Results of the linear discriminant analysis (LDA)

All categories provided for scoring in the second round are shown on each LDA figure. The first two axes of the LDA were used to provide a visual representation of differences and similarities among expertise in relation to the major categories within each of the topics.

For each LDA figure, arrows show the direction of the gradient of larger scores, and the length of the arrows is proportional to the correlation between the variable (category) and the ordination (data points). Longer arrows in the same direction as the ordination of a particular expertise group, indicate that the group generally scored the category higher than the overall average. Whereas longer arrows in the opposite direction of the ordination of a particular expertise group, indicate that the group generally scored the category lower than the overall average. Ellipses were plotted to aid in the visualisation of expertise group scores. The ellipses indicate the 95% tolerance region of data points within each expertise group, estimated by fitting a bi-variate normal distribution to the covariance matrix of each expertise group. In some cases, the data for a particular expertise group were insufficient, therefore the ordination is plotted but there is no ellipse to indicate the 95% tolerance region.

Overall, there was substantial overlap among the expertise groups for all categories within each topic, with little correlation observed between expertise group and categories. However, in some cases there were slight trends that could be identified visually. Where slight trends among expertise groups for each topic could be identified, these are interpreted in the results sections below.

1. Characterising concepts of stranded cetacean welfare and survival

A LDA was performed, and the first two discriminant axes accounted for 72% of the variation (Figure 1). The results of this showed that there was substantial overlap among expertise groups with little correlation between particular expertise groups and certain variables (categories). Although the 'Other' expertise was grouped more on the negative side of LD2. Some generalised trends seen on the LDA suggest that 'cetacean expert (including cetacean conservation and biology)' (n=16) were less likely to score 'physical state and wellbeing, health, injury and disease status' (PhysState) as important for characterising welfare than the 'animal welfare expert with knowledge and/or focus on cetaceans' (n=3). In contrast, the 'animal welfare expert (including animal welfare science, welfare/animal ethics)' (n=9) were less likely to score 'Normal physiology and homeostasis' (Physiol) as important for characterising welfare, whereas 'veterinarian' (n=20) were more likely to score this variable as important for characterising welfare.

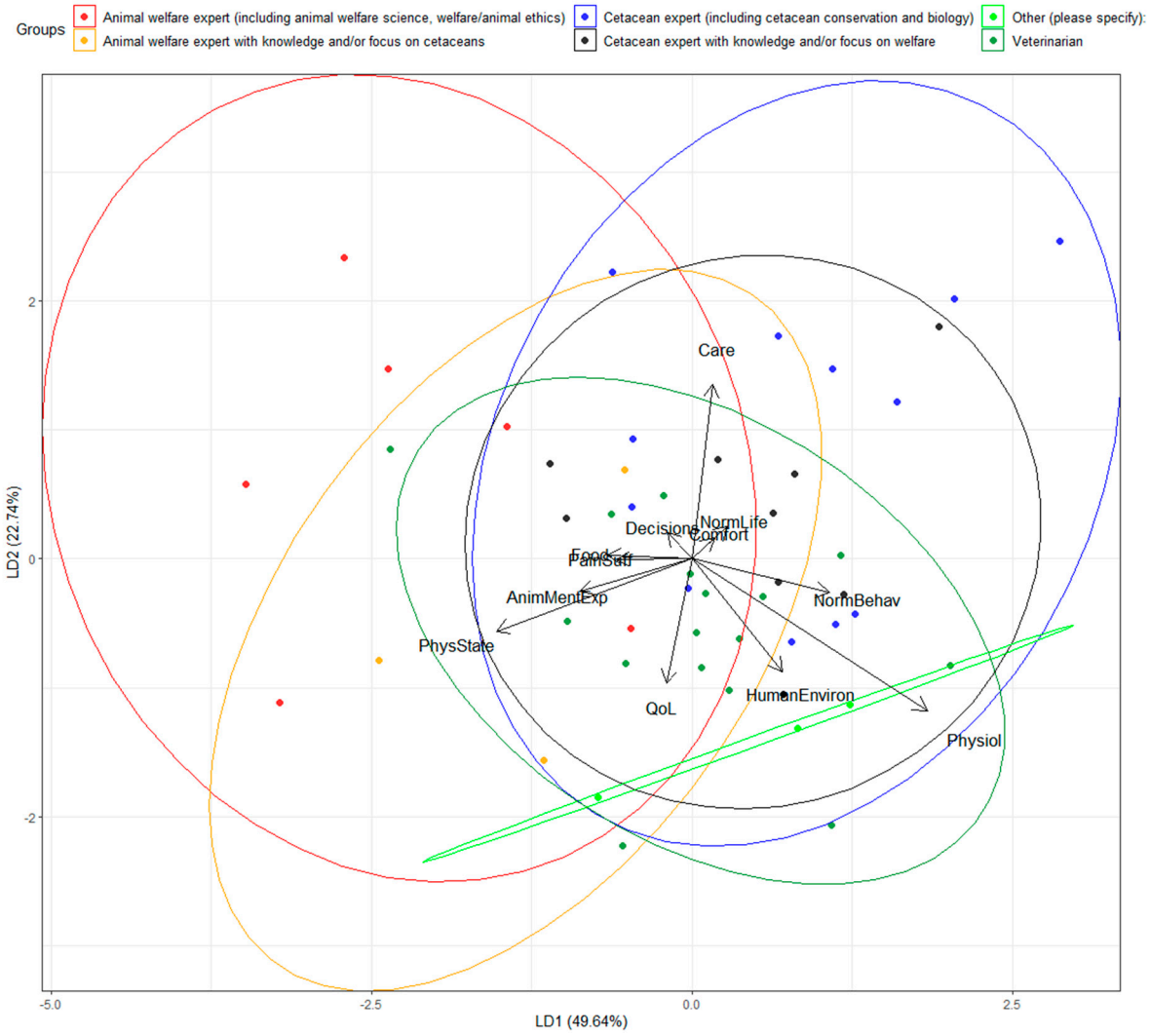

Figure 1. Biplot of the linear discriminant analysis of category scores for the topic characterising welfare, which attempts to find axes that discriminate among expertise groups. Category key: PhysState: Physical state and wellbeing, health, injury and disease status; AnimMentExp: Animal's experience/perception of situation, mental or psychological state or well-being, affective states or feelings; PainSuff: Pain and suffering, distress, stress or fear; NormLife: Ability to live in normal/natural social and environmental conditions or habitat; Decisions: Appropriate decision-making about re-floating or euthanasia, and targeted rescue/re-floatation efforts to prioritize animal welfare; NormBehav: Normal, natural or wild behaviour; Care: Treatment and care by humans, including during stranding response; Food: Sufficient food and water; Comfort: Physical comfort/discomfort; Physiol: Normal physiology and homeostasis; QoL: Overall wellbeing or Quality of life; HumanEnviron: Human activities in environment.

In terms of survival, the LDA of the first two discriminant axes accounted for 72% of the variation (Figure 2). The LDA showed overlap among all expertise groups. However, it showed that 'animal welfare expert (including animal welfare science, welfare/animal ethics)' (n=9) grouped more on the negative side of LD1 and were more likely to score 'Animal survives after re-floating' (SurviveRefloat) highly for characterising survival. In contrast, 'veterinarian' (n=20) were less likely to score that variable as important for characterising survival, and instead scored 'Animal alive 1 month after stranding' (X1mnth) as important for characterising survival.

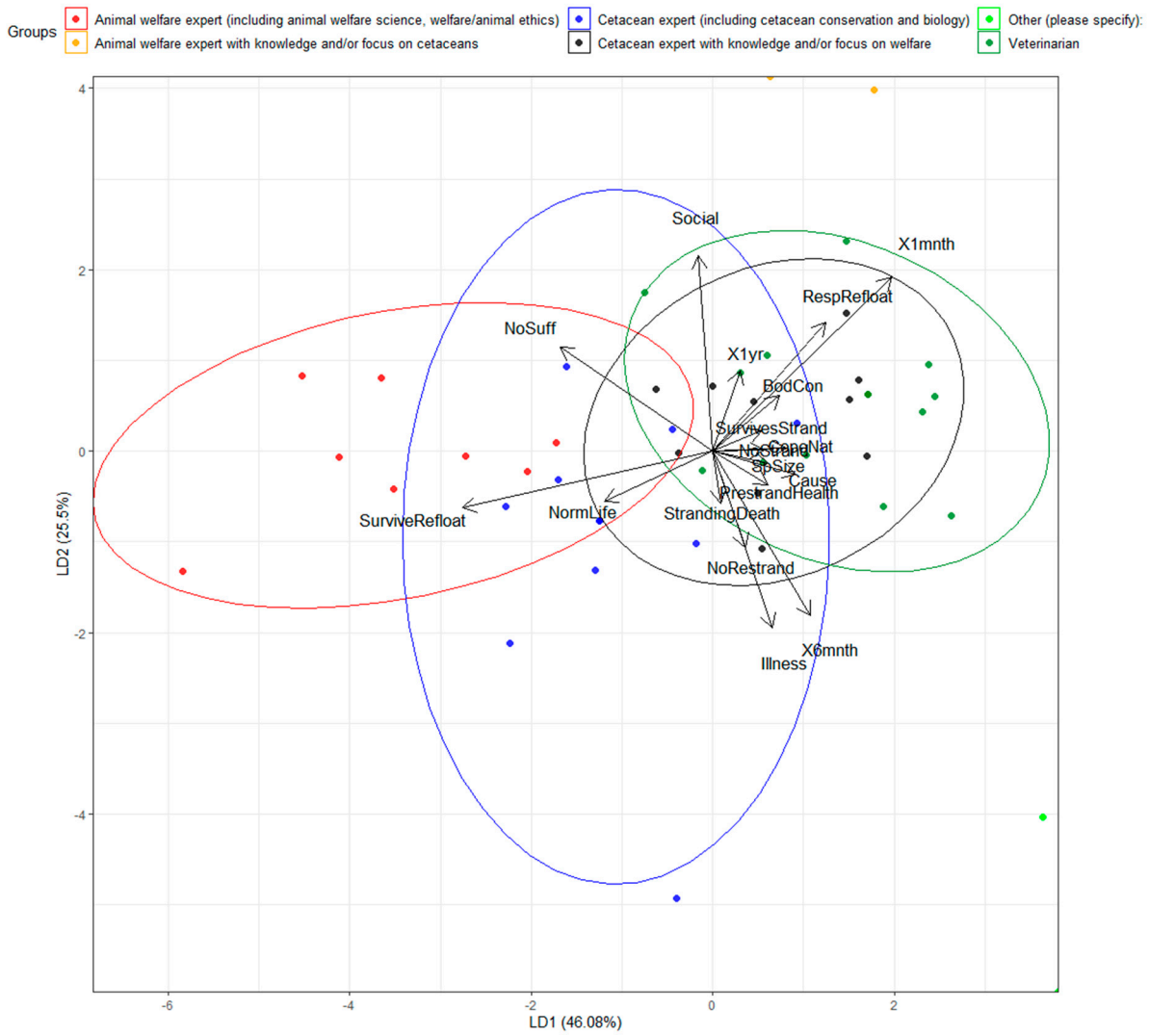

Figure 2. Biplot of the linear discriminant analysis of category scores for the topic characterising survival, which attempts to find axes that discriminate among expertise groups. Category key: NormLife: Animal returns to normal life and full functioning in its natural environment; SurvivesStrand: The chance that the animal survives after stranding; StrandingDeath: Animal does not die of stranding related injuries or damage; Illness: Animals health condition, disease and illness status; Social: Animal returns and socially re-integrate with its conspecific group/pod; CopeNat: Animal is able to respond and cope with natural conditions to ensure its survival; SurviveRefloat: Animal survives after re-floating; PrestrandHealth: Animal returns to pre-stranding life and health status; SpSize: Survival is affected by species and size; X1mnth: Animal alive 1 month after stranding; X1yr: Animal alive 1 year after stranding; NoRestrand: Animal does not re-strand within days of re-float; 6mnth: Animal alive 6 months after stranding; BodCon: Animal's body condition; NoStrand: The number of re-stranded animals; RespRefloat: Response of animal when re-floated; NoSuff: Avoids suffering; Cause: Cause of stranding still present.

2. Highlighting knowledge gaps for assessing stranded cetacean welfare and survival

A total of 3.8% "Don't know" responses were provided in answer to this question for welfare, and which data imputation was undertaken. The LDA carried out found that the first two discriminant axes accounted for 70% of the variation (Figure 3). The LDA again showed substantial overlap among expertise groups, though the 'animal welfare expert with knowledge and/or focus on cetaceans' appeared slightly more differentiated. However, the variance among the group appeared larger and there were few data points (n=3). 'Animal welfare expert with knowledge and/or focus on

cetaceans' group appeared to score 'Ability to diagnose internal injuries ante-mortem, including capture myopathy' (InternInj) as less of a knowledge gap in contrast to 'cetacean expert (including cetacean conservation and biology)' (n=16) that were more likely to score this category as an important knowledge gap. The 'animal welfare expert (including animal welfare science, welfare/animal ethics)' (n=9) were more likely to score 'Ability to assess what animals feel or their mental state' (Feel) as a key knowledge gap.

Figure 3. Biplot of the linear discriminant analysis of category scores for the topic on welfare knowledge gaps, which attempts to find axes that discriminate among expertise groups. Category key: PostRlse: Post release monitoring to understand survival, outcomes or success of re-floatation; CollctData: Collection and documentation of empirical data to assist triage/ decision-making; Dec2Euth: How to make decisions about when and how to euthanise stranded cetaceans; LackInf: Lack of information, education and awareness for potential responders about if, when and how to respond; SpSizeWelf: Effects of species, animal size and features of the stranding (geographical location and duration) on welfare; InternInj: Ability to diagnose internal injuries ante-mortem, including capture myopathy; Physiol: Ability to assess physiological indicators and recognise deviations from normal/baseline; Feel: Ability to assess what animals feel or their mental state; HlthDiseaseState: Understanding the health and disease status of the animal; ExpAdvice: Lack of specialist/ expert advice and consultation from those with field experience and veterinarian; NeuroState: Assessment and interpretation of indicators of neurological state and responsiveness/sensibility; BdyCond: Ability to assess body condition; StrCauses: Causes of stranding

and how to prevent stranding; IntrprtBehvr: Ability to interpret stranded cetacean behaviour in terms of welfare state; SocCues: Understanding social support and communication among animals.

There was more uncertainty about survival knowledge gaps, with 11% "Don't know" responses provided, for which data imputation was undertaken. In the LDA the first two discriminant axes accounted for 63% of the variation (Figure 4). Once again, the LDA found overlap among expertise groups, although the 'animal welfare expert (including animal welfare science, welfare/animal ethics)' group (n=9) appeared to group slightly more on the negative side of LD1. They were more likely to score 'Ability to diagnose diseases and infections on the beach' (Disease) as an important knowledge gap. The 'cetacean expert (including cetacean conservation and biology)' (n=16) scored 'Lack of post release monitoring to measure survival outcomes' (SurvivOutcome) as an important knowledge gap and scored 'Lack of data for species-specific survival' (SpSurvival) as less of a knowledge gap, which was in contrast to 'cetacean expert with knowledge and/or focus on welfare' (n=12) who scored these categories inversely.

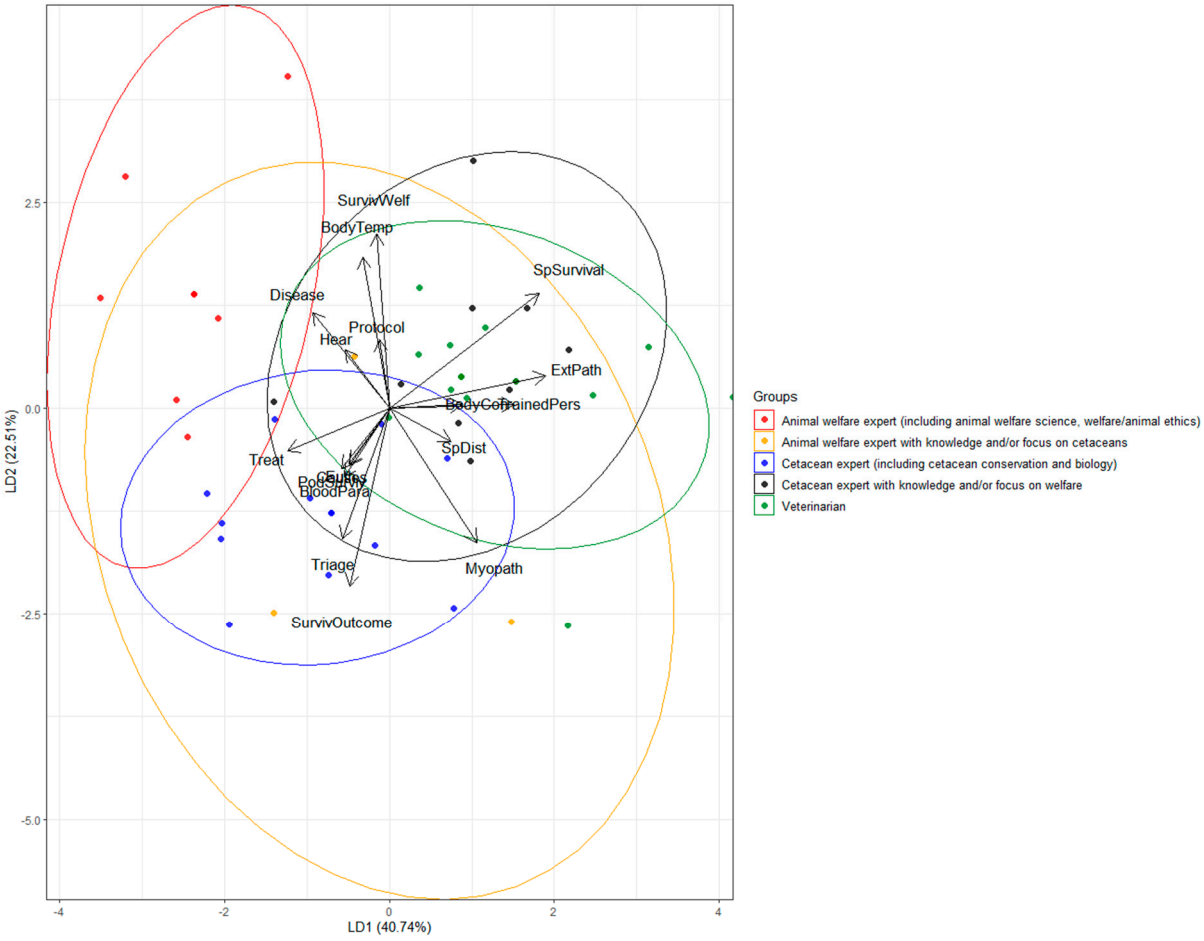

Figure 4. Biplot of the linear discriminant analysis of category scores for the topic on survival knowledge gaps, which attempts to find axes that discriminate among expertise groups. Category key: SurvivOutcome: Lack of post release monitoring to measure survival outcomes; BloodPara: Lack of normal/baseline blood parameters and profiles; SpSurvival: Lack of data for species-specific survival; SurvivWelf: Lack of knowledge on the links between survival and welfare; Myopath: Ability to determine presence of myopathy; Disease: Ability to diagnose diseases and infections on the beach; Causes: Lack of knowledge about causes and prevention of strandings and effects of local ecosystem changes; TrainedPers: Lack of trained and skilled responders; BodyCon: Ability to assess body condition and blubber thickness; SpDist: Lack of data on species distribution; PodSurviv: Lack of data on the effects of conspecifics presence on survival; Euth: How to make decisions about when and how

to euthanise stranded cetaceans; Triage: Ability to triage current state/condition; BodyTemp: Ability to assess internal body temperature; Hear: Lack of knowledge about hearing impairments; Protocol: Lack of standardised protocols to follow; Treat: Lack of knowledge of treatments and their effectiveness; ExtPath: Lack of knowledge on the links between external assessments and pathology.

3. Identifying key concerns about stranded cetacean welfare and survival

There were 6% responses of "Don't know" for this welfare question, for which data imputation was carried out. In the LDA undertaken the first two discriminant axes accounted for 70% of the variation (Figure 5). The LDA found that 'animal welfare expert with knowledge and/or focus on cetaceans' (n=3) appeared to group more on the positive side of LD1 and negative side of LD2. They scored 'Difficulty breathing, inhalation of water' (DiffBreathe) as a key concern for welfare, but scored 'Physical damage, stress, pain and thermal discomfort due to overheating, hyperthermia, heat stroke and hypothermia' (PhysDamage) as less of a concern. In contrast, 'veterinarian' (n=20) appeared to score these two categories inversely. Experts in 'animal welfare expert (including animal welfare science, welfare/animal ethics)' (n=9) scored 'Skin damage and associated pain due to sunburn, dehydration/desiccation occurring when out of water in sun' (SkinDamage) as an important welfare concern, whereas 'cetacean expert (including cetacean conservation and biology)' (n=16) scored 'Inappropriate human intervention, poor handling, responder training and experience, and public pressure influencing decisions' (InappInterv) as a more important welfare concern.

Figure 5. Biplot of the linear discriminant analysis of category scores for the topic on key welfare concerns, which attempts to find axes that discriminate among expertise groups. Category key: InappInterv: Inappropriate human intervention, poor handling, responder training and experience,

and public pressure influencing decisions; PainPhys: Pain and suffering due to physical injury or trauma caused by stranding, particularly substrate; StressHuman: Stress, fear, distress or pain caused by human presence, interactions, noise; Pressure: Effects of gravity, body weight, pressure on animal's organ function and physiology and causing internal injuries and pain as a result of not being supported by water; UnableMove: Fear, stress, distress or helplessness at being unable to move or help themselves; StrangeEnviron: Fear and stress at being in a strange, novel environment; Separation: Separation from conspecifics/social group, including mother-calf separation; StressStrand: Suffering, stress and anxiety associated with stranding; SkinDamage: Skin damage and associated pain due to sunburn, dehydration/desiccation occurring when out of water in sun; FeasibRescue: Feasibility of rescue/re-floatation based on human and equipment resources, location of stranding, time of day, responder expertise and experience and human safety; PhysDamage: Physical damage, stress, pain and thermal discomfort due to overheating, hyperthermia, heat stroke and hypothermia; Predation: Fear and pain from predation; EuthDecis: Delays to deciding on euthanasia to relieve suffering; Weather: Weather and environmental conditions; BodyCond: Nutritional stress, poor body condition; Illness: Animals suffering from illness, disease and underlying health conditions; DiffBreathe: Difficulty breathing, inhalation of water; SpecBiol: Effect of species biology, resilience and stranding type on welfare outcomes; PainManag: Pain and its management.

For survival there were 7% responses of "Don't know" and data imputation was undertaken. The first two discriminant axes in the LDA accounted for 73% of the variation (Figure 6). The LDA showed that 'animal welfare expert with knowledge and/or focus on cetaceans' (n=3) grouped more on the negative side of LD1 whilst the 'Other' expertise grouped on the positive side of LD1. However, there was still overlap among groups. The 'animal welfare expert with knowledge and/or focus on cetaceans' scored variables 'Substrate/terrain at the stranding location' (Substrate) as an important concern for survival and scored 'Presence of predators and scavengers' (Predators) as less important, this was in contrast to the 'cetacean expert (including cetacean conservation and biology)' (n=16) who scored these categories in the inverse. The 'animal welfare expert (including animal welfare science, welfare/animal ethics)' (n=9) scored 'Availability of appropriate and timely human intervention and handling, responder training and experience' (AvailHuman) as an important survival concern but scored 'Feasibility and speed of rescue/re-floatation based on human and equipment resources, location of stranding, time of day, responder expertise and experience and human safety' (FeasibRefloat) as a less important concern.

Figure 6. Biplot of the linear discriminant analysis of category scores for the topic on key survival concerns, which attempts to find axes that discriminate among expertise groups. Category key: FeasibRefloat: Feasibility and speed of rescue/re-floatation based on human and equipment resources, location of stranding, time of day, responder expertise and experience and human safety; Restrand: Length of time stranded and number of re-strandings; Weather: Weather and environmental conditions, including tides; Injury : Physical injury or trauma caused by stranding; Illness: Animal suffering from illness, disease and underlying health conditions; Separation: Separation from conspecifics/social group; Age: Animal age based on length/weight and reproductive status; Pressure: Effects of gravity, body weight, pressure on animal's organ function and physiology and causing internal injuries and pain as a result of not being supported by water; BodyCon: Body condition and nutritional status; AvailHuman: Availability of appropriate and timely human intervention and handling, responder training and experience; HabitatRange: Geographical location of stranding and being out of habitat or range; SpBiol: Effect of species biology on survivorship; Cause: Cause of stranding still present; StressStrand: Stress, anxiety and associated conditions caused by stranding; Predators: Presence of predators and scavengers; DiffBreath: Difficulty breathing, inhalation of water; SkinDam: Skin damage and associated pain due to sunburn, dehydration/desiccation occurring when out of water in sun; Substrate: Substrate/terrain at the stranding location; AbnormMov: Abnormal movements and reduced limb function; Aware; Animal awareness and neurological status.

Discussion of the agreement across expert disciplines

A secondary aim of this study was to look for differences in the way welfare and survival likelihood are understood, the associated key concerns and knowledge gaps, among expert respondents with different backgrounds. Our data were collectively generated by an interdisciplinary panel of international experts in cetacean biology, medicine, and animal welfare science. This diversity was vital to ensure elicitation of both welfare and conservation focused factors since previous studies have found perspectives on relevant topics to be discipline-specific [1,2].

Interestingly, the findings revealed consensus among the varied expertise regarding how to characterise and understand the welfare and survival likelihood of stranded cetaceans. Despite almost half the participants reporting no knowledge of animal welfare and a third reporting only some knowledge, overlap among expertise for all categories was evident in the analyses, suggesting a lack of effect of expertise. Consensus was also evident among the expert panellists regarding the major knowledge gaps that need to be addressed and the key concerns that may affect stranded cetacean welfare and survival likelihood. Overall, this suggests that experts from the different backgrounds represented in this study, conceptualise the welfare and survival of stranded cetaceans similarly and have comparable concerns about these issues.

The experts in this study represent those disciplines that provide guidance and influence decision-making at strandings. Although unity among experts in this study was evident, management of stranding events has typically been focused on re-floating as many individuals as possible, reflecting a conservation focus. However, based on our results, it is clear that stranding management decisions should be undertaken based on scientific assessment of the animal, both in terms of welfare state and survival likelihood. This is particularly pertinent since welfare compromised individuals may experience prolonged suffering and may not survive, even if re-floatation is achieved [3–6].

References

1. Beausoleil, N.J.; Mellor, D.J.; Baker, L.; Baker, S.E.; Bellio, M.; Clarke, A.S.; Dale, A.; Garlick, S.; Jones, B.; Harvey, A.; et al. "Feelings and Fitness" Not "Feelings or Fitness"-The Raison d'etre of Conservation Welfare, Which Aligns Conservation and Animal Welfare Objectives. *Frontiers Veterinary Science* **2018**, *5*, 296, doi:10.3389/fvets.2018.00296.
2. Clegg, I.L.K.; Boys, R.M.; Stockin, K.A. Increasing the Awareness of Animal Welfare Science in Marine Mammal Conservation: Addressing Language, Translation and Reception Issues. *Animals* **2021**, *11*, doi:10.3390/ ani11061596.
3. Brownlow, A.; Davison, N.; Ten Doeschate, M. *Scottish Marine Animal Stranding Scheme: Annual Report 2015 (1 January to 31 December 2015) for Marine Scotland, Scottish Government*; Scottish Marine Animal Stranding Scheme: Inverness, Scotland, 2015;
4. Dolman, S.; Moore, M. Welfare Implications of Cetacean Bycatch and Entanglements. In *Marine Mammal Welfare*; Butterworth, A., Ed.; Springer International Publishing: Switzerland, 2017.
5. Marks, W.; Burton, S.; Stratton, E.; Zolman, E.; Biedenbach, G.; Page-Karjian, A. A Case Study of Monofilament Line Entanglement in a Common Bottlenose Dolphin (Tursiops Truncatus): Entanglement, Disentanglement, and Subsequent Death. *BMC Veterinary Research* **2020**, *16*, 223, doi:10.1186/s12917-020-02436-x.
6. Sharp, S.M.; Knoll, J.S.; Moore, M.J.; Moore, K.M.; Harry, C.T.; Hoppe, J.M.; Niemeyer, M.E.; Robinson, I.; Rose, K.S.; Brian Sharp, W.; et al. Hematological, Biochemical, and Morphological Parameters as Prognostic Indicators for Stranded Common Dolphins (Delphinus Delphis) from Cape Cod, Massachusetts, U.S.A. *Marine Mammal Science* **2014**, *30*, 864–887, doi:10.1111/mms.12093.