stranding response.

KEYWORDS: ANIMAL WELFARE; DEATH; DECISION MAKING; END-OF-LIFE; MANAGEMENT; MARINE MAMMAL

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INTRODUCTION

Live cetacean strandings (herein strandings denotes live strandings) occur globally and present complex challenges for animal welfare, conservation and public health (Moore *et al.*, 2018; Boys *et al.*, 2022a; Grattarola *et al.*, 2024). While some stranded individuals may be viable candidates for refloating (the assisted return of the animal to sea under trained/veterinary guidance), many strandings involve debilitated or compromised animals with low survival likelihood due to severe trauma, physiological compromise, advanced disease, or prolonged time ashore (Herráez *et al.*, 2013; Câmara *et al.*, 2019; Boys *et al.*, 2022b). In such cases, euthanasia may represent the most humane intervention to minimise or prevent further suffering. However, its justification extends beyond the alleviation of acute physical pain to encompass broader welfare considerations, including irreversible loss of functional autonomy, compromised future quality of life, and the absence of realistic recovery or response options. Despite its importance as a welfare outcome, euthanasia decision-making during live cetacean strandings remains one of the most ethically, logistically, and socially challenging aspects of organised incident response, and is sometimes considered ‘taboo’, being avoided in normal conversation and opposed by the public (Barco *et al.*, 2016; Boys *et al.*, 2021; Boys *et al.*, 2022c).

Animal welfare considerations are central to euthanasia decision-making but can be overridden by human perceptions (Stockin *et al.*, 2022). The primary ethical objective is to minimise suffering, particularly where prognosis is poor and intervention is unlikely to result in survival or acceptable quality of life (Leary *et al.*, 2020). However, welfare-based decision-making may be complicated by competing ethical pressures, including strong public expectations – often exacerbated by social media – to attempt rescue or direct intervention by the public themselves, cultural and/or religious beliefs, and limited availability of financial and human resources (Boys *et al.*, 2022c; Stockin *et al.*, 2022). A further challenge arises from variability in governance and legal frameworks across regions, which may result in unclear mandates and diffuse responsibility among competent authorities (IWC, 2014; Barco *et al.*, 2016).

To date, research has predominantly focused on euthanasia methods and technical guidance (Daoust & Ortenburger, 2001; Dunn, 2006; Coughran *et al.*, 2012; Kolesnikovas *et al.*, 2012; Hampton *et al.*, 2014; Harms *et al.*, 2014; Boys *et al.*, 2026), while few have investigated the systemic barriers that influence the broader decision-making processes, how guidance is interpreted and implemented across jurisdictions, and support mechanisms for responders. This gap is particularly notable given the substantial sociocultural, legal, and organisational differences among countries that may shape end-of-life decisions. Indeed, recent research indicates that international euthanasia guidance (e.g., from the International Whaling Commission [IWC]) is applied inconsistently across response contexts, highlighting the need to better understand the structural and contextual factors that underpin euthanasia decision-making in practice (Boys *et al.*, 2022c; Stringfellow *et al.*, 2022).

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Collectively, these challenges indicate a clear need for improved understanding of the factors influencing euthanasia decision-making during cetacean strandings and for the development of coordinated, welfare-focused approaches. The aims of this research were to (1) gather knowledge on when and how euthanasia is conducted at stranding events (where it is considered medically and logistically feasible); (2) understand what barriers exist to undertaking euthanasia; and (3) define what improvements could be made to better enable euthanasia to be appropriately implemented at strandings.

METHODS

Two different methods were used to gain insight from stranding responders on how euthanasia is conducted at stranding events:

1. To gather international perceptions, a global online survey was shared via listserv emails to the global marine mammal research and management community (MARMAM), the European Cetacean Society (ECS-TALK), and stranding networks registered with the Global Stranding Network (<https://globalstrandingnetwork.com>) and/or listed in the CRC Handbook for Marine Mammal Medicine (Simeone & Moore, 2018). The survey comprised a mix of open and closed questions and was available to respondents for six weeks (April–May 2025). A snowball approach (Patton, 2002) was used to increase the number of respondents to the survey; thus, the invitation to participate could be shared further. For a response to be included, participants had to: (1) identify the country in which they work; (2) clarify whether euthanasia is an option in the country of work; and (3) outline what barriers/constraints are faced when applying euthanasia in their country of work.
2. A full-day in-person workshop led by the first and senior authors (RMB and KAS) took place at the 36th European Cetacean Society conference in Ponta Delgada, Azores, Portugal, in May 2025. Stranding responders and/or those with expertise in euthanasia were invited to attend the workshop. The workshop participants were split into five groups of six people. Participants were assigned to groups to ensure representation across gender, career stage, specialist expertise (e.g., veterinary medicine, marine biology, zoology) and geographical representation. This was to ensure that discussions would cover as many key factors, concerns and potential improvements as possible, and to reduce any potential bias towards discussing a single issue. A facilitator was included in each group who was provided with a set of points to aid discussions and who transcribed notes for the primary author (RMB) to collate. All notes were transcribed intelligent verbatim (i.e., spelling and grammar were corrected) and then provided via email to all participants to comment on and ensure that points were sufficiently and appropriately covered.

Both the survey and workshop focused on four key topics:

1. Whether euthanasia should be undertaken and what other end-of-life options exist;
2. When end-of-life decisions should be enacted and what factors to consider;
3. What training and post-event support exists or is required (at individual and community level);
4. How to communicate the importance of end-of-life decisions to the public and media.

For both methods, no identifiable data were collected, ensuring full anonymity. The responses were transcribed intelligent verbatim and reviewed independently by the primary and senior authors using reflexive thematic analysis to collate common themes from the qualitative data (Braun & Clarke, 2019).

RESULTS

Global online survey

A total of 68 responses were received; 71% ($n = 48/68$) met inclusion criteria, representing 22 countries (Fig. 1). Euthanasia was reported as available in 82% ($n = 18/22$) of countries, restricted in three, and not currently an

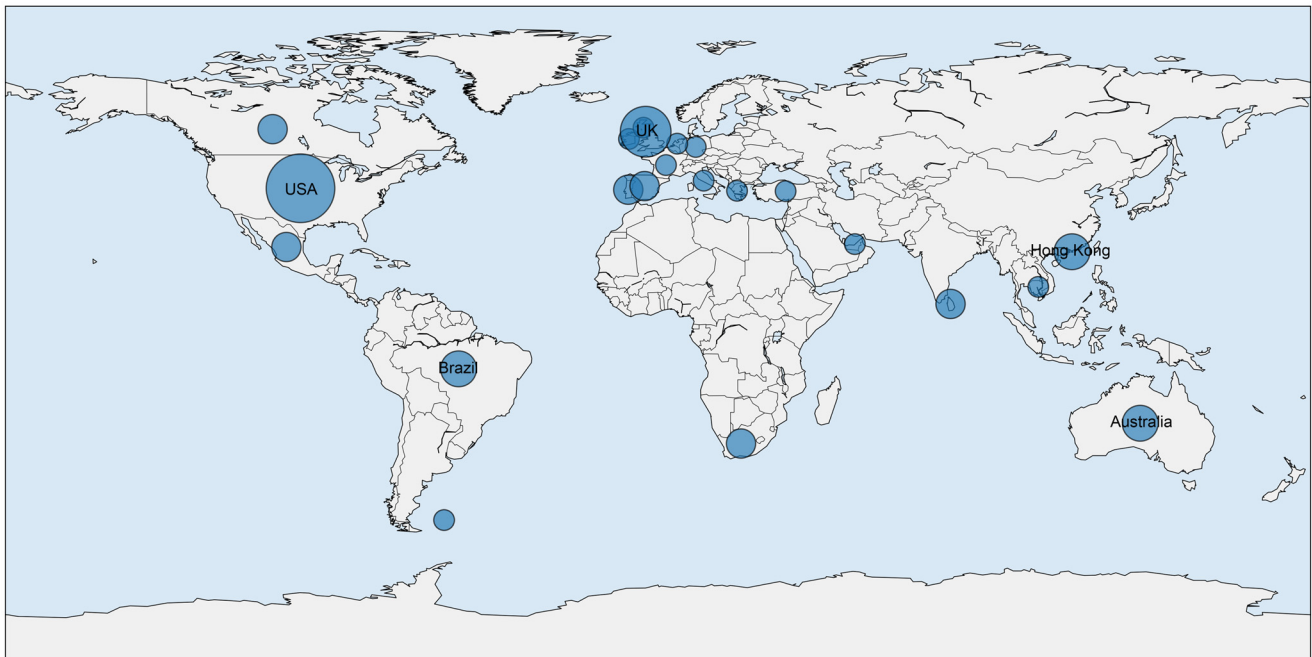


Figure 1. Bubble map of survey respondents who met inclusion criteria ($n = 48$). Size of bubble indicates number of respondents, varying from 1–11. Countries represented by ≥ 3 respondents have a country name label. Note: Countries were self-reported with six respondents stating 'UK' which could relate to England, Wales, Scotland or Northern Ireland.

option in one due to a lack of veterinary training and funding (Cambodia). Respondents from 77% of countries ($n = 17/22$) reported that cetacean euthanasia had been conducted with no cases reported by respondents from Sri Lanka, Germany, Cambodia, Mexico, or the United Arab Emirates.

Species and methods of euthanasia

Euthanasia was reported for 10 of 14 cetacean taxonomic groups (Fig. 2), most frequently *Delphinidae* (98%, $n = 45/48$), likely reflecting their higher stranding incidence and/or cosmopolitan/global distribution. No euthanasia cases were reported for the families *Iniidae*, *Lipotidae*, *Neobalaenidae*, or *Platanistidae*.

Chemical euthanasia was reported by 83% ($n = 40/48$) of respondents, most commonly using barbiturates (62.5%, $n = 25/40$). Sedatives (xylazine, midazolam, acepromazine) were sometimes used prior to potassium chloride (KCl) or barbiturates. Among respondents reporting administration routes ($n = 15$), 93% cited intravenous injection, though procedural detail was limited. Other routes were reported (intracardiac, intramuscular, intrathoracic, intraperitoneal), but technical details were rarely specified.

Physical methods were used in 48% ($n = 23/48$) of responses. Of these, 39% ($n = 9/23$) specified the use of ballistics (.308 or .375 calibre rifles; small-calibre rifles or shotguns). Only one respondent specified ammunition, specifically 180 grain monolithic flat-nose projectiles. Explosives ($n = 2$) and exsanguination ($n = 2$) were also reported as methods, but no procedural details were provided.

Key themes influencing euthanasia decision-making

Thematic analyses (see Supplementary Material, Tables S1–S8) indicated that euthanasia decision-making is mainly influenced by training and personnel availability, access to effective methods, and sociocultural or political acceptance, alongside logistical, safety, and regulatory constraints. Only 4% ($n = 2/48$) reported minimal barriers to undertaking euthanasia.

Decision-making was typically veterinarian-led but embedded within multi-layered governance, with uncertainty around legal authority and contingency decision-makers. Funding was most often provided by non-governmental organisations (NGOs), charities, or individual professionals (69%, $n = 33$), with partial or inconsistent government support sometimes provided (25%, $n = 12$).

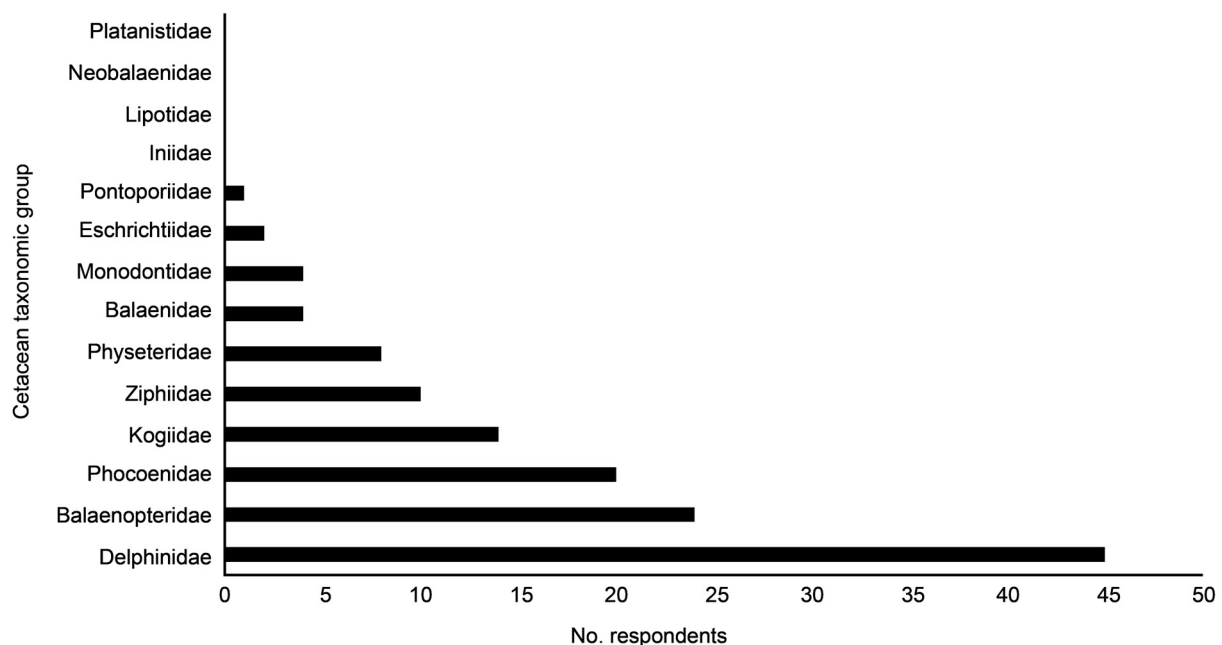


Figure 2. Number of respondents reporting euthanasia cases in their country by cetacean taxonomic group.

Euthanasia was usually performed by veterinarians (54%, $n = 26$), with authorised non-veterinary personnel applying physical methods where required (23%, $n = 11$). Most practitioners were part of stranding networks or government agencies (85%, $n = 41$).

Overall, respondents emphasised that euthanasia at strandings remains a multifactorial challenge, constrained by funding, legal ambiguity, public misunderstanding, and limited capacity, particularly for large whales (e.g., baleen whales and sperm whales) and mass strandings.

In-person workshop

A total of 30 participants from 15 countries joined the workshop in person (Fig. 3). Participants comprised biologists (40%; $n = 12/30$) and veterinarians (60%; $n = 18/30$), representing doctoral students and early-career and senior researchers. The female-to-male ratio was 2:1 (females: 67%, $n = 20/30$; males: 33%, $n = 10/30$).

Key themes influencing euthanasia decision-making

Workshop participants consistently identified euthanasia decision-making during cetacean strandings as a complex, multifactorial process. Participants highlighted such events as highly context-dependent, influenced by logistics, animal welfare considerations, responder capacity, governance frameworks, and public and media pressures. Across discussions, the effectiveness and timeliness of decisions were strongly shaped by the availability of trained personnel, access to appropriate equipment and chemical agents, and clarity regarding legal authority. In many cases, participants reported that what could be done during a stranding was constrained more by legal, logistical, and organisational factors than by what would be optimal for animal welfare.

FACTORS INFLUENCING WHETHER AND WHEN TO EUTHANISE

Decisions regarding *whether* to euthanise were primarily dependent on the ability to conduct accurate and consistent welfare assessments. Key limiting factors included access to trained assessors, availability of diagnostic information, logistical and financial constraints, and external pressures from the public or media. Participants identified improved training, consistent assessment frameworks, and long-term investment in staff retention as priority areas for improvement.

Decisions regarding *when* to euthanise were strongly influenced by the availability of trained personnel, equipment, logistical capacity, and legal authority. Participants highlighted challenges relating to unclear organisational roles and responsibility for decision-making during events.

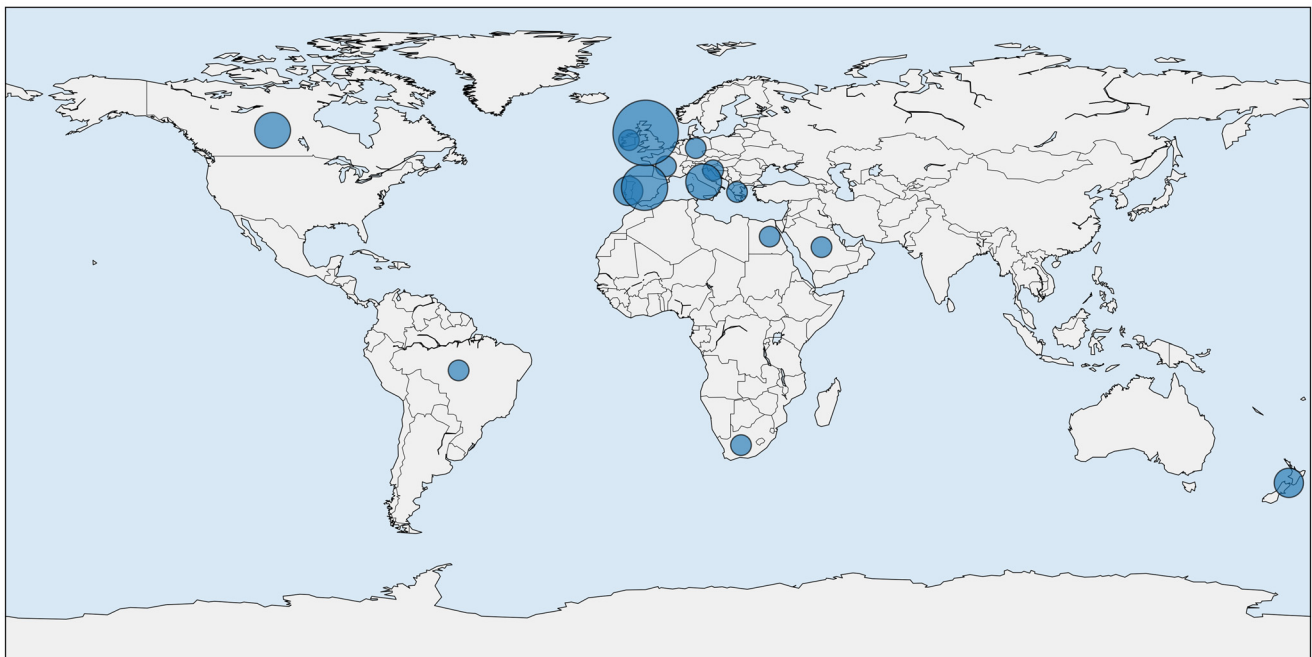


Figure 3. Bubble map of workshop participants (n = 30). Size of bubble indicates number of participants, varying from 1–10. Participants were working in: UK, Egypt, Spain, Canada, Greece, Portugal, Italy, New Zealand, Germany, Croatia, Brazil, Saudi Arabia, France, Ireland, South Africa.

ASSESSMENT OUTCOMES AND INTERVENTION OPTIONS

Participants considered four primary outcomes following welfare assessment of live stranded animals: refloating, euthanasia, palliative care, or no intervention with natural death. Decisions on intervention were suggested to be guided by animal welfare indicators, clinical prognosis, and contextual constraints. Euthanasia was considered appropriate where prognosis was poor and suffering was likely to be prolonged, refloating was unsafe or unfeasible, or animal independence could not be guaranteed. Selection of a given euthanasia method also required consideration of human safety, animal species and size, stranding location (e.g., proximity to populated areas) and substrate, legal constraints, and carcass disposal implications.

Barriers to euthanasia decision-making

Eight overarching themes emerged from thematic analysis as recurrent barriers or concerns: (1) decision-making complexity and contextual constraints; (2) resource constraints; (3) animal welfare and ethical considerations; (4) public and media influence; (5) governance and legal authority; (6) training and capacity gaps; (7) responder mental health and wellbeing; and (8) the need for international consistency (see Supplementary Material Table S9).

DECISION-MAKING COMPLEXITY AND CONTEXTUAL CONSTRAINTS

Participants emphasised that each stranding event is unique, requiring flexible, context-specific evaluation. Species-specific factors, such as body size, cranial anatomy, degree of sociality, and maternal or social dependency, were reported to critically influence both feasibility and animal welfare outcomes of interventions. Environmental variables, including tidal state, weather conditions, substrate type, accessibility, and seasonality, were also identified as major determinants of what actions were possible during an event.

RESOURCE CONSTRAINTS

Resource availability emerged as a central constraint, with limited access to trained personnel, suitable euthanasia equipment, drugs, and transport often determining decision outcomes. Participants noted that in resource-limited settings, decisions may be driven by logistical feasibility rather than welfare-based best practice.

Additionally, lack of funding was commonly highlighted as a regional constraint that dictates decision-making and the governance of strandings. The lack of funding was directly related to training and other resource constraints. Lack of funding was noted across most regions, whether stranding response was led by an NGO or government.

ANIMAL WELFARE AND ETHICAL CONSIDERATIONS

Minimising animal suffering was consistently identified as the primary goal guiding euthanasia decisions, with participants acknowledging that euthanasia is often the most humane option when prognosis is poor, and that no intervention or palliative care alone can also be considered a valid option where no euthanasia methods are available. However, ethical tensions were reported in situations involving strong public pressure to attempt rescue despite a low likelihood of survival, the allocation of limited resources to individual high-cost cases, and in the use of palliative care approaches that may alleviate immediate suffering but potentially prolong the dying process. Such tensions reflect forms of moral distress commonly described in end-of-life practice, where professionals experience psychological strain when external constraints or conflicting expectations impede what they perceive to be the most ethically appropriate course of action.

PUBLIC AND MEDIA INFLUENCE

Although members of the public and the media can play a supportive role during live stranding responses, they were also widely reported as potentially having a negative influence on or disrupting euthanasia decision-making. Participants described frequent public misunderstanding of the rationale for euthanasia and rapid escalation of misinformation through social and mainstream media, leading to it being considered a 'taboo'. Limited personnel and resources were identified as barriers to proactive communication. Participants agreed that clear, transparent, and empathetic messaging delivered early during strandings response through designated spokespersons would improve public understanding, trust, and literacy.

GOVERNANCE AND LEGAL AUTHORITY

Considerable variability was reported between countries and regions in legal and regulatory frameworks governing euthanasia during cetacean strandings. Participants described differences in statutory authority, including who holds formal decision-making power (e.g., government departments, veterinarians, environmental agencies), which species may legally be euthanised, and whether specific methods – such as chemical, ballistic, or other physical approaches – are permitted under national legislation. In several jurisdictions, euthanasia decisions require prior formal approval from government authorities (sometimes involving multiple administrative levels) and/or cultural partners, which can introduce delays in time-sensitive situations and potentially compromise animal welfare outcomes. Participants also highlighted instances where legal ambiguity or lack of explicit guidance created uncertainty among responders, underscoring the need for clearer regulatory pathways and harmonised frameworks to support timely and welfare-informed decision-making.

TRAINING AND CAPACITY GAPS

A lack of formalised, standardised training in cetacean euthanasia was identified as a critical barrier. Participants noted that few countries offer structured euthanasia training, and that chemical euthanasia is often learned informally by veterinarians without species-specific instruction. Ballistics training was reported to be particularly limited. Participants highlighted the importance of undertaking necropsies following physical euthanasia to refine and improve procedures. Confidence in decision-making was frequently reduced by limited access to Standard Operating Procedures (SOPs), low case exposure, and reluctance to share mistakes or adverse outcomes. The latter was felt to be a key point and vital in helping to improve future response to live strandings.

RESPONDER MENTAL HEALTH AND WELLBEING

Respondents described substantial psychological burdens associated with cetacean euthanasia, including mental trauma, profound sadness, guilt, (fear of) public criticism, and concern about reputational consequences. These pressures were reported to arise not only from external audiences, such as media and members of the public – whose cultural perceptions of stranded animals and euthanasia vary considerably across regions – but also from professional communities, including colleagues from the broader cetacean field. Participants emphasised that

disagreement or criticism could significantly intensify stress for decision-makers, particularly in high-profile cases. Such experiences align with broader concepts of moral distress in wildlife practice, where professionals experience psychological strain when external expectations, governance constraints, or social pressures conflict with their clinical judgement regarding the most animal welfare-appropriate course of action. Over time, repeated exposure to these ethically charged situations may contribute to cumulative psychological harm, potentially affecting responder wellbeing, retention, and long-term network capacity. Despite this, very few organisations were described as having structured post-event debriefing or formal mental health support systems in place. Therefore, participants highlighted the importance of peer support, clear communication pathways, and access to professional psychological services to safeguard responder wellbeing and sustain effective stranding response operations.

INTERNATIONAL CONSISTENCY

Participants identified training and communication as central enablers of welfare-appropriate euthanasia decisions. Participants suggested that priority training areas for global stranding networks should include cetacean biology and anatomy, welfare assessment, legal frameworks, euthanasia methods, practical simulations, carcass disposal, public communication, health and safety, and mental health support. Participants emphasised the need for globally standardised yet regionally adaptable training, delivered through a combination of virtual and in-person formats, and supported by international collaboration and shared resources.

DISCUSSION

Results from the online survey and the workshop suggest that, at a global level, euthanasia decision-making during cetacean strandings is primarily constrained by systemic limitations in training, resources (both financial and logistical), governance, communication and public understanding of such events, rather than a lack of ethical clarity regarding animal welfare. While minimising suffering was universally identified as the primary objective, participants repeatedly described situations in which logistical, legal, or organisational barriers delayed, complicated or prevented euthanasia, potentially prolonging animal suffering. While our results provide important, relevant context for barriers to cetacean euthanasia as experienced by researchers and/or strandings response personnel, policymakers involved in stranding response did not attend the workshop, though they were invited to participate. Future work should include policymakers who can provide a more nuanced understanding of current governance and legal frameworks that are identified as barriers.

The authority to make euthanasia decisions, the legality of specific methods (e.g., chemical versus ballistic), and species-specific protections differ widely among countries and, in some cases, within jurisdictions (Daoust & Ortenburger, 2015; Barco *et al.*, 2016; Harms *et al.*, 2018; Leary *et al.*, 2020; Boys *et al.*, 2022c). In certain contexts, euthanasia decisions require formal governmental approval, potentially delaying intervention and increasing animal suffering. Additionally, participants reported inconsistencies in financial responsibilities and resources for strandings, highlighting a structural governance issue. This heterogeneity in legal and operational frameworks complicates the development of consistent, welfare-informed responses to strandings and underscores the need for clearer delegation of authority and pre-established decision pathways. The implementation of coordinated monitoring and response frameworks developed under multilateral conservation agreements can aid in the standardisation of stranding response procedures and emphasise the importance of welfare-based decision-making (ACCOBAMS, 2018).

Training and responder capacity are widely recognised as critical determinants of euthanasia outcomes. Accurate welfare assessment and safe implementation of euthanasia require specialised knowledge of cetacean biology, anatomy, physiology, behaviour, and species-specific responses to both chemical and ballistic methods. Nevertheless, formal, standardised training in cetacean euthanasia is limited globally, and practical experience is often gained informally or on an *ad hoc* basis (Barco *et al.*, 2016; Boys *et al.*, 2021). This lack of structured training and access to SOPs may reduce responder confidence, contribute to inconsistent decision-making, and increase risks to both animals and personnel. The lack of formalised training in both chemical and ballistic euthanasia represents a critical gap, particularly given the potentially high-risk nature of these procedures for both animals and humans (Leary *et al.*, 2020).

Public and media engagement represents an additional layer of potential pressure. Cetacean strandings often attract intense public interest, and euthanasia decisions may be viewed as a taboo topic or be subject to scrutiny, bias, misunderstanding, or opposition (Boys *et al.*, 2022c; Stockin *et al.*, 2022). The rapid spread of misinformation through social and mainstream media can further influence public perception and place additional pressure on responders (Boys *et al.*, 2022c). Proactive, transparent, and empathetic communication has been identified as essential for maintaining public trust and supporting welfare-based decisions for marine mammals (Nunny *et al.*, 2025; see lay statement in Supplementary Material), yet many stranding networks lack the resources or training necessary to implement effective communication strategies.

Finally, the emotional and psychological impacts of euthanasia on responders are increasingly recognised as a significant but under-addressed concern. First responders, veterinarians, and markspersons may experience moral distress, compassion fatigue, and long-term psychological effects following euthanasia events, particularly in the absence of structured post-event support (Caro, 2018; Yeung *et al.*, 2017, 2021). Failure to address responder wellbeing risks attrition, reduced capacity, and loss of institutional knowledge within stranding networks.

Overall, respondents identified trained personnel, standardised yet contextually adaptable protocols, and sustained government-supported systems as the primary determinants of effective euthanasia during stranding events. Implementation capacity was closely linked to legislative clarity, secure funding, defined governance pathways, and structured training, with public education and responder wellbeing recognised as essential enabling conditions. In the absence of these foundational elements, euthanasia decisions were perceived as vulnerable to inconsistency, delay, and external pressures, with direct implications for animal welfare. Collectively, the survey and workshop findings underscore the need for coordinated investment in training, resource allocation, governance harmonisation, and knowledge-sharing to support transparent, timely, and welfare-centred decision-making, while strengthening operational resilience and public trust in stranding response systems.

RECOMMENDATIONS

Based on the views expressed during the workshop, participants proposed the following recommendations, many of which could be progressed via a workshop supported by an international body (e.g., IWC).

Strengthen international governance and coordination

- Increase funding, equipment, and personnel to support humane and efficient euthanasia assessments and interventions.
- Establish an International Marine Mammal End-of-Life Working/Research Group to evaluate existing protocols and outcomes, develop welfare-centred decision trees, and guide training programmes and development of new techniques.
- Mandate leadership from established bodies (e.g., IWC) to harmonise euthanasia guidance while allowing for legal and cultural adaptation.
- Develop standardised but adaptable protocols to reduce delays caused by fear of public or legal repercussions.

Build regional response capacity

- Create regional euthanasia response teams in areas with frequent strandings to reduce national costs and maintain responder competence.
- Implement mixed-experience deployment models pairing specialists with less experienced responders to ensure long-term operational capacity.
- Address cross-border barriers (including but not limited to personnel authorisation, drug/firearm transport, and funding) through existing multilateral agreements.

Improve public communication and social licence

- Develop science communication training and share tools to reduce misinformation and improve public understanding of euthanasia as a humane outcome (see lay statement in Supplementary Material).
- Reframe euthanasia as a proactive welfare tool rather than a last resort measure.
- Build trust through transparency and welfare-centred messaging to enhance social licence to implement euthanasia.
- Use pre-approved science-based messaging that prioritises 'welfare over hope' during high-profile events to better prepare the public and protect responders (see lay statement in Supplementary Material).

Integrate mental health support into response frameworks

- Embed mental health support structures into training and operational protocols to prevent burnout and attrition.
- Implement structured post-incident debriefing after euthanasia events.
- Establish peer-support networks and access to professional counselling.
- Provide psychological first-aid training for responders facing acute stress.

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REFERENCES

- ACCOBAMS (2018). Guidelines for a Coordinated Cetacean Stranding Response During Mortality Events Caused by Infectious Agents and Harmful Algal Blooms. ACCOBAMS. https://www.accobams.org/wp-content/uploads/2018/09/GL_coordinated_cetacean_stranding_response.pdf
- Barco, S.G., Walton, W.J., Harms, C.A., George, R.H., D'Eri, L.R., & Swingle, W.M. (2016). Collaborative development of recommendations for euthanasia of stranded cetaceans. Technical Memorandum NMFS-OPR-56, US NOAA. <https://doi.org/10.7289/V5/TM-OPR-56>
- Boys, R.M., Beausoleil, N.J., Betty, E.L., & Stockin, K.A. (2021). Deathly Silent: Exploring the Global Lack of Data Relating to Stranded Cetacean Euthanasia. *Animals* 11(5): 1460. <https://doi.org/10.3390/ani11051460>
- Boys, R.M., Beausoleil, N.J., Pawley, M.D.M., Littlewood, K.E., Betty, E.L., & Stockin, K.A. (2022a). Fundamental concepts, knowledge gaps and key concerns relating to welfare and survival of stranded cetaceans. *Diversity* 14(5): 338. <https://doi.org/10.3390/d14050338>
- Boys, R.M., Beausoleil, N.J., Pawley, M.D.M., Littlewood, K.E., Betty, E.L., & Stockin, K.A. (2022b). Identification of potential welfare and survival indicators for stranded cetaceans through international, interdisciplinary expert opinion. *R. Soc. Open Sci.* 9(10): 220646. <https://doi.org/10.1098/rsos.220646>
- Boys, R.M., Beausoleil, N.J., Betty, E.L., & Stockin, K.A. (2022c). When and how to say goodbye: An analysis of Standard Operating Procedures that guide end-of-life decision-making for stranded cetaceans in Australasia. *Mar. Pol.* 138: 104949. <https://doi.org/10.1016/j.marpol.2021.104949>
- Boys, R.M., Stewart, R.O., Lye, G., Beausoleil, N.J., & Stockin, K.A. (2026). Estimating the welfare impacts of differing projectile types utilised for stranded cetacean euthanasia. *Sci. Rep.* 16: 20825. <https://doi.org/10.1038/s41598-026-50867-7>
- Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qual. Res. Sport Exerc. Health* 11(4): 589–597. <https://doi.org/10.1080/2159676X.2019.1628806>
- Cámara, N., Sierra, E., Fernández-Maldonado, C., Espinosa de los Monteros, A., Arbelo, M., Fernández, A., & Herráez, P. (2019). Stress cardiomyopathy in stranded cetaceans: A histological, histochemical and immunohistochemical study. *Vet. Rec.* 185(22): 694–694. <https://doi.org/10.1136/vr.105562>
- Caro, J. (2018). Compassion Fatigue among Wildlife Rescue and Rehabilitation Workers in South Africa. PhD Thesis, The Chicago School of Professional Psychology.
- Coughran, D.K., Stiles, I., & Mawson, P. (2012). Euthanasia of beached humpback whales using explosives. *J. Cetacean Res. Manage.* 12(1): 137–144. <https://doi.org/10.47536/jcrm.v12i1.600>
- Daoust, P., & Ortenburger, A. (2001). Successful euthanasia of a juvenile fin whale. *Can. Vet. J.* 42: 127–129.
- Daoust, P.-Y., & Ortenburger, A. (2015). Advice on Euthanasia Techniques for Small and Large Cetaceans. Document 2014/111, DFO Canadian Science Advisory Secretariat.
- Dunn, J.L. (2006). Multiple-Agent Euthanasia of a Juvenile Fin Whale, *Balanoptera Physalus*. *Mar. Mammal Sci.* 22(4): 1004–1007. <https://doi.org/10.1111/j.1748-7692.2006.00073.x>
- Grattarola, C., Pietrolungo, G., Belluscio, D., Berio, E., Canonico, C., Centelleghé, C., Cocumelli, C., Crotti, S., Denurra, D., Di Donato, A., Di Francesco, G., Di Guardo, G., Di Nocera, F., Di Renzo, L., Gavaudan, S., Giorda, F., Lucifora, G., Marino, L., Marcer, F., & Casalone, C. (2024). Pathogen Prevalence in Cetaceans Stranded along the Italian Coastline between 2015 and 2020. *Pathogens* 13(9): 762. <https://doi.org/10.3390/pathogens13090762>
- Hampton, J., Mawson, P., Coughran, D., & Vitali, S. (2014). Validation of the use of firearms for euthanising stranded cetaceans. *J. Cetacean Res. Manage.* 14(1): 117–123. <https://doi.org/10.47536/jcrm.v14i1.528>
- Harms, C.A., Greer, L., Whaley, J., & Rowles, T.K. (2018). Euthanasia. In: *CRC Handbook of Marine Mammal Medicine* (3rd ed., pp. 675–691). CRC Press.
- Harms, C.A., McLellan, W.A., Moore, M.J., Barco, S.G., Clarke III, E.O., Thayer, V.G., & Rowles, T.K. (2014). Low-residue euthanasia of stranded mysticetes. *J. Wildl. Dis.* 50(1): 63–73. <https://doi.org/10.7589/2013-03-074>
- Herráez, P., Espinosa de los Monteros, A., Fernández, A., Edwards, J. F., Sacchini, S., & Sierra, E. (2013). Capture myopathy in live-stranded cetaceans. *Vet. J.* 196(2): 181–188. <https://doi.org/10.1016/j.tvjl.2012.09.021>
- IWC (2014). Report of the IWC Workshop on Euthanasia Protocols to Optimize Welfare Concerns for Stranded Cetaceans. https://iwc.int/public/documents/v6Jne/IWC%20Euthanasia%20Workshop%20Report_FINAL_31-03-14.pdf
- Kolesnikovas, C., Groch, K., Groch, K., Moraes, A., Flores, P., Pretto, D., Freitas, R., Gaidzinski, M., & Moreira, L. (2012). Euthanasia of an Adult Southern Right Whale (*Eubalaena australis*) in Brazil. *Aquat. Mammals* 38(3): 317–321. <https://doi.org/10.1578/am.38.3.2012.317>
- Leary, S., Underwood, W., Anthony, R., Cartner, S., Grandin, T., Greenacre, C., Gwaltney-Brant, S., McCrackin, M., Meyer, R., Miller, D., Shearer, J., Turner, T., & Yanong, R. (2020). *AVMA Guidelines for the Euthanasia of Animals: 2020 Edition*. American Veterinary Medical Association.
- Moore, K.M., Simeone, C.A., & Brownell Jr., R.L. (2018). Strandings. In: B. Würsig, J. Thewissen, & K. M. Kovacs (Eds.), *Encyclopedia of Marine Mammals*. Academic Press/Elsevier.
- Nunny, L., Bossley, M., Boys, R.M., Brakes, P., Genov, T., Parsons, E.C.M., Peters, K., Rose, N.A., Stockin, K.A., Vail, C.S., Visser, I., & Simmonds, M.P. (2025). Out of Habitat Marine Mammals – Identification, Causes and Management Recommendations. *Mar. Pol.* 177: 106652. <https://doi.org/10.1016/j.marpol.2025.106652>
- Patton, M. (2002). *Qualitative Research and Evaluation Methods*. SAGE.
- Simeone, C., & Moore, K. (2018). Appendix 5. In: F. Gulland, L. Dierauf, & K. Whitman (Eds.), *CRC Handbook of Marine Mammal Medicine* (3rd edn., pp. 1035–1087). CRC Press.
- Stockin, K.A., Pawley, M.D.M., Jarvis, R.M., & Boys, R.M. (2022). Examining the role of human perceptions during cetacean stranding response in New Zealand. *Mar. Pol.* 145: 105283. <https://doi.org/10.1016/j.marpol.2022.105283>

- Stringfellow, H., Butterworth, A., & Simmonds, M. (2022). An analysis of the approaches taken around the world to whale euthanasia. *Anim. Welf.* 31(1): 113–123. <https://doi.org/10.7120/09627286.31.1.010>
- Yeung, P., White, B., & Chilvers, B.L. (2017). Exploring Wellness of Wildlife Carers in New Zealand: A Descriptive Study. *Anthrozoös* 30(4): 549–563. <https://doi.org/10.1080/08927936.2017.1370213>
- Yeung, P., White, B., Ziccardi, M., & Chilvers, B.L. (2021). What Helps Oiled Wildlife Responders Care for Animals While Minimizing Stress and Compassion Fatigue. *Animals* 11(7). <https://doi.org/10.3390/ani11071952>

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SUPPLEMENTARY MATERIAL

EXAMPLE LAY STATEMENT FOR POTENTIAL USE DURING A LIVE STRANDING EVENT

This statement is scientific in nature, and, for the purposes of public communication, it can be acceptable to use emotive descriptions to express feelings of empathy by the organisations and responders involved to better connect with the public.

Cetaceans (porpoises, dolphins, and whales) occasionally strand alive on shores and coastal areas for a variety of reasons, but a significant number of them may have stranded due to a serious health issue that has left them weak and disoriented.

In these situations, where a veterinary/welfare or health assessment concludes that the animal has a limited chance of long-term survival, the most compassionate option for the stranded cetacean is to euthanise them. Returning a sick animal to the water often leads to further suffering, and they typically strand again shortly afterwards.

It is also important to understand that, even if the cetacean appears healthy when they strand, they will quickly be affected by the consequences of being trapped on land. They can deteriorate rapidly as a result, and generally, the larger the animal, the more quickly and severely they can suffer from life-threatening complications. These complications are not always reversible, and, in some cases, euthanasia or enabling as peaceful a natural death as possible may be necessary due to the impact of live stranding on the cetacean.

Similar to many other animals (e.g., pets, farm animals), euthanasia for smaller cetaceans is usually performed through the injection of a drug that induces death. In addition, in some situations, a firearm may be used by a qualified marksperson to humanely euthanise the animal. Each method is intended to cause death as quickly and with as little distress as possible. However, for larger species, such as almost all baleen whales as well as sperm whales, euthanasia becomes much more difficult (and in some cases impossible) to perform.

There are many reasons why euthanising large whales is challenging, but the difficulty is primarily due to their sheer size. These animals are often so large that the previously mentioned euthanasia methods are not practically feasible; for example, the quantities of drugs required would be difficult to obtain and administer safely and humanely. Additionally, ballistic methods may not be powerful enough to ensure a quick and painless death.

Another key issue is human safety, which is a top priority when response teams attend a stranded cetacean. Sometimes, it is just not safe to approach the animal without risking serious injury, or even death, especially if the animal is highly stressed and thrashing as a result.

Ultimately, this dilemma leads to situations where, particularly in the case of large cetaceans, euthanasia is not feasible. In such cases, the chosen course of action is to not intervene further or to provide palliative care, if safe and logistically possible to do so, and allow the cetacean to die naturally. Although this may not be the desired outcome for some people, it is often in the best interests of the stranded cetacean. Research is ongoing to find solutions to this problem, and it is hoped that, in the near future, viable euthanasia options will be available for these larger animals. In the meantime, when faced with such situations, response teams strive to ensure the animal experiences the least distress possible.

This can understandably be upsetting to witness, and it can be difficult to process and accept the fact that no other options are available. However, organisations experienced in cetacean stranding response assess each stranding on a case-by-case basis, in consultation with a veterinarian, where possible, to determine the best outcome for the animal's welfare.

THEMES IDENTIFIED FROM RESPONDENTS' WRITTEN RESPONSES TO THE SURVEY QUESTIONNAIRE

Table S1
Barriers and constraints to applying euthanasia at cetacean stranding events

Theme	Description	Illustrative quotes (verbatim)
Logistical and access constraints	Physical access to animals, remoteness, weather, terrain, time delays	"Very remote locations, private land"; "Topography of the beach...sometimes inaccessible or accessible just by boat"; "Distances"; "Availability to reach stranding sites, Weather"
Limited availability of trained personnel	Shortage of experienced marine mammal veterinarians and trained responders	"Limited vets"; "Lack of veterinary support"; "Small amount of trained marine mammals' vet"; "Local vets are not trained in marine mammals"
Equipment and method limitations	Lack of appropriate drugs, firearms, ballistics, or tools (especially for large whales)	"Availability of chemicals/ballistic methods"; "Limited euthanasia methods, especially in case of baleen whales strandings"; "Lack of specialized equipment (large whales)"
Legal, administrative, and governance barriers	Bureaucracy, unclear authority, permitting delays	"Permission from the national department needed first"; "Legal barrier, despite the fact that the protocol mentions that euthanasia can be applied"; "Convincing bureaucrats that immediate euthanasia in emergencies requires rapid permission"
Public, cultural, and media opposition	Public perception, cultural beliefs, fear of backlash	"Ethical and cultural bias. Public reaction."; "Public opinion is our main barrier now"; "General public demonstrates their objection against euthanasia on-site"
Safety and environmental risks	Risks to responders, contamination concerns, carcass disposal	"Safety of personnel"; "Environmental contamination"; "Proper disposal of the contaminated carcass"
Funding constraints	Insufficient or unstable funding for euthanasia response	"Funding for material acquisition"; "Financial- live stranding response is voluntary"; "Costs can escalate for larger animals"

Table S2
Most important barriers to applying euthanasia (Max. 3)

Priority theme	Description	Illustrative quotes (verbatim)
Availability of trained personnel	Lack of experienced vets and authorised responders	"Availability of suitably qualified persons"; "Lack of trained personnel"; "Limited training opportunities for the wildlife vets on cetaceans"
Access to methods and equipment	Drug availability, firearms, tools for large whales	"Availability of appropriate weapons and drugs"; "Drug availability"; "Lack of policy for large whale euthanasia"
Public perception and political reluctance	Fear of backlash influencing decisions	"Public (and volunteers') perception"; "Authorities' cowardice"; "Government delegates are timid to take action"

Table S3
Decision-makers for euthanasia at stranding events

Theme	Description	Illustrative quotes (verbatim)
Veterinarian-led decisions	Vet holds primary authority	"The vet in charge"; "Veterinarian"; "The attending vet"
Collaborative decision-making	Vet in consultation with networks or authorities	"The on-site veterinarian in consultation with stranding network"; "Responding organization's attending veterinarian, in consultation with stranding coordinator"
Government or agency-controlled decisions	Formal authority held by state bodies	"Department of Wildlife Conservation"; "Environmental authorities"; "NOAA authorizes Stranding Networks"
Unclear or ad hoc decision-making	No formal protocol or authority	"Whoever is there. There is no official protocol."; "Currently unknown."

Table S4
Responsibility for costs of euthanasia

Theme	Description	Illustrative quotes (verbatim)
Charities and NGOs	Non-profits bear most costs	"Costs fall on charities"; "Our organization bears the cost 100%"; "Local non-profit institution making the decision"
Government or public authorities	State-funded or shared responsibility	"Ministry"; "Government"; "Stranding Network (under public funding)"
Veterinary practices or individuals	Donated services, drugs, or time	"Drugs if used are covered by donating vet practice"; "Vets and others volunteer their services"
Unclear or inconsistent funding	No clear cost owner	"Don't know!"; "This is unclear."

Table S5
Who undertakes/enacts euthanasia

Theme	Description	Illustrative quotes (verbatim)
Veterinarians	Direct administration by vets	"Vet"; "Veterinarian"; "Stranding network veterinarian"
Authorised personnel under vet oversight	Firearms officers, marksmen, police	"Veterinarians or marksmen"; "Police in some cases (firearms)"; "Firearms officers carry out physical euthanasia supervised by wildlife vets"
Stranding network staff	Trained responders or biologists	"Stranding network team members at the site"; "Qualified biologists"
Non-standard actors	Landowners or military in exceptional cases	"Some landowners have also done it themselves"; "It has been done by the MoD"

Table S6
Key needs and areas for improvement

Theme	Description	Illustrative quotes (verbatim)
Training and certification	Skills development and competence	"Veterinary service training on euthanasia"; "Specific marine mammal euthanasia training and certification courses"; "More clinical practice"
Standardised protocols and decision tools	Clear SOPs and guidance	"A protocol is needed"; "Clear specs-specific guidelines and decision trees"; "A decision-making tree with a fast response"
Access to methods and equipment	Reliable drugs, firearms, tools	"Better access to effective methods"; "Alternatives to barbiturates"; "More relevant weapons and equipment"
Governance and accountability	Clear authority and responsibility	"No assigned decision-maker"; "Chain of action (administrative permits)"
Public communication and education	Managing public and media	"Clear criteria as to when and why (for public)"; "Website explaining why the End of Life (EoL) decision was made"
Responder wellbeing	Emotional and psychological support	"Emotional support for responders"; "Mental health support post euthanasia"
Funding and infrastructure	Sustainable resources	"Consistent funding to stranding networks"; "Increase economic resources"

Table S7
Most important improvement and implementation

Priority	Description	Illustrative quotes (verbatim)
Training and standardised protocols	Foundational improvement across regions	“Training and certification – Currently in our country there does not exist any sort of standardized certification”; “Harmonization and application of a common management protocol”
Government leadership and funding	Structural responsibility	“The government should ‘decentralize’ the authority of decision making”; “It is increasingly indefensible for governments to outsource responsibility”

Table S8
Desired outcomes following the workshop and survey

Theme	Description	Illustrative quotes (verbatim)
Actionable outputs	Practical tools and guidance	“A written report presenting the aspects discussed”; “Suggested protocols and flow charts”; “A clear concise report”
Harmonisation and best practice sharing	International alignment	“An agreed approach to methods”; “Efficient successful practices other networks apply”
Policy and institutional impact	Influence on governments and agencies	“Pressure national conservation agencies”; “A collaborative paper outlining the need for fully developed and adequately supported euthanasia processes”
Capacity building and cultural change	Improved confidence and acceptance	“A recognition that we can and should do better”; “Open dialogue and capacity building”

THEMES IDENTIFIED FROM RESPONDENT DISCUSSIONS AT THE IN-PERSON WORKSHOP

Table S9
Summary of each group discussion at the in-person workshop

Discussion topic	Summary of discussions across groups
When end-of-life decisions should be enacted and what factors to consider	• Logistical constraints: availability of personnel, equipment, and ability to access the site. • Resource limitations: funding, trained responders, transport, communication tools. • Bureaucracy and legal issues: permits, jurisdictional authority, procedural delays. • Cultural/social factors: public expectations, community values, social pressure. • Technological tools: communication systems, diagnostics. • Environmental conditions: tides, storms, weather, daylight, beach geography. • Animal-related assessment: health status, body condition, likelihood of survival, age/social status, clinical signs indicating irreversible compromise. • Portugal: Vet-led, chemical euthanasia only, no government oversight; all carcasses recovered; increasing small-cetacean cases; resource and funding issues. • Germany: Federal system with government oversight; mainly physical euthanasia by licensed hunter; low staff numbers risking institutional memory loss. • Canary Islands: Spanish authority oversight; chemical euthanasia only; all animals recovered; vet-led per island; public perception and rehabilitation capacity influence decisions. • Brazil: Vet-led but government authority required; chemical euthanasia predominates; communication can be hindered by political sensitivities. • Azores: Difficult inter-island logistics; high public visibility; seasonal mix of species; strong public pressure. • Canada: Large coastline causing access issues; overlapping legal departments; vets decide chemical euthanasia, firearms done by separate department; limited resources; protected-species legal constraints. • Authority and governance: Who legally decides: national vs local; number and background of decision-makers (vet, biologist); legal authority for performing euthanasia; transferring responsibility between professionals. • Influence of politics/culture: Government involvement, cultural expectations, and interference in decision chains. • Public perception challenges: Social media visibility, crowd behaviour, aggression; need for uniformed officers for crowd control; public misinterpretation of euthanasia. • Assessment considerations: Species type, age or dependency status, health findings (clinical assessment, blood chemistry, blowhole parasitology, reflexes), behaviour, weather, safety, ability to monitor post-release. • Personnel and method availability: Chemical vs ballistic euthanasia varies by country; veterinary qualifications differ; often delays in mobilising trained responders; season influences staffing and detection. • Legal and practical constraints: Some countries prohibit euthanasia of certain species; requirements for special firearms licensing; restrictions on public first aid. • Rehabilitation: Often not available (Italy, UK); very limited capacity in Canada. • Disposal: Varies by country, owner, town, or government; chemically euthanised animals often must be removed. • Indigenous/community considerations: Cultural use of carcasses in parts of Canada; requirement for consultation may delay decisions. • Greece: Only vets can euthanise; refloat unless health assessment advises against; strong public and government influence; no rehabilitation centre; coordinated vet network. • Italy: Vet responsibility; stranding network; regional variability; chemical euthanasia preferred. • South Africa: No rehabilitation; health assessment essential; large whale euthanasia requires police collaboration; medium cetaceans via ballistics; small cetaceans chemically euthanised. • Croatia: No rehabilitation; limited marine mammal veterinary training; ministry and university involvement; no euthanasia cases yet. • USA: Government coordinators; vets euthanise with government permission; chemical euthanasia dependent on drug availability; region-specific but aligned protocols. • France: stranding network coordination; pilot programme to euthanise animals that cannot be refloated; vets and environmental police authorised in emergencies. • Canary Islands: Few live strandings; limited rehabilitation capacity; euthanasia requires government permission, sometimes delayed; need more trained personnel and structured networks.

Table S9 continued

Discussion topic	Summary of discussions across groups
	• Response network: Clear call-out system, decision trees, permissions, support structures. • Public & media considerations: Managing on-site public, aggression, media presence; ensuring safety. • Animal health assessment: Species ID, age, independence/weaning, body condition, wounds, parasites, reflexes, behaviour (on beach and in water), neurological signs. • Logistics: Carcass disposal, accessibility of site, weather, season, human safety. • Personnel & equipment: Availability of trained personnel, correct chemicals, firearms where applicable. • Legal constraints: Required authorisations, species restrictions, permits.
Whether euthanasia should be undertaken and what other end-of-life options exist	Core ethical question: “Should we?” • Decisions must be animal-centred, not human-centred. • Palliative care may prolong suffering and must be weighed carefully. Safety considerations • Human safety is a major factor: risk when approaching distressed, large, or inaccessible animals. • Safety/logistics influence whether euthanasia is even possible. Feasibility: “Can we?” • Availability of resources, equipment, permission, trained personnel, appropriate euthanasia tools. • Social licence: cultural expectations, public acceptance of euthanasia. Logistical constraints • Access to the site, weather, tide, geography. • Delegated responsibility: clarity on who holds the authority to decide. Animal-related assessment • Health assessment for stranded animals. • For free-swimming animals: ethics and optics of intervention; risk of harassment; viability of capture. • Out-of-habitat scenarios require species- and context-specific reasoning. Public misunderstanding • Do not underestimate human ignorance about cetacean behaviour and suffering, which affects public pressure and response options. National & network variations • Countries differ: some remove animals to euthanise, others euthanise onsite. • Differences in legal frameworks, species-specific rules, and access to firearms or drugs. Species-led decision making • Deep divers (beaked, striped dolphins), vaquita-type species, out-of-habitat animals, and maternally dependent calves may have poor prognosis and influence euthanasia decisions. Social considerations • Strong public opinion/pressure; misunderstanding of veterinary/biological roles. • Public perception of chemical vs physical euthanasia. • Crowd control essential; social media influences decisions. Health & welfare assessment • Behaviour, injury, entanglement, nutritional state. • Stranding history: time stranded, repeated public refloat attempts. Logistics & environment • Location, tide, weather, topography. • Substrate influences method choice (risk of ricochet). Free-swimming cases • Very hard to assess; legality and safety issues. • Tagging may support decisions to refloat vs euthanise. Financial & resource constraints • Euthanasia drugs, palliative options, and manpower limited in many regions. Communication • Need for transparent communication with public, media, and responders. Social, media & public involvement • Public misconceptions about causes (e.g., blaming aquaculture). • Aggressive or emotional public behaviour influences decisions. • Responders and media personnel may become upset, affecting judgement. • Conspiracy theories and public “experts” can disrupt decisions.

Table S9 continued

Discussion topic	Summary of discussions across groups
	Assessment (stranded or free-swimming) • Free-swimming assessments using drones/remotely operated vehicles (ROVs): body condition, entanglement, diving/breathing patterns. • Intervention stress must be weighed; some species tolerate herding or capture better than others. Refloat vs euthanasia decisions • Depends on health assessment, logistics, personnel, equipment. • Species considerations: social species may require locating conspecifics before refloat. • Public pressure often pushes for refloat even when inappropriate. Palliative care • Can reduce suffering but may prolong dying or complicate carcass disposal. • More relevant when euthanasia is not immediately possible. • In mass strandings, use of palliative care is limited because triage must be rapid. Euthanasia method considerations • Chemical and ballistic; CO₂ rejected as inhumane. • Large animals costly to euthanise chemically; drugs not always stocked. External influences • Logistics, environmental conditions, crowd control. • Stranding history: number of previous refloat attempts, time on beach, substrate, temperature. • Importance of post-release monitoring and tagging (not permitted in all countries). Individualised decision making • Each animal is unique; decision trees help but cannot capture all complexity. • Need flexibility due to differing health issues, logistics, zoonotic disease risk. Terminology and approach • Prefer “responders” over “rescuers” to reduce bias toward refloat outcomes. Public & media management • Important to engage proactively during major strandings. • Sometimes euthanasia is performed quietly to minimise public backlash. • Cultural differences: locality affects public behaviour. Assessment & veterinary role • Debate over whether blood tests or portable diagnostics should be required. • Veterinary exam essential, but availability and response time vary. • Need for overarching medical assessment protocols. Context & resource dependency • Euthanasia options depend on where the animal is and what resources exist. • Local emergency teams often make real-time decisions. Jurisdictional boundaries • Different authorities may claim responsibility depending on where the animal strands. Need for research • Proposal to create a dedicated study on stranding decision-making and validate through veterinarians. Reasons for intervention • Animal welfare: prime motivator. • Safety: risk to responders and the animal. • Public expectation: pressure to “do something.” Ethical considerations • Is intervention justifiable? • Distinguish natural vs anthropogenic causes (often difficult). • Should large funds be used for individual animals vs population-level conservation? • Balancing speed of action with avoiding premature decisions. Health assessment • An anamnesis is needed (species, age, sex, background). • Clinical and behavioural examination; must weigh environmental/logistical constraints. • Disease risk and zoonosis considerations. Safety & feasibility • Human and animal safety during approach. • Decisions complicated by season, weather, and presence/absence of rehabilitation facilities.

Table S9 continued

Discussion topic	Summary of discussions across groups
	Decision making under pressure • Teams must not feel constrained by external judgement – each case is unique. • Singular cases present unique welfare dilemmas with no universal algorithm.
What training and post-event support exists or is needed (at individual and community level)	Training Needs Across Roles • Training required for: vets (chemical methods), responders, ballistics/markspersons, public communication teams. • Create cheat sheets for inexperienced vets facing real-time decisions. • Identify marine mammal experts to mentor less experienced vets. Protocols & Institutional Knowledge • Need to write, update, and maintain protocols; integrate regular reviews after each event. • Barrier: high turnover → loss of institutional knowledge; training must compensate. Communication Skills • Training in public communication, including explaining decisions calmly and clearly. • Community involvement: post-event follow-up and communication during events. Post-event Support • Importance of debriefs and emotional support for responders. Technical Training Requirements • Training needed in both physical and chemical euthanasia methods. • Emphasis on practical, hands-on training using dead animals: - o Ballistics practice. - o Chemical technique confidence-building. - o Understanding anatomy, landmarks, and safety. • Practice should be iterative: learn from each event and improve. Behaviour & Welfare Knowledge • Understanding behaviour pre- and during euthanasia. • Awareness of species-specific reactions. Training for Support Roles • Crowd control, logistics, safety personnel, media responders. • Public education on what responders do and why. Media & Public Interaction Training • How to communicate decisions under pressure. • How to handle misinformation and public distress. Post-euthanasia Support • Training on compassion fatigue, trauma, and emotional variance across staff. • Formal “lessons learned” debriefs essential. Team Structure • Clarify roles & responsibilities – but retain flexibility. • Training must acknowledge that stranding events involve small teams, intense periods, unpredictable workloads. • Address sexism from public or within professions that disrupts response dynamics. Training Should Cover All Levels Not only the vet or marksperson – training needed for: • Public call-handlers • Volunteers • Crowd control teams • Medics/responders • Media/media liaison • Support personnel • Ballistics operators • Disposal teams Core Content Areas • Compassion, what euthanasia involves, what to expect. • How to explain decisions to public and responders. • Clinical assessment under uncertainty. • Species-specific anatomy and expected reactions. • Substrate influences on ballistics. Practical & Resource-focused Training • Lists of available trained personnel and equipment. • Training in carcass disposal options (bury, incinerate, sink) – often ad hoc.

Table S9 continued

Discussion topic	Summary of discussions across groups
	Country-specific Differences • UK: guidance but no formal training in euthanasia; ballistics training lacking. • Spain: annual rescuer training, but euthanasia training is informal/on-the-job. • Italy: formal marine mammal euthanasia training as part of specialist veterinary course. • Canada: vets/pathologists have some chemical euthanasia experience but little/no ballistics training. Emotional & Mental Health Support • PTSD awareness and support should be built into training. • Include counselling or debriefing frameworks. • Training for marksperson/support teams on traumatic nature of euthanasia. Learning from Experience • Formal debriefs; volunteers should witness euthanasia to understand processes. • Explain what may go wrong in the procedure to prepare personnel. • Training in how methods impact carcass disposal. Network-wide Training • Multiple streams: coordination, crowd control, assessment, veterinary care. • Public training to promote prompt reporting of strandings. Current Training • South Africa: no formal euthanasia training; hunters use ballistics; police involved for large whale explosive euthanasia. • Croatia: no euthanasia yet; suggestion to collaborate with Italy's vets for training. • Italy: Stranding programme provides formal training, mainly chemical euthanasia; limited ballistics. • UK: Mostly chemical euthanasia; Scotland uses more ballistics; need for protocols and training. • Greece: No formal euthanasia agency; strong need for international certification; Stranding network vets trained to respond; euthanasia included in legislation. Training Gaps & Requirements • Lack of structured euthanasia training for responders and vets in many countries. • Demand for international training/certification, possibly globally standardised. • Need more training on: ◦ Practising euthanasia skills ◦ Decision-making around euthanasia ◦ Species-specific protocols ◦ Mass stranding responses Resources & Constraints • Insufficient resources for comprehensive training. • Variability in mass stranding frequency influences training needs. Mental Health / Post-event Support • Post-event support rarely funded; should be officially recognised. • Online debriefs helpful but not enough. Public Engagement Component • Train responders to communicate euthanasia as a humane option ("good death scenario"). Current State • UK: Stranding network has public live courses, but no specific vet euthanasia training. • Italy: no euthanasia training outside specialist veterinary pathways. • Saudi Arabia & Egypt: informal/unstructured stranding response, no euthanasia training. Training Infrastructure Needs • Regular, repeated inter-network discussions. • Consistent protocol use among official authorities. Global or Regional Training Strategy • Question of who should oversee training: Possible global leadership from IWC, Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS), Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS), European Cetacean Society (ECS), The Society for Marine Mammalogy (SMM). • Need for: ◦ Training sessions ◦ Toolkits ◦ Virtual learning modules ◦ Adaptable materials for low-income countries

Table S9 continued

Discussion topic	Summary of discussions across groups
	Inter-country Learning • Cross-country case-sharing (e.g., Cetacean Café, Global Stranding Network webinars). • Better promotion of existing tools and networks. Mental Health & Peer Support • Strong need for post-event support: - o Decision-makers - o On-scene responders - o Individuals performing euthanasia - o Public-facing personnel • Combination of professional mental health support and peer support. • UK: Stranding network online debriefs exist, but professional mental health support still needed. Cross-field cooperation • Collaboration across veterinary, rescue, marine science, mental health, and emergency organisations.
How to communicate the importance of end-of-life decisions to the public and media	• Prepare sample press releases in advance for a range of stranding/euthanasia scenarios. • Messaging must be clear, consistent, honest, and realistic. • Aim to set public expectations early and avoid mixed messages. What to Communicate • Necropsy results for euthanised or high-profile cases should be shared with: - o public - o media - o policymakers • Live strandings tend to be less politically sensitive than bycatch cases. Communication Strategy • Improve communication pathways from scientists to the media and the public. • Tailor messages for different audiences (public, media, policy). • Highlight wider issues such as morbidity, conservation and welfare context. Training & Capacity • Strong need for media training, potentially via workshops. • Resource limitations (time, money, personnel) constrain communication quality. • Government-level barriers to transparent communication also exist. Political Context • Public cynicism around government messaging; political climates (e.g., some administrations can influence trust and narrative around marine mammal welfare decisions). Timing & Transparency • Communicate as soon as possible, onsite and on social media. • Explain why euthanasia is being considered (poor outcomes, disease, age/dependency, prolonged stranding, social species without conspecifics). • Emphasise: “doing what is best for the animal.” Content • Begin with general/basic information, add detail as more is known. • Provide updates if the animal dies, is euthanised, and after necropsy. • Share post-mortem results with: - o public - o partners - o people who reported the animal - o on-scene responders Delivery & Structure • Ideally one designated local spokesperson (trusted figure). • Use press release templates for: - o initial media statements - o social media messaging - o post-necropsy summaries • Crowd control and public engagement are part of communication planning. Operational Considerations • Shield the vet and care team from media during the incident. • Allocate dedicated personnel for social media and press liaison.

Table S9 continued

Discussion topic	Summary of discussions across groups
	Public Perception and Cultural Factors • Visibility is variable (“just because it’s not on social media doesn’t mean it didn’t happen”; “just because it’s on social media doesn’t mean that’s what happened”). • Information disclosure depends on public sensitivity and cultural norms. • Some countries may be more prepared to accept euthanasia due to experience with other species. Organisational Communication Infrastructure • Need press officers and public-education capacity. • Build groundwork in advance to prepare: - o public - o government departments - o local communities Protecting Personnel • Communication should protect vets and responders from backlash. • External pressures and reputational risk can influence decisions. Media Relationships • Establish trusted contacts in media. • Use prepared statements; media inaccuracy is common without guidance. • Follow-up public relations (PR) opportunities after the event can help reinforce correct narratives. Training & Tools • Science communication training needed. • Use IWC guidance, case studies, self-produced articles. • Messaging must acknowledge risk of AI-generated misinformation. Public Acknowledgement • Good practice to publicly acknowledge partners, stakeholders, and accurate facts. When to Communicate • As early as possible – but: - o consider governmental approval processes - o some organisations legally cannot speak to the media • Real-time updates can provoke negative public reactions; timing must be strategic. Who Should Communicate • Ideally the stranding network or trained responders. • Communication responsibilities should be clear within the network. Message Content & Format • Prepare euthanasia statements with short social media versions and long-form detailed versions. • Develop globally adaptable messaging appropriate for different: - o countries - o literacy levels - o cultural contexts Structural Needs • Euthanasia and communication should be included in training curricula for stranding organisations. • Better advertising of tools and support networks (e.g., Global Stranding Network, IWC Expert Advisory Panel on Strandings). Communication Barriers • Government control, slow approval chains. • Lack of training in how and when to communicate