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Fundamental Concepts, Knowledge Gaps and Key Concerns Relating to Welfare and Survival of Stranded Cetaceans

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Abstract: Wildlife management can influence animal welfare and survival, although both are often not explicitly integrated into decision making. This study explores fundamental concepts and key concerns relating to the welfare and survival of stranded cetaceans. Using the Delphi method, the opinions of an international, interdisciplinary expert panel were gathered, regarding the characterisation of stranded cetacean welfare and survival likelihood, knowledge gaps and key concerns. Experts suggest that stranded cetacean welfare should be characterised based on interrelated aspects of animals' biological function, behaviour, and mental state and the impacts of human interventions. The characterisation of survival likelihood should reflect aspects of stranded animals' biological functioning and behaviour as well as a 6-month post-re-floating survival marker. Post-release monitoring was the major knowledge gap for survival. Welfare knowledge gaps related to diagnosing internal injuries, interpreting behavioural and physiological parameters, and euthanasia decision making. Twelve concerns were highlighted for both welfare and survival likelihood, including difficulty breathing and organ compression, skin damage and physical traumas, separation from conspecifics, and suffering and stress due to stranding and human intervention. These findings indicate inextricable links between perceptions of welfare state and the likely survival of stranded cetaceans and demonstrate a need to integrate welfare science alongside conservation biology to achieve effective, ethical management at strandings.

Keywords: animal welfare; conservation decision making; Delphi; expert opinion; management; marine mammals; wildlife

Citation: Boys, R.M.; Beausoleil, N.J.; Pawley, M.D.M.; Littlewood, K.E.; Betty, E.L.; Stockin, K.A. Fundamental Concepts, Knowledge Gaps and Key Concerns Relating to Welfare and Survival of Stranded Cetaceans. *Diversity* **2022**, *14*, 338. https://doi.org/10.3390/d14050338

Academic Editors: Michael Wink and Miriam A. Zemanova

Received: 22 March 2022
Accepted: 23 April 2022
Published: 26 April 2022

1. Introduction

Wildlife management and decision making are most often conservation-focused, despite increasing recognition that animal welfare can affect the outcomes of management decisions if not considered in parallel [1–3]. Traditionally, conservation and wildlife management have focused on assessing population fitness, yet animal welfare is usually considered to be a property of the individual animal. Importantly, survival does not necessarily mean good welfare [4–6], and poor animal welfare can negatively impact conservation efforts by reducing fitness [7,8] and even survival itself [9]. Therefore, to achieve optimal outcomes for wildlife, a multidisciplinary approach to management that includes the consideration and assessment of both welfare and survival is required [1,10].

Consideration of both welfare state and survival likelihood is particularly important in cases where humans engage with wildlife likely to be in distress. Such interventions include rescue and/or rehabilitation and release of animals [11,12]. In many cases, intervention

may improve animal welfare, by returning animals to wild environments, providing vital medical treatment or performing humane killing (sometimes termed euthanasia) [13]. Additionally, human intervention may be used as a tool to improve survival as part of a wider conservation strategy [14–16]. However, there is limited knowledge regarding the immediate and longer-term effects of human interventions on welfare and survival for many species [14,17–19]. In particular, systematic, science-based evaluations of welfare state and survival likelihood are lacking [20,21]. Such assessments are required to inform decisions regarding appropriate interventions, including whether an animal is suitable for release [20] or if end-of-life decisions, such as euthanasia or palliative care, should be undertaken [13].

Live cetacean strandings are a classic exemplar of wildlife management situations that involve human intervention but for which there is limited empirical evidence to inform management decision making. Cetacean strandings are a global phenomenon [22–24] that appear to occur both naturally [25,26] and due to anthropogenic activities [27,28]. The physical state of live stranded cetaceans can range from animals appearing outwardly healthy to those that are clinically ill or moribund [29–31]. Despite the often-compromised state of the animals, most stranding events focus on attempts to 'rescue' the animals by re-floating them. Yet, the current lack of empirical data informing response procedures [32] means that appropriate intervention [33] may not reliably be undertaken. This has been identified as a major potential concern for cetacean welfare [15,34] and one for which further work is needed to develop optimal response procedures [34].

The first step to address this lack of data is to develop an understanding of the fundamental concepts relating to the welfare and survival of stranded cetaceans. This is particularly important since the disciplines of conservation biology and animal welfare science have generally emphasised different facets of welfare. The former has tended to focus on fitness and the latter on 'feelings' (i.e., affective experiences) and fitness [1,10,35,36], which can lead to different practical approaches to welfare assessments [37]. There is also a need to identify the degree to which knowledge exists to support evaluations of welfare state and survival likelihood, and to identify the key factors or features of stranding and/or human intervention likely to affect stranded cetacean welfare and survival.

An initial way to acquire such data is to harness the expertise of those working in various relevant interdisciplinary fields. Previously, expert opinion has been used to identify welfare issues and indicators for several terrestrial mammals [38–40] and to inform wildlife management policies [41,42]. Concerning the management of live stranded cetaceans, expert opinion can provide consensual and face validity to concepts relevant to the development of practical assessments of welfare and survival [43]. Such information can then be applied in the field and re-evaluated for further refining.

Our study aimed to develop consensual and face validity through expert opinion on (1) fundamental concepts relating to the characterisation of stranded cetacean welfare and likelihood of survival, (2) current knowledge gaps that hamper the ability to assess stranded cetacean welfare and the likelihood of survival, and (3) key concerns about stranded cetacean welfare and the likelihood of survival. We also explored whether the self-declared area of expertise within the expert panel influenced the way welfare and survival likelihood are understood, the knowledge gaps considered to be important and the key concerns to be addressed. These data can be applied to develop in-field welfare and survival likelihood assessment protocols to inform cetacean stranding response.

2. Materials and Methods

2.1. The Delphi Method

The Delphi method is a questionnaire-based approach that enables structured group communication among experts to explore complex issues [44,45]. It consists of two or more iterative rounds of questionnaires, with summarised responses from expert respondents informing the next round of questions [38,45–49]. The questionnaires are structured to enable review of previous questions. This allows for the confirmation and revision of

responses, ensuring an accurate representation of opinions. A particular strength of the Delphi method is that respondents remain anonymous to each other, reducing the potential for social bias, and allowing both formal and informal knowledge to be collected in a transparent manner [50].

Our study employed a two-round online Delphi process using the questionnaire tool Qualtrics [51] to explore concepts relating to stranded cetacean welfare and survival likelihood. Expert opinion on fundamental concepts, knowledge gaps and key concerns relating to the welfare and survival of stranded cetaceans were elicited using an exploratory sequential mixed method design [52]. The findings from the first round (mainly open-ended questions) were subsequently used to inform the development of the second round (predominantly closed-ended questions) [53]. To achieve the aims of this study, the findings reported here pertain to the quantitative and qualitative data from the second round and the quantitative data from the first round.

2.2. Recruitment and Characterisation of Expert Participants

Invited participants (n = 168) were identified as experts in the fields of cetacean biology/ecology and/or wild animal welfare by first searching the peer-reviewed literature, documents from related workshops and stranding network lists. The inclusion of stranding network lists and workshops ensured that individuals who may not have published peer-reviewed research but who still have extensive in-field experience (e.g., senior first responders/medics) were included. Prospective respondents were contacted via email and provided with a detailed information sheet regarding the project (S1) as well as an invitation to participate. The email also included an anonymous link to the questionnaire on Qualtrics, where experts provided their consent to participate. All participants were invited to both rounds although there was no requirement to complete both, and individual responses from the first questionnaire were not personally linked to responses from the second. Therefore, some participants who provided scores in the second round for data generated from the first round may not have participated in the generation of those data in the first round and vice versa [50,54].

2.3. Questionnaire Design and Implementation

Data collection was conducted between February and April 2021. The first questionnaire was available for participants to complete for 15 working days, after which time the questionnaire closed, and no further responses were accepted. Three weeks later, the second questionnaire was initiated for 30 working days [41,55].

Prior to initial questionnaire distribution, a pilot study was conducted. A draft Qualtrics questionnaire was completed by four participants, two with expertise in animal welfare science and two in cetacean biology/ecology. Participants were asked to assess question clarity, questionnaire useability and the amount of time required to complete. These results were used to refine the questions and format for the final questionnaires sent to expert participants in rounds one and two. Pilot data were not included in the final dataset.

2.3.1. Final Questionnaire Design Implementation

No identifiable data were collected, ensuring full anonymity [44,56]. Each questionnaire contained three questions regarding the demographics of the participants. This information was collected to assess the variety of expertise and geographical coverage of the participants. Experts were asked to self-identify their area of expertise by choosing a single pre-defined category in a closed question, based on which they felt was most applicable: 'cetacean expert (including cetacean conservation and biology)', 'animal welfare expert (including animal welfare science, welfare/animal ethics)', 'cetacean expert with knowledge and/or focus on welfare', 'animal welfare expert with knowledge and/or focus on cetaceans', 'veterinarian' or 'other'. Participants were also asked for their current field of work (open-ended question) and region of work (closed-ended question).

Aside from the questions on demographics, each questionnaire was split into two sections: the first related to the welfare of stranded cetaceans and the second to their survival. Similar questions were asked in each section relating to (1) characterising welfare or survival, (2) knowledge gaps relevant to welfare or survival and (3) key concerns regarding welfare or survival. The first questionnaire applied a mixture of twelve unstructured, open-ended questions and two closed-ended questions. Responses to the latter were made on a continuous numerical scale (0–10, measured to two decimal places) and reflected the perceived usefulness of currently available knowledge to assess stranded cetacean welfare and survival (S2). The questions with continuous scalar responses in the first questionnaire offered the option to choose "Not applicable" if an expert felt that they did not have sufficient knowledge about the currently available information. Participants were also encouraged to provide any additional comments if desired.

Following completion of data collection from the first questionnaire, the primary author worked independently to review the responses. All responses were recorded as intelligent verbatim transcription and, using reflexive thematic analysis, common ideas for each topic were collated into major themes [57,58]. Major theme collations were subsequently reviewed by the collective research team to generate final major themes for each topic (S3 and S4). These themes were subsequently used in the development of the second, quantitative questionnaire. Due to the large number of themes identified for some topics (e.g., key concerns regarding survival), a maximum of 20 major themes per topic were provided as categories for scoring in the second questionnaire, minimising questionnaire fatigue whilst maximising data collection [59]. In such cases, themes were identified for subsequent inclusion as 'categories' based on their common nomination by expert participants, as well as being the most important and relevant elements for the study as identified by the study's research team [60].

The second round required participants to review and score multiple major categories within each topic using a semi-structured questionnaire (S5) [47]. Twelve closed-ended questions with continuous scalar responses (0–10) and five open-ended questions were provided. All questions with a scalar response, except those characterising welfare or survival, contained an option to select "Don't know" if experts felt they had insufficient knowledge to score a particular theme. The major categories to be scored within each topic were presented in a randomised order among participants to remove possible bias from a list that may otherwise have appeared ranked [61,62]. That is, within a single topic (e.g., key survival concerns), up to 20 major categories (e.g., 20 different survival concerns) were presented for scoring, and the order in which these appeared varied for each participant.

Participants were encouraged to provide any additional comments throughout the questionnaire. In addition to these comments, qualitative data were collected regarding the barriers perceived by experts to hinder assessment of how key concerns may affect welfare or survival.

2.3.2. Characterising Concepts of Stranded Cetacean Welfare and Survival

In the first questionnaire, participants were asked to explain, in their own words, what 'animal welfare/well-being' and 'survival likelihood' mean to them in relation to stranded cetaceans. These answers were collated into major themes which were provided back to participants in the second questionnaire as 'categories' to score their importance for characterising stranded cetacean welfare or survival likelihood. Scoring was on a continuous scale (0–10) where '0 = No importance', '5 = Some importance', and '10 = Great importance' for each of the categories.

2.3.3. Highlighting Knowledge Gaps for Assessing Stranded Cetacean Welfare and Survival

In the first questionnaire, participants were asked to score, on a continuous scale of 0–10, the usefulness of the body of information currently available to undertake assessments of stranded cetacean welfare or survival likelihood, where '0 = Not useful at all' and '10 = Very useful'. Participants were subsequently provided with the opportunity to identify, in their

own words, the most significant knowledge gaps (i.e., the gaps that, if filled, would improve the ability to assess stranded cetacean welfare or survival likelihood). For each of the major themes arising from the open responses in the first questionnaire, participants were asked to score (as categories in the second questionnaire) their agreement that filling that knowledge gap would improve the ability to assess stranded cetacean welfare or survival likelihood, where '0 = Would not improve' and '10 = Would greatly improve'.

2.3.4. Identifying Key Concerns Regarding the Welfare and Survival of Stranded Cetaceans

Concerns identified by participants in the first questionnaire were collated into themes for welfare and survival likelihood and provided in the second questionnaire as 'categories' for scoring. Participants scored the extent to which each category may be expected to affect welfare or survival likelihood on a continuous scale from 0 to 10 where '0 = This will not have an effect', '5 = This will have a bad effect' and '10 = This will have a severely bad effect'.

Participants were also asked to score the extent to which knowledge is currently available to assess how each of these categories affects the welfare or survival likelihood of stranded cetaceans with '0 = Knowledge is insufficient', '5 = Some knowledge is present' and '10 = Knowledge is complete'. Finally, participants were invited to provide their opinions on any barriers to determining how these categories affect stranded cetacean welfare or survival likelihood.

2.4. Analysis of Data

The quantitative data collected in questionnaire 1 were used to calculate descriptive statistics (median, range, mean and mode) to provide an overall impression of how useful experts consider the existing information to be for assessing welfare or survival likelihood. Additionally, to examine whether there were differences in opinion regarding the usefulness of information among participants based on their background, we calculated the rank for raw scores from three expertise super-groups: (1) cetacean experts ('cetacean expert including cetacean conservation and biology' and 'cetacean experts with knowledge and/or focus on welfare'), (2) welfare experts ('animal welfare expert including animal welfare science, welfare/animal ethics' and 'animal welfare expert with knowledge and/or focus on cetaceans') and (3) veterinarians. The rank scores of each group for welfare or survival likelihood were compared using Kruskal–Wallis non-parametric tests to account for the unequal group sizes.

For each of the major categories presented in the second questionnaire regarding (1) characterisation of welfare or survival likelihood, (2) knowledge gaps and (3) key concerns, the median score and range were calculated. Higher median scores for categories within a topic reflected (1) greater relative importance of the category for characterising welfare/survival likelihood; (2) higher agreement that filling the knowledge gap would improve the ability to assess welfare/survival likelihood; and (3) greater level of concern that the category affects welfare/survival likelihood, respectively. When calculating median scores, responses of "Don't know" were not included.

Similarly, median scores and ranges were calculated for experts' perceptions of the sufficiency of knowledge available to assess each of the key welfare and/or survival likelihood concerns presented in questionnaire 2. This enabled an appraisal of the relationship between the level of concern and the perceived sufficiency of knowledge about that specific concern, using a Spearman's rank correlation test.

Quantitative data from the categories in questionnaire 2 were collected on a continuous scale, as this has been suggested to be more precise for questionnaires examining people's subjective perceptions [63]. However, to evaluate consensus among experts, the raw scores for each category were pooled into four groupings (score: 0–3.99; 4–6.99; 7–10; "Don't know"). Consensus was considered reached when at least 70% of participants provided a score within the same group [64–66].

Qualitative data regarding barriers to assessing key concerns presented in questionnaire 2 were investigated using reflexive thematic analysis to collate common themes [57,58].

These themes are presented to provide context for interpretation of the experts' views on the sufficiency of current knowledge regarding specific concerns about welfare or survival likelihood.

To visualise whether self-identified participant expertise influenced the scoring of categories within each topic, we applied linear discriminant analyses (LDA) in R (V. 1.2.5033) using package MASS [67] on the raw scores for each topic from questionnaire 2. Where experts responded, "Don't know", data imputation was undertaken using the mean score for that category, which was calculated across the expertise group, ensuring sufficient data to undertake multivariate analysis. The LDA generated orthogonal axes that maximally separated the six expertise groups based on the participants' scores for each category within a topic. The first two axes of the LDA were used to provide a visual representation of differences and similarities, based on overlap, among expertise groups in relation to the major categories within each of the topics. Figures were prepared using the ggplot2 package [68].

3. Results

Of the 168 experts invited to participate, 40.5% (n = 68) participated in the first round, representing seven regions: Europe (n = 27; 40%), Oceania (n = 17; 25%), North America (n = 15; 22%), South America (n = 4; 6%), Asia (n = 3; 4%), Central America (n = 1; 1%) and Africa (n = 1; 1%). These participants reported primary expertise in cetacean conservation and biology (n = 18; 26%), veterinary medicine (n = 16; 24%), animal welfare science/ethics (n = 11; 16%), cetacean biology with a focus on welfare (n = 11; 16%) and animal welfare with a focus on cetaceans (n = 2; 3%). A further 10 chose 'other' with four (6%) of these involved in active stranding response.

In the second round, 37.5% (n = 63) of experts participated. These experts represented the same seven regions in approximately the same proportions: Europe (n = 26; 41%), Oceania (n = 19; 30%), North America (n = 10; 16%), South America (n = 4; 6%), Central America (n = 2; 3%), Africa (n = 1; 2%) and Asia (n = 1; 2%). Their reported expertise was in veterinary medicine (n = 20; 32%), cetacean conservation and biology (n = 16; 25%), cetacean biology with a focus on welfare (n = 12; 19%), animal welfare science/ethics (n = 9; 14%) and animal welfare with a focus on cetaceans (n = 3; 5%). three (5%) participants chose 'other' and noted being involved in stranding response or broader ecology.

3.1. Characterising Concepts of Stranded Cetacean Welfare and Survival Likelihood

Twelve major themes were generated from the reflexive thematic analysis for characterising the concept of 'welfare/well-being' as it relates to stranded cetaceans, and seventeen major themes were identified for characterising survival likelihood. All these themes were provided to participants in the second round for scoring as categories. Ten of the welfare categories and seven of the survival likelihood categories were considered by more than 70% of the participants to be of great importance (scores $\geq$7; Table 1). No categories reached consensus as being unimportant for characterising welfare or survival likelihood.

3.2. Knowledge Gaps for Assessing Stranded Cetacean Welfare and Survival Likelihood

In the first questionnaire, experts rated the knowledge currently available to assess stranded cetacean welfare as being somewhat useful, with a median score of 6.5 (range = 2–10; mean = 6.5, mode = 5, n = 53). The other fifteen (22%) experts responded with 'NA' to this question. The expertise group did not affect perceived usefulness scores (Kruskal–Wallis: H(46) = 6.23; P = 1.0), with a mean rank usefulness score of 30.1 for welfare experts, 27.0 for cetacean experts and 31.0 for veterinarians. Fifteen major themes were identified from reflexive thematic analysis as significant welfare knowledge gaps; all were presented as categories for scoring in the second round. Nine of these categories were scored by at least 70% of experts as greatly important knowledge gaps; i.e., if addressed, they would greatly improve the ability to assess welfare (scores $\geq$7 grouping; Table 2).

Table 1. The major categories for characterising the concepts of welfare and survival likelihood arising from reflexive thematic analysis of participant responses to questionnaire 1, and median score and range for each category from questionnaire 2. Categories are ranked by the percentage of experts that scored them as having great importance for characterising the concepts (score in ≥7 grouping). Those categories above the bold line reached consensus (≥70%).

Welfare Category	Median Score (Range)	% Experts Scored ≥7	Survival Likelihood Category	Median Score (Range)	% Experts Scored ≥7
Pain and suffering, distress, stress or fear	10.0 (5.7–10.0)	98.4	Animal alive 6 months after stranding	9.3 (1.2–10.0)	94.3
Physical state and well-being, health, injury and disease status	10.0 (3.7–10.0)	93.7	Animal returns to normal life and full functioning in its natural environment	9.7 (4.9–10.0)	90.6
Normal physiology and homeostasis	9.1 (4.7–10.0)	91.9	Animal alive 1 year after stranding	10.0 (0.4–10.0)	90.4
Appropriate decision-making about re-floating or euthanasia, and targeted rescue/re-floatation efforts to prioritize animal welfare	9.2 (2.2–10.0)	88.7	Animal is able to respond and cope with natural conditions to ensure its survival	9.0 (4.6–10.0)	86.0
Physical comfort/discomfort	9.1 (2.6–10.0)	87.3	Animal returns and socially re-integrate with its conspecific group/pod	8.9 (4.8–10.0)	84.9
Animal's experience/perception of situation, mental or psychological state or well-being, affective states or feelings	8.4 (1.8–10.0)	82.5	Animal returns to pre-stranding life and health status	9.4 (4.1–10.0)	84.6
Ability to live in normal/natural social and environmental conditions or habitat	9.1 (0.5–10.0)	80.6	Animal's health condition, disease and illness status	8.8 (4.7–10.0)	77.4
Overall well-being or quality of life	9.6 (0.0–10.0)	80.6	Animal alive 1 month after stranding	8.2 (3.8–10.0)	69.8
Treatment and care by humans, including during stranding response	8.7 (3.5–10.0)	73.3	The chance that the animal survives after stranding	8.7 (0.0–10.0)	66.0
Normal, natural or wild behaviour	8.3 (0.8–10.0)	71.0	Cause of stranding still present	8.4 (1.0–10.0)	65.4
Sufficient food and water	8.0 (0.1–10.0)	65.5	Animal does not re-strand within days of re-float	8.0 (0.5–10.0)	62.3
Human activities in environment	6.9 (0.1–10.0)	49.2	Response of animal when re-floated	7.3 (1.6–10.0)	62.3
			Survival is affected by species and size	7.7 (1.8–10.0)	60.4
			Animal's body condition	7.3 (1.0–10.0)	60.4
			Animal does not die of stranding related injuries or damage	7.8 (0.6–10.0)	54.9
			Avoids suffering	7.0 (0.9–10.0)	54.2
			The number of re-stranded animals	7.1 (0.0–10.0)	51.9
			Animal survives after re-floating	7.0 (0.6–10.0)	49.1

Table 2. The major categories for knowledge gaps, that if addressed, would greatly improve the ability to assess stranded cetacean welfare and survival likelihood arising from reflexive thematic analysis of participant responses to questionnaire 1, and median score and range for each category from questionnaire 2. Categories are ranked by the percentage of experts that strongly agreed that filling the knowledge gap would improve the ability to assess welfare/survival likelihood (scores in ≥7 grouping). Categories above the bold line reached consensus (≥70%).

Welfare Knowledge Category	Median Score (Range)	% Experts Scored ≥7	Survival Likelihood Knowledge Category	Median Score (Range)	% Experts Scored ≥7
Understanding the health and disease status of the animal	8.5 (3.3–10.0)	84.1	Lack of post-release monitoring to measure survival outcomes	9.1 (4.7–10.0)	78.8
How to make decisions about when and how to euthanise stranded cetaceans	9.3 (0.7–10.0)	83.6	Ability to diagnose diseases and infections on the beach	8.4 (0.4–10.0)	66.7
Ability to diagnose internal injuries ante-mortem, including capture myopathy	9.0 (5.2–10.0)	82.5	Ability to determine presence of myopathy	8.4 (2.0–10.0)	63.0
Post-release monitoring to understand survival, outcomes or success of refloatation	9.1 (4.2–10.0)	82.0	Lack of data for species-specific survival	8.1 (1.2–10.0)	62.3
Collection and documentation of empirical data to assist triage/decision making	8.6 (1.1–10.0)	82.0	How to make decisions about when and how to euthanise stranded cetaceans	8.1 (0.5–10.0)	62.3
Ability to assess physiological indicators and recognise deviations from normal/baseline	8.9 (2.0–10.0)	82.0	Lack of knowledge on the links between survival and welfare	8.2 (0.0–10.0)	60.4
Lack of specialist/expert advice and consultation from those with field experience and veterinarians	8.8 (4.0–10.0)	81.0	Ability to triage current state/condition	8.1 (3.0–10.0)	60.4
Ability to interpret stranded cetacean behaviour in terms of welfare state	8.7 (0.9–10.0)	74.6	Lack of knowledge on the links between external assessments and pathology	8.1 (3.0–10.0)	60.4
Ability to assess body condition	8.0 (2.0–10.0)	71.4	Lack of knowledge of treatments and their effectiveness	8.1 (0.1–10.0)	56.6
Assessment and interpretation of indicators of neurological state and responsive-ness/sensibility	8.2 (1.1–10.0)	69.8	Lack of knowledge about hearing impairments	7.2 (0.0–10.0)	53.8
Effects of species, animal size and features of the stranding (geographical location and duration) on welfare	8.1 (1.9–10.0)	69.5	Lack of trained and skilled responders	7.7 (4.3–10.0)	50.9
Lack of information, education and awareness for potential responders about if, when and how to respond	8.3 (0.3–10.0)	68.3	Lack of knowledge about causes and prevention of strandings and effects of local ecosystem changes	7.1 (0.0–10.0)	47.2
Ability to assess what animals feel or their mental state	7.6 (0.9–10.0)	60.3	Lack of data on the effects of conspecifics presence on survival	6.5 (1.0–10.0)	43.4
Causes of stranding and how to prevent stranding	8.0 (0.0–10.0)	58.1	Ability to assess internal body temperature	7.1 (1.0–10.0)	41.5

Table 2. *Cont.*

Welfare Knowledge Category	Median Score (Range)	% Experts Scored ≥7	Survival Likelihood Knowledge Category	Median Score (Range)	% Experts Scored ≥7
Understanding social support and communication among animals	7.5 (1.3–10.0)	54.0	Ability to assess body condition and blubber thickness	6.7 (0.6–10.0)	40.7
			Lack of standardised protocols to follow	6.8 (0.0–10.0)	40.7
			Lack of normal/baseline blood parameters and profiles	6.6 (0.0–10.0)	39.6
			Lack of data on species distribution	4.4 (0.0–10.0)	24.5

The knowledge currently available to assess survival likelihood was judged to be somewhat useful (median = 5.1; range = 1.3–10; mean = 5.7, mode = 4, *n* = 44) in the first questionnaire. A further 24 (35%) experts responded 'NA' to this question. No effect of expertise group on perceived usefulness of knowledge was detected (Kruskal–Wallis: H(40) = 3.20; P = 1.0), with a mean rank usefulness score of 28.2 for welfare experts, 18.3 for cetacean experts and 24.1 for veterinarians. Eighteen major themes were identified from reflexive thematic analysis as significant knowledge gaps; all were presented as categories for scoring in questionnaire 2. Of these, only 'lack of post-release monitoring' was scored as greatly important (score ≥7 grouping) by at least 70% of experts in the second questionnaire (Table 2).

3.3. Key Concerns about Stranded Cetacean Welfare and Survival Likelihood

3.3.1. Level of Concern That the Category Affects Welfare or Survival Likelihood

Thirty-seven themes were identified from reflexive thematic analysis for concerns about the welfare and, likewise, about survival likelihood from the responses provided in the first questionnaire. From these, 19 major categories were presented for welfare and 20 major categories were presented for survival likelihood. Of these, 12 categories overlapped as concerns for both welfare and survival likelihood (bold in Table 3).

Table 3. The major categories for concerns about welfare and survival likelihood arising from reflexive thematic analysis of participant responses to questionnaire 1, and median score and range for each category from questionnaire 2. Categories are ranked by the percentage of experts that scored them as having severely bad effects (scores in ≥7 grouping). Categories above the bold line reached consensus (≥70%). Concern categories that overlapped for welfare and survival likelihood are shown in bold.

Welfare Concern Categories	Median Score (Range)	% Experts Scored ≥7	Survival Likelihood Concern Categories	Median Score (Range)	% Experts Scored ≥7
Physical damage, stress, pain and thermal discomfort due to overheating, hyperthermia, heat stroke and hypothermia	9.4 (5.3–10.0)	91.2	**Animal suffering from illness, disease and underlying health conditions**	9.0 (3.8–10.0)	86.8
Difficulty breathing, inhalation of water	9.6 (4.4–10.0)	86.4	Length of time stranded and number of re-strandings	9.2 (4.3–10.0)	83.0
Delays to deciding on euthanasia to relieve suffering	8.7 (5.0–10.0)	74.1	**Difficulty breathing, inhalation of water**	9.1 (4.3–10.0)	79.3
Separation from conspecifics/social group, including mother–calf separation	8.0 (0.6–10.0)	72.9	**Availability of appropriate and timely human intervention and handling, responder training and experience**	8.7 (0.0–10.0)	73.1

Table 3. *Cont.*

Welfare Concern Categories	Median Score (Range)	% Experts Scored ≥7	Survival Likelihood Concern Categories	Median Score (Range)	% Experts Scored ≥7
Pain and suffering due to physical injury or trauma caused by stranding, particularly substrate	8.2 (2.0–10.0)	72.4	**Feasibility and speed of rescue/refloatation based on human and equipment resources, location of stranding, time of day, responder expertise and experience and human safety**	8.7 (0.0–10.0)	69.8
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	9.0 (2.0–10.0)	72.4	Cause of stranding still present	8.6 (1.9–10.0)	69.8
Suffering, stress and anxiety associated with stranding	8.2 (1.8–10.0)	72.4	**Physical injury or trauma caused by stranding**	8.2 (2.7–10.0)	65.4
Skin damage and associated pain due to sunburn, dehydration/desiccation occurring when out of water in sun	8.5 (1.0–10.0)	71.2	**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**	8.7 (0.0–10.0)	65.4
Pain and its management	8.1 (0.4–10.0)	69.5	**Body condition and nutritional status**	8.0 (2.2–10.0)	60.4
Inappropriate human intervention, poor handling, responder training and experience, and public pressure influencing decisions	8.9 (2.4–10.0)	69.0	Abnormal movements and reduced limb function	8.0 (1.8–10.0)	60.4
Fear, stress, distress or helplessness at being unable to move or help themselves	8.0 (1.2–10.0)	67.8	**Weather and environmental conditions, including tides**	7.5 (2.5–10.0)	55.8
Animals suffering from illness, disease and underlying health conditions	8.6 (0.3–10.0)	67.2	Geographical location of stranding and being out of habitat or range	8.0 (1.1–10.0)	53.9
Feasibility of rescue/refloatation based on human and equipment resources, location of stranding, time of day, responder expertise and experience and human safety	8.5 (0.4–10.0)	62.1	Animal awareness and neurological status	7.5 (0.0–10.0)	52.9
Nutritional stress, poor body condition	7.7 (0.5–10.0)	59.3	**Stress, anxiety and associated conditions caused by stranding**	7.4 (1.2–10.0)	50.9
Stress, fear, distress or pain caused by human presence, interactions, noise	7.2 (0.5–10.0)	56.9	**Effect of species biology on survivorship**	7.0 (1.6–10.0)	47.1
Fear and stress at being in a strange, novel environment	7.2 (0.7–10.0)	53.5	**Skin damage and associated pain due to sunburn, dehydration/desiccation occurring when out of water in sun**	6.9 (0.8–10.0)	45.3
Fear and pain from predation	7.3 (0.8–10.0)	46.6	**Separation from conspecifics/social group**	6.9 (1.6–10.0)	41.5

Table 3. *Cont.*

Welfare Concern Categories	Median Score (Range)	% Experts Scored ≥7	Survival Likelihood Concern Categories	Median Score (Range)	% Experts Scored ≥7
Effect of species biology, resilience and stranding type on welfare outcomes	7.0 (0.5–10.0)	40.4	Presence of predators and scavengers	6.9 (2.0–10.0)	39.6
Weather and environmental conditions	6.2 (1.0–10.0)	37.9	Substrate/terrain at the stranding location	6.3 (0.0–10.0)	39.6
			Animal age based on length/weight and reproductive status	5.5 (0.8–10.0)	33.3

Participants scored all 19 categories as having 'bad' to 'severely bad' effects on welfare (median scores >6; Table 3). Eight of these were scored by at least 70% of participants as having severely bad effects on welfare (scores in ≥7 grouping; Table 3). Similarly, all 20 major categories were scored as having a 'bad' to 'severely bad' effect on survival likelihood (median scores >5; Table 3). Four of these categories were scored as having 'severely bad' effects on survival likelihood by over 70% of the experts (scores in ≥7 grouping; Table 3).

3.3.2. Knowledge Available to Assess How Various Concerns Affect Welfare and Survival Likelihood of Stranded Cetaceans

In terms of the 19 welfare concern categories presented, moderate knowledge (median range: 3.0–7.1) was considered to be available, and all were judged to have at least a 'bad' effect on welfare. Participants considered more knowledge to be available regarding concerns about the animal's physical status, such as difficulty breathing, illness/disease, nutritional stress, skin damage, thermal status, and about the feasibility of undertaking rescue/re-floatation (Figure 1). In contrast, experts considered less information to be available regarding concerns related to animals' mental status. The welfare concern categories perceived to have the least available knowledge (median scores ≤5) related to animal fear, stress and pain. A moderate positive monotonic correlation was found between the participants' rating of the level of concern and the available knowledge for welfare categories (Spearman's Rank Correlation: $rs(17) = 0.51$; $P = 0.03$), supporting a general trend for participants to report less relative concern about welfare categories for which they perceive less information to be available, although concern was high for all categories.

Similarly, of the 20 survival likelihood concern categories presented, moderate knowledge (median ranges: 4.4–7.0) was considered to be available, and all concerns were judged to have at least a 'bad' effect on survival likelihood. Participants considered that more knowledge was available related to concerns about the animal's physical status, including illness/disease, difficulty breathing, skin damage and body condition, as well as about the length of time stranded, number of re-strandings and the feasibility of stranding response (Figure 2). In contrast, experts considered the least knowledge to be available related to animal awareness and neurological status (median score 4.4). A moderate correlation was found between the participants' rating of the level of concern and the available knowledge for survival-related themes ($rs(18) = 0.55$; $P = 0.01$), suggesting lower concern about survival likelihood categories for which less information is available, although concern was strong for all categories.

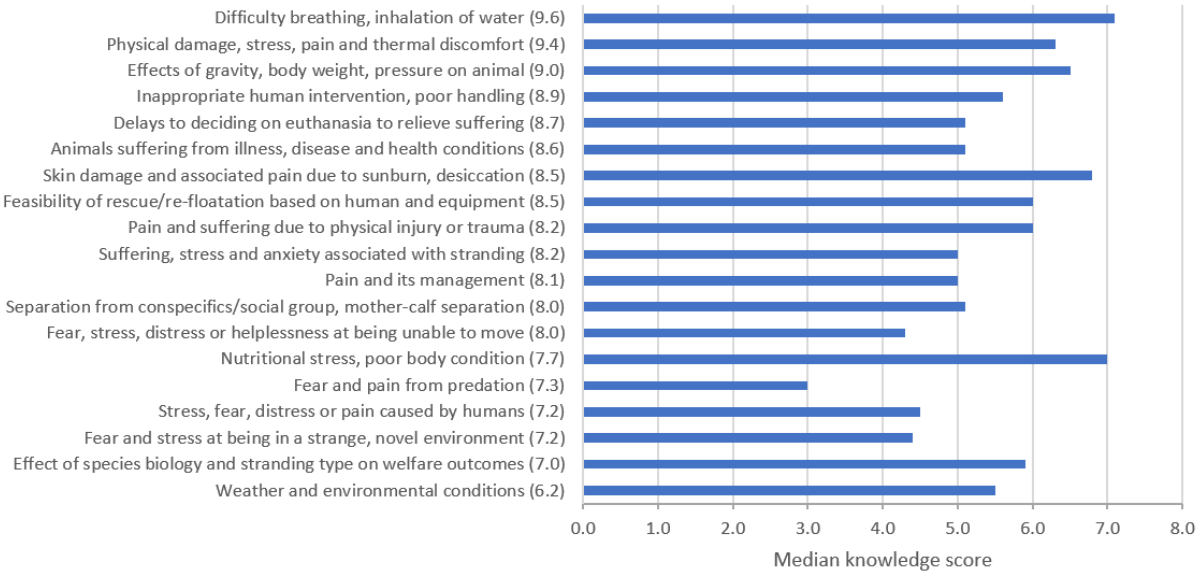

Figure 1. The median scores for the perceived level of knowledge available to assess concern categories about welfare. Ranked in order of the median scores for the perceived severity of the effect of each concern category (in parentheses) on cetacean welfare, arising from participants' responses on questionnaire 2. Category labels have been reduced to best fit; please refer to Table 3 for full category labels.

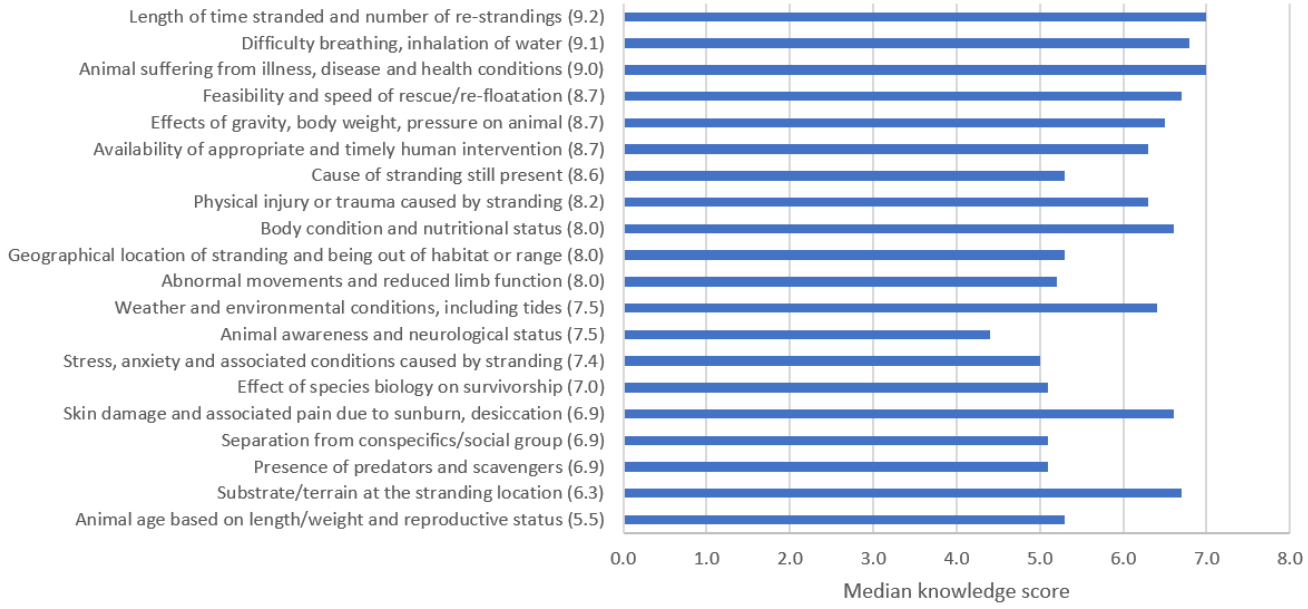

Figure 2. The median scores for the perceived level of knowledge available to assess concern categories about survival likelihood. Ranked in order of the median scores for the perceived severity of the effect of each concern category (in parentheses) on cetacean survival likelihood, arising from participants' responses on questionnaire 2. Category labels have been reduced to best fit; please refer to Table 3 for full category labels.

3.3.3. Barriers to Assessing Concerns about Welfare and Survival Likelihood of Stranded Cetaceans

For welfare, 25 participants (40%) provided written answers regarding barriers to assessing the effects of concerns presented in questionnaire 2. Three major themes were found from the reflexive thematic analysis of these qualitative responses:

1. Skills/training/knowledge of responders;
2. Complexity of factors influencing welfare;
3. Lack of knowledge/data to enable welfare assessments.

Experts suggested a major barrier to determining how the welfare of stranded cetaceans might be affected relates to the skills, training, and knowledge of personnel on the beach carrying out assessments and stranding responses. Approximately one-third of experts who provided comments noted that in many instances, those responding to the animals are members of the public with no or limited experience/training. For example, one participant noted:

> *"Very often decisions may be taken by individuals or representatives of organisations that have very little knowledge and have failed to contact those that have the requisite skills and knowledge. [. . .]"*

Related to this, in the question on welfare, participants highlighted that the amount of knowledge and available resources vary geographically:

> *"Large geographical difference. E.g., stranding response in Australia and NZ is likely high, with many trained volunteers. Same in EU, but not at all for Africa and Asia."*

Related to the inadequacy and variability in responder knowledge and training, it was emphasised that no single welfare concern will occur in isolation at a stranding, and that it is important to understand the complexity of factors influencing the welfare of stranded cetaceans. One participant noted:

> *"Many of these topics occur in a gradation and/or categories are well known in one aspect but not in others (e.g., how size affects large whales compared to smaller cetaceans) or short term or shallow water grounding may have minimal effects, but long term may have greater effects. In addition, an animal that is grounded longer term but also experiences hyperthermia will have compounding effects that cannot necessarily be teased apart."*

Finally, the paucity of knowledge available to assess the welfare state of individual stranded cetaceans emerged as a barrier. In particular, there is a need for improved knowledge and data on measurable indicators of welfare to understand the impacts of stranding. This is reflected by one participant, with regard to understanding welfare concerns:

> *"Fundamentally, if we accept the current paradigm that welfare is a function of multiple layers, from the basic ability to breathe right up to maintaining a complex positive cognitive state, itself a function of multiple influences, then we quickly run up against a wall of what we can measure. If we can't measure something we then have to extrapolate the effect of what it means to the individual based on what we know in other mammals, including humans. We struggle to do this with cetaceans for all the obvious reason, so the barriers are that—what we can measure, and if we can't measure it, how reliable we think our estimates are."*

Similar sentiments were expressed by other participants. For example:

> *"In my opinion, we need more foundational knowledge of indicators of affective states in cetaceans, before we can then assess how each of the above issues affect welfare. [. . . .] Large datasets with post-release monitoring and post-mortem data are the only way to see whether our welfare assessments on the beach are accurate."*

Regarding survival likelihood, only 14 participants (22%) provided written answers regarding barriers to assessing the effects of the concerns presented in questionnaire 2. Three major themes were found from the reflexive thematic analysis of these qualitative responses:

1. Lack of data regarding survival likelihood and the need for post-release monitoring;
2. Complexity of factors influencing survival likelihood;
3. Skills/training/knowledge of responders.

A major barrier to determining how the survival likelihood of stranded cetaceans might be affected by concerns relates to the need for further monitoring of animals that are released to assess survival. For example:

> *"One of the biggest problems is that there is little study of the successfully rescued and refloated animals—there is more knowledge from the dead animals via necropsies. Tagging animals at refloat can create further stress and should never delay a refloat and the data received back is limited. Using data taken from animals in captivity can be hyped and provide incomplete guidance for wild animals due to the unnatural habitat. So, the biggest barrier to understanding how these factors really affect survival is that we know little about those that do survive and how they react to their stranding experience."*

It was also highlighted that many concerns will not occur in isolation and determining how each may influence survival likelihood can be complex. One participant noted:

> *"Many of these items are difficult to separate and actually determine how much impact each individual indicator may have."*

The ability to assess these concerns was emphasised, by several participants, to be hindered by the lack of knowledge and necessity to have trained, skilled personnel on the beach to undertake assessments. For example:

> *"Ability to assess some of these aspects, having trained people in place to take out the assessments"*

3.4. Agreement across Disciplines

Overall, LDAs revealed overlap among expertise groups in the scoring of categories within every topic in round two, suggesting that self-reported expertise did not have a major effect on the scoring of categories (results presented in the Supplementary Materials, S6). Therefore, results specific to expertise group were not further analysed, and results presented for each topic were based on the median scores and consensus of all participants.

4. Discussion

The primary aim of this study was to explore how experts understand animal welfare and survival likelihood in the context of cetacean strandings, their main concerns about stranded cetacean welfare and survival likelihood, and the knowledge gaps they feel need to be filled to improve our ability to assess welfare and likelihood of survival in such contexts. Overall, the results highlight how both welfare and survival are understood to be complex and multi-faceted. These multiple dimensions need to be considered when trying to understand the state of a stranded cetacean to inform management decisions. Experts considered many concerns to have negative ('bad' or 'severely bad') effects on stranded cetacean welfare and survival likelihood. Generally, the available knowledge was considered to be somewhat useful for assessing welfare and survival likelihood. Key barriers to improving assessment included a lack of empirical data about the state of stranded animals and post-release monitoring. Notably, the level of available knowledge seemed to influence the level of concern experts reported about specific issues.

4.1. Fundamental Concepts of Stranded Cetacean Welfare, Concerns, Knowledge Gaps and Barriers

Ten of the 12 major categories generated from reflexive thematic analysis of expert opinions were considered by the experts to be important for understanding stranded cetacean welfare, reaching consensus and with median scores of greater than eight. Many of these categories reflected the animal's physical state in terms of health, injury, disease, physiology, and comfort, as well as the animal's own experience of the situation including various negative mental states, such as "pain", "suffering", "distress", "stress", and "fear" and overall 'quality of life'.

Even though most of the experts did not identify themselves as animal welfare scientists, these categories are consistent with contemporary frameworks for understanding and assessing animal welfare. Animal welfare science now often conceptualises welfare to be the property of the individual animal, based on the animal's experience of its own life in terms of its mental state [1,69]. For example, for a physical aspect to be considered important for an animal's welfare, it must be likely that it is impacting upon the animal's

mental state. Therefore, animal welfare applies only to those species that are sentient, including cetaceans [70–74], and that can experience both positive and negative mental states depending on their circumstances [1,69,70,75–77].

Contemporary animal welfare science, therefore, considers the interrelated aspects of biological functioning—reflecting the animal's internal state—and its current circumstances, as well as behaviour, and the cumulative impacts that these have on the animal's mental (affective) state [69,78,79]. In this study, almost all these aspects were generated by experts unprompted and subsequently confirmed as important categories. This suggests that the welfare of stranded cetaceans is understood by those working in relevant fields to be consistent with contemporary animal welfare science. The findings also suggest that experts believe welfare should be approached considering the likely perspective of the individual animal [69]. Overall, the results indicate that the welfare of stranded cetaceans should be approached holistically and assessed in a multidisciplinary manner. The way in which these concepts are conceived will influence how they are assessed and which features are emphasised when evaluating outcomes [1].

Contrary to expectation, while the category 'Sufficient food and water' was considered important by experts based on the median score (8.0), it did not reach consensus (scored $\geq$7 by 65.5%). This is notable, since it is a common factor in most animal welfare assessments [80–82]. The lack of consensus may have been due to experts feeling that it was not as relevant for the context of cetacean strandings, where animals are in an abnormal environment and unable to feed. Additionally, some cetaceans are known to feed minimally during migration and instead use nutritional reserves [83]. Therefore, experts may perceive that the inability to feed or obtain water during a relatively short stranding event, involving a cetacean in good nutritional condition or that fed prior to stranding, may not have a significant impact on welfare. However, in contrast, an animal in poor nutritional condition or that has not fed in the days prior to stranding may suffer additional compounding welfare impacts when already experiencing a negatively valenced welfare state [80].

Based on expert consensus, the subjective affective states of stranded cetaceans may be affected by the animal's physical state (health and biological functioning) and behaviour as well as the impacts of its surrounding environment including stranding response procedures (see below). Therefore, stranded cetacean affective states may be inferred by cautiously interpreting measurable or observable indicators of these categories. Systematic frameworks that guide the interpretation of welfare indicators in this way are well established in animal welfare science. A commonly utilised framework is the Five Domains Model [84], which systematically facilitates consideration of impacts in each of three physical/functional domains (nutrition, physical environment and health), the behavioural interactions animals may have (Domain Four), and the associated impacts these conditions have on the animal's affective state (Domain Five). This allows for scientifically grounded and transparent evaluation of affective states that are not directly measurable [1,80,85–87]. By applying such frameworks to cetacean strandings, we can use empirical data about the animals' welfare states to inform decision making and ensure the most appropriate intervention for the welfare of the stranded cetacean.

Many of the concerns directly related to physical state would be due to a stranded cetacean being out of its natural environment and unable to alleviate or avoid the factors of concern. Importantly, all these physical concerns matter in terms of welfare as they are likely associated with negative affective experiences such as "stress", "pain" and "suffering". For example, hyperthermia, sunburn and skin damage may occur simultaneously and will likely cause "pain" and "discomfort"; this suffering may severely impact welfare when strandings occur on summer days and/or during bright, sunny conditions. These physical impacts also have the potential to lead to dehydration and hypovolemic shock in stranded cetaceans [88,89], which are expected to lead to other negative affective states. Likewise, organ compression, occurring when the animal's weight is not supported whilst out of the water [89,90], can lead to pulmonary lesions and congestion [91]. These conditions may be associated with the negative state of breathlessness [92]. Furthermore, rhabdomyolysis

of the skeletal and cardiac muscle may occur, followed by acute renal failure [93], which could be painful.

Additionally, pre-existing health conditions were also highlighted to be an important welfare concern. These can have detrimental impacts upon animal welfare and may be the cause of the stranding itself, as is commonly reported in single stranding events [25,94]. Experts may consider this category important, since animals that are already suffering negative welfare states due to underlying health conditions will likely be subjected to compounding negative welfare states when stranded due to the additional "pain", "anxiety", and "stress" that may be experienced.

Notably, while experts felt that more information was available about these particular concerns than about others, they also highlighted major knowledge gaps in terms of diagnosing internal injuries, health and capture myopathy, and recognising deviations from the normal baseline for many physiological and behavioural parameters [95,96]. This was reinforced by the major barriers described by several experts about the current lack of systematically collected data from stranding events and the limited availability of skilled/trained personnel to interpret parameters and inform decision making. Additionally, lack of post-release monitoring was highlighted as a key knowledge gap, which was likely in relation to assessing long-term health and welfare following human intervention [97–99].

Unfortunately, these knowledge gaps also affect the ability to understand key welfare concerns directly associated with mental states, including "suffering", "stress" and "anxiety" due to being stranded and in an abnormal environment; and "distress" and "helplessness" likely experienced due to stranded cetaceans' inability to move or help themselves. This lack of knowledge was reinforced by experts as they perceived these welfare concerns to be the least well understood, i.e., the least knowledge available to be able to assess their impact. This is because cautious inference of affective states requires interpretation of validated indicators of biological function, health and behaviour [80,100–102]. Although these are likely measurable at strandings, studies to validate the use of specific physiological and behavioural indicators in terms of the welfare state of stranded cetaceans are yet to be conducted.

Interestingly, the experts also regarded welfare at strandings to include consideration of the animal's ability to live in normal social and environmental conditions in the event it is re-floated. This relates to the concept of natural living, which reflects the idea that the environment should enable animals to perform their natural behaviours [103,104]. Natural living is often used as a key concept for evaluating welfare in captive settings such as zoos [105]; i.e., good welfare occurs when the environment enables animals to live the most 'natural' life possible. However, a captive animal will never be in exactly the same situation as a wild counterpart, and therefore, too much emphasis may be put on naturalness as a way of 'improving' wild animal welfare in zoos, particularly as it is thought to reflect public perception of welfare [106,107]. Similarly, stranded cetaceans are in an entirely abnormal environment; thus, the expression of normal or natural behaviour is almost impossible, and its use as a way of understanding variations in welfare state in this context is limited. The fact that humans commonly intervene in stranding situations exacerbates the abnormal circumstances of stranded cetaceans and it is difficult, currently, to interpret stranded cetacean behavioural responses to human intervention in terms of their welfare using a natural living approach.

Related to this, experts emphasised social separation, including maternal–filial separation as a major welfare concern. Socially separated cetaceans likely experience negative mental states such as anxiety and grief [108,109]; and for maternally dependent calves, separation from mothers will compromise their welfare and survival likelihood. Indeed, maternally dependent calves that strand alone are typically candidates for euthanasia or captivity due to their inability to forage and integrate successfully [110,111].

Several categories that reached consensus for welfare characterisation related to the effects of human interventions on animal welfare rather than features of the animal itself. The fact that human intervention was considered as part of welfare characterisation may relate to the traditional resource-based understanding of animal welfare, which focused on

resource/management inputs rather than on animal-centric outputs [112], i.e., what we provide for animals rather than how the animal experiences what we provide. However, it could also reflect variation in participants interpretation of the question posed, providing responses to 'what affects animal welfare?' rather than 'what is animal welfare?'.

Experts suggested that appropriate decision making in terms of re-floatation versus euthanasia must be considered as part of characterising stranded cetacean welfare; such decisions are likely to be particularly important for welfare, since they can be contentious and are often delayed, which can prolong any suffering that may be occurring [110,113,114]. Consistent with that, the only concern directly related to stranding response that reached consensus was associated with delays to undertaking euthanasia decisions. Experts in this and previous studies emphasised that decisions on when and how to euthanise stranded cetaceans are a major knowledge gap [110,115]. Unfortunately, the poorly defined criteria for identifying animals requiring end-of-life decisions [110,116], and the conflicting expectations of preservation of life [110,117,118], means that some compromised cetaceans likely experience prolonged suffering accordingly.

Other important management concerns (median scores >8) also related to the lack of skilled/trained personnel on beaches. Experts reinforced this point in the barriers to assessing welfare, including inappropriate human intervention and the feasibility of re-floatation based on available resources. These concerns are likely to be important as animals that are re-floated inappropriately, rather than undergoing comprehensive assessments prior to intervention procedures, e.g., [119–121], are likely to suffer additional physical injuries and prolonged negative affective states. Furthermore, experts noted that none of these concerns would occur in isolation and that adequately assessing the welfare impacts will require these to be understood cumulatively.

Importantly, the most recent update to the Five Domains Model framework [84] has included an understanding of the impacts of human interactions on animals, with various impacts suggested that could relate to stranded cetaceans during intervention procedures. For example, negative welfare impacts may occur since individual stranded cetaceans are likely to have had no or minimal contact with humans prior to stranding. Given that stranded individuals are in an atypical life-threatening situation, the presence and intervention of humans may induce additional anxiety and/or fear. Additionally, well-intentioned humans at stranding events often perceive themselves to have emotional bonds with the stranded cetaceans, which can cause delays to end-of-life decisions for compromised individuals [110,114] and prolong animal physical and mental suffering. Conversely, some common stranding response procedures may minimise harm and the associated negative welfare states. For example, providing shade or cooling water over the animal's body [120] may reduce concerns such as hyperthermia and skin damage, which likely cause "pain" and "discomfort" to stranded cetaceans.

4.2. Fundamental Concepts of Stranded Cetacean Survival Likelihood, Concerns, Knowledge Gaps and Barriers

Seven of the 18 major categories were considered to be important—reaching consensus and with median scores of greater than eight—for understanding the likelihood of a stranded cetacean surviving. Expert conceptualisation suggests that the interrelated concepts of health, biological function, and behaviour (natural state) are considered important to understand survival likelihood.

Experts suggested that persistence to at least 6–12 months after re-floatation should be a criterion when characterising the likelihood of survival. This time period may have been scored as most important to ensure that individuals would have had time to re-integrate to normal life post-intervention [99,122]. Such characterising categories were also emphasised by experts in terms of understanding the animal's ability to socially and physically re-integrate and live a 'normal' life. Yet, these require re-floatation and post-release monitoring to have occurred.

Few studies have carried out post-stranding monitoring and have generally lasted only a few weeks, e.g., 3–6 weeks, [19,123,124], due to technological limitations and difficulties locating individual cetaceans at sea. Consistent with this, the single major knowledge gap and main barrier to assessing survival likelihood was highlighted by experts as the lack of post-release monitoring. Nevertheless, a recent study on a small group of cetaceans found that most individuals (73%) surviving to one year were still traceable by field observation five years post-release [99]. Thus, the one-year criterion for post-stranding survival in our study would likely be a good predictive timeframe to assess long-term survivorship. Additionally, the application of tags to monitor survival requires trained personnel to ensure appropriate deployment and avoid additional welfare compromise [125]. This need for trained personnel at strandings was also highlighted as a barrier to assessing survival likelihood concerns.

Notably, most of the categories seemed to assume that the animal had already been re-floated. This may reflect the participants' interpretation of the question posed, providing responses to 'how can the animal's survival be understood?' rather than 'how can the animal's likelihood of survival be understood?'. In the latter case, characterisation would likely include categories that relate to survivorship prognosis such as 'normal haematological parameters' [30]. This distinction is important, as rescue attempts are often considered to be 'successful' once animals are re-floated, yet in most cases, post-release monitoring is not undertaken, and the fate of the released animals remains unknown [126]. This characterisation is likely to create unrealistic public expectations and increase pressure on decision makers at stranding events to re-float animals [114,118].

'Animal health and disease status' also reached consensus and can provide direct understanding of an individual's likelihood to survive. Consistent with this, animal suffering from illness, disease and underlying health conditions was highlighted as a key concern for stranded cetacean survival likelihood. Previously, animals with underlying health conditions have mostly been associated with single strandings [25,127] and unusual mortality events [128–130], whereas mass strandings tend to involve outwardly healthy animals [94] that strand due to social cohesion [131] or navigational error [132]. Thus, animals involved in mass strandings are predicted to have increased survival likelihood when considering pre-existing health conditions [94,123]. Importantly, understanding of this category could provide some indirect evidence of whether the animal is likely to survive for the 6–12-month period and return to 'normal' life in the event it is re-floated. However, as discussed in Section 4.1, there are currently difficulties in diagnosing health conditions in live stranded cetaceans [97,133,134], which will limit the ability to predict survival likelihood.

Another physical disruption that was a key concern for stranded cetacean survival likelihood was difficulty breathing; it was likely emphasised since it has been linked to pulmonary congestion and can play a role in post-release mortality [91,127,135]. Other concerns perceived to be important (median scores $\geq$8) but that did not reach consensus related to animal physical state including physical injuries, organ compression, body condition, and abnormal movements with reduced limb function. Previous studies have highlighted that such physical disruptions can detrimentally affect survival [93,127]. In some cases, these physical conditions can lead to mortality only after a substantial period of time [98,136] while in others, death can occur soon after human intervention [137,138].

The length of time stranded and number of re-strandings were highlighted as key concerns for survival likelihood. Their perceived importance likely relates to the potential for compounding detrimental effects on animal physical state the longer the animal is out of its natural environment. For example, capture myopathy is more likely to occur in prolonged stranding events due to the sustained stress response [93], causing ischemia and reperfusion injuries which often contribute to death [137,139]. Such damage is untreatable and may cause re-floated animals to re-strand [95]. Therefore, the number of times that an individual re-strands can give some indication of its internal state, ability to function normally, and its likelihood to survive if re-floated again [89,91,120]. Improved data

collection to provide evidence-based recommendations for interventions involving re-stranded animals is vital. Experts emphasised this need for increased data collection and the necessity to have skilled responders interpreting parameters to be able to assess these complex, cumulative concerns.

Finally, the availability of appropriate and timely human intervention was highlighted as a key concern for survival. While well-intentioned members of the public may try to re-float animals, this often happens before comprehensive assessments can be undertaken and can involve the use of inappropriate interventions, increasing injury and/or mortality risk [140]. Conversely, timely, appropriate intervention could minimise the effects of internal damage such as caused by organ compression and capture myopathy, and lead to improved chances of survival [93,137]. Another human-related concern that was considered important (median score 8.7), but did not reach consensus, was the feasibility of rescue based on available resources. Such resources likely include the number of trained responders and the availability of appropriate re-floatation equipment. This will affect whether appropriate and timely intervention can occur, thereby affecting the animal's survival likelihood.

4.3. Similarities and Differences in Concepts Relating to Stranded Cetacean Welfare and Survival

The expert panel emphasised the inextricable links between welfare and survival beginning with their characterisation of the concepts; both included interrelated aspects of health, biological function and behaviour. The difference was that survival likelihood was not understood to be related to the animal's mental experience, and conversely, welfare did not relate to longevity in terms of the animal surviving until a particular timepoint. This suggests that experts consulted in this study may perceive there to be no requirement of survival to a certain point when considering welfare as the priority at strandings and that the animal's affective state would take precedence over longevity, permitting decisions such as euthanasia. This appears at odds with strandings response driven by societal desire, which typically focuses on re-floating animals [110,114,141].

The knowledge gaps and barriers to assessing concerns about welfare and survival were also similar, including the lack of empirical data available from stranding events and the critical need to have, and variable availability of, skilled personnel to interpret parameters and undertake assessments. However, the link between welfare and survival was most apparent in the key concerns for stranded cetaceans, with twelve concerns rated as having negative ('bad' or 'severely bad') effects for both concepts. Importantly, based on the key concerns generated in this study, welfare compromise of even healthy individuals is likely at strandings, and this compromise has the potential to affect an individual's survival likelihood. Breathing difficulty was the only concern that reached consensus for both welfare and survival likelihood. This likely reflects concern about the survival-critical nature of respiratory impairment and the inherent empathy for the unpleasantness and unnaturalness [92,142] of the stranded environment for these marine animals.

A further six key concerns were scored as having a severe effect on both welfare and survival likelihood by at least 50% of the experts. These included illness/disease, physical injury/trauma, organ compression, body condition/nutritional status, stress/anxiety caused by stranding, and appropriate human intervention. This is consistent with previous studies that have identified some of these factors as affecting the outcome of strandings [93,95,120,137,143]. Furthermore, contemporary animal welfare studies have highlighted some similar concerns for other mammal species [40,144,145] and cetaceans in other circumstances [81,97,134,146].

Interestingly, while social separation was noted as a concern for both welfare and survival likelihood, maternal–filial separation was only considered to have a 'bad' effect on welfare (i.e., it was not included as a specific category for survival). This is despite the low survival likelihood of maternally dependent animals; maternal–filial separation is a cause of high mortality for many stranding events involving a variety of species [127,135,147]. It is possible that experts assumed that a decision of euthanasia would be implicit in the

stranding of a maternally dependent calf [110,111], and that the survival likelihood of such an animal would therefore not be relevant. However, as has been previously reported, such decisions are not always undertaken promptly [110].

Fewer physical disruptions were included as key concerns for survival likelihood in comparison to those emphasised for welfare. This is despite the fact that these are likely to cause pathophysiological impacts which could play a role in mortality following live stranding events and reduce the effectiveness of any stranding response procedures [93]. It is possible that experts did not consider some physical disruptions, such as skin damage, to be as relevant to survival likelihood as to immediate welfare, as this likely occurs naturally in the wild and animals must therefore have sufficient mechanisms to survive [148,149]. Additionally, physical concerns such as hyperthermia may not have featured for survival since experts may assume that some hyperthermic animals in mass strandings do survive [123,150], but it may be concerning for welfare due to the likelihood of discomfort and associated pain. However, even post-release, some physical disruptions may continue to impact the animal over time and can lead to eventual death or reduced fitness, e.g., [98]. The current lack of empirical data on such concerns and limited post-release monitoring hinders assessments of the effects of these factors on survival.

Surprisingly, the length of time stranded was only a concern for survival, even though welfare compromise could be expected to increase with time out of the water (see Section 4.1). Additionally, abnormal movements were also only considered a survival concern. It is possible that experts did not include abnormal movements as a welfare concern, since they are commonly understood to be indicators of welfare compromise [101,151] and therefore were likely not viewed as a welfare concern per se. For example, in captive cetaceans, abnormal behaviour is used as an indicator for concerns related to underlying health conditions [152] and as part of rehabilitation–release assessments to predict survival likelihood [111].

4.4. Agreement across Expert Disciplines

This is one of the first studies to explicitly ask experts from different disciplines about their views on animal welfare; previously, most differences have been inferred from the peer-reviewed literature. Based on the results, the experts appear less siloed in their thinking than previously suggested [1,5,10] see S6 for further discussion. Similar overlap in the opinions of cetacean and welfare experts was also found in a recent study, where expertise groups provided comparable median scores when assessing the severity of effect of vessel traffic on the welfare of free-ranging Orca (*Orcinus orca*) [146]. These similarities may be due to the increase in conservation-welfare publications and discussions among disciplines over the past few years [10,36,71,153].

4.5. Study Considerations

The categories presented to the experts for scoring in the second questionnaire were generated using a data-driven, reflexive thematic analysis approach and using verbatim wording from experts. This enabled the researchers to explore and draw conclusions from the data rather than approaching it with preconceived ideas [57,58,60]. Nonetheless, we acknowledge that our perspectives as researchers cannot be separated from the generated knowledge to create 'objective' data. Thus, the primary researcher (RMB), in particular, has had an active role in co-generating the categories presented [154,155]. As a marine biologist focused on cetacean stranding events, the primary researcher has personal experiences and beliefs relating to the concepts explored in this study. To provide further support for the outcomes of the reflexive thematic analysis, experts were able to provide additional comments throughout the second questionnaire. No comments on categories were received, suggesting that experts did agree with those presented for scoring, providing a degree of 'ground-truthing' to the data generated [156].

Some aspects of the various characterising categories for welfare or survival, generated by the researchers from reflexive thematic analysis of the expert opinions, appear to overlap. For example, the welfare category relating to 'physical health and injury' could also be

considered to include 'normal physiology, physical comfort and discomfort'. For survival, overlap was observed in the categories of an animal remaining alive for both 6 and 12 months. This overlap arose through the reflexive thematic analysis due to the use of verbatim expert responses. However, the generation of categories in this way has ensured that the participants' concepts are mirrored, and over interpretation during researcher co-generation of categories has been minimised [57].

One limitation of the methods may be that some experts scoring categories in questionnaire 2 had not participated in the generation of themes in questionnaire 1. This could mean that some experts had additional concepts, knowledge gaps or concerns that were not presented for scoring in questionnaire 2. However, no additional themes were provided in the comments section of questionnaire 2, suggesting that experts responding did not feel that any important categories were missing. There were some differences in the proportion of respondents in each expertise group between questionnaires; however, the overlap in category scoring among expertise suggests this had minimal effects (see S6). Additionally, the geographical representation across questionnaires was similar, with approximately 87% of the experts from Europe, Oceania and North America. These are areas that have been highlighted as common sites of cetacean stranding events [22,23] and have well-established stranding response networks [157], indicating the relevance of the expert opinions gathered.

Importantly, while much of the discussion focused on those categories that achieved consensus, lack of consensus does not imply that a category was not considered important, just that not all participants rated it in the top grouping. For example, while only eight of the 19 major categories relating to concerns about stranded cetacean welfare reached the threshold for consensus, 18 had median scores of seven or greater, reflecting their overall importance to the topic. Therefore, future work should still consider those themes that did not reach consensus.

Finally, experts did appear to focus their characterisation on 'survival' rather than 'survival likelihood', which may be due to perception of the question asked (see Section 4.2). Despite this, we propose that the concerns emphasised by experts for survival likelihood could be used to extrapolate themes necessary to further conceptualise survival likelihood for stranded cetaceans. In this way, similar categories of characterisation would remain (health, biological function, and behaviour/natural state) with the addition of considering human intervention/stranding response.

A clear understanding of the concepts of welfare and survival likelihood and systematic approaches to addressing experts' concerns are required to ensure that decision making is scientifically informed as opposed to being driven by public sentiment [110]. Systematic scientific approaches to animal welfare are well implemented in domesticated species and involve structured frameworks, such as the Five Domains Model, to provide guidance, facilitating a more holistic understanding of animal welfare [84]. The development and implementation of such a framework are recommended to integrate animal welfare science and guide decision making at stranding events.

5. Conclusions

Our results highlight the inextricable link between welfare and survival, and the need to integrate welfare science alongside conservation biology to achieve management goals at stranding events. The high level of consensus among expertise suggests that a more holistic approach to understanding stranded cetaceans is supported by both conservation and animal welfare experts. The knowledge collected in this study should be considered as a starting point for developing a systematic, structured framework for welfare assessment in the strandings context. Specifically, our data can provide guidance on which parameters to use in stranded cetacean evaluations through the conceptualisation of welfare and survival likelihood; as well as highlight key concerns that will need to be addressed to ensure the best welfare outcomes and highest survival likelihood for viable stranded cetaceans. Increased data collection and comprehensive evaluation of both the welfare and survival

likelihood of stranded cetaceans will provide the empirical evidence necessary to ensure informed decision making at future stranding events.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/d14050338/s1, S1: Information sheets provided to participants regarding the study; S2: Questionnaire 1; S3 Table S1: Themes of welfare characterisation based on reflexive thematic analysis of expert opinion transcribed as intelligent verbatim; S3 Table S2: Themes of welfare knowledge gaps based on reflexive thematic analysis of expert opinion transcribed as intelligent verbatim; S3 Table S3: Themes of welfare concerns based on reflexive thematic analysis of expert opinion transcribed as intelligent verbatim; S4 Table S1: Themes of survival characterisation based on reflexive thematic analysis of expert opinion transcribed as intelligent verbatim; S4 Table S2: Themes of knowledge gaps relating to survival likelihood based on reflexive thematic analysis of expert opinion transcribed as intelligent verbatim; S4 Table S3: Themes of survival likelihood concerns based on reflexive thematic analysis of expert opinion transcribed as intelligent verbatim; S5: Questionnaire 2; S6: Results and discussion of the linear discriminant analysis (LDA).

Author Contributions: Conceptualisation, R.M.B. and K.A.S.; methodology, R.M.B., N.J.B., K.E.L. and K.A.S.; validation, R.M.B., N.J.B., K.E.L. and K.A.S.; formal analysis, R.M.B. and M.D.M.P.; investigation, R.M.B. and M.D.M.P.; resources, K.A.S.; data curation, R.M.B.; writing—original draft preparation, R.M.B.; writing—review and editing, R.M.B., N.J.B., M.D.M.P., K.E.L., E.L.B. and K.A.S.; visualisation, R.M.B. and M.D.M.P.; supervision, N.J.B., M.D.M.P., E.L.B. and K.A.S.; project administration, K.A.S. and N.J.B.; funding acquisition, R.M.B. and K.A.S. All authors have read and agreed to the published version of the manuscript.

Funding: This manuscript is part of the PhD research of Rebecca M Boys. Rebecca M Boys was supported by an Association of Commonwealth Universities Doctoral Scholarship, Karen A Stockin was supported by a Royal Society Te Apārangi New Zealand Royal Society Fellowship (2019–2024). The research was additionally supported by Animal Ethics Inc Research Grant USA, Wildbase Research Trust Fund New Zealand, New Zealand Veterinary Association Marion Cunningham Memorial Fund Grant and Animal Behavior Society Amy R Samuels Grant USA. The funding sources had no involvement in study design, data collection, analysis or interpretation, or in the writing of the article.

Institutional Review Board Statement: This project was evaluated by peer review and judged to be low risk according to criteria set by Massey University Human Ethics Committees. Consequently, it was not reviewed by one of the University's Human Ethics Committees. Instead, project details were notified to the committee (Notification number: 4000023382). All participants gave their informed consent for inclusion before they participated in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The raw data are not publicly available due to ethical considerations regarding identifiable data. Non-identifiable data are contained within the Supplementary Materials.

Acknowledgments: We thank all the participants that took part in our study and the four pilot study participants who commented to help improve questionnaire design. We also thank the mana whenua (representing the Indigenous people of Aotearoa New Zealand) for their extended support of this mahi. The anonymous reviewers and the editors are kindly acknowledged for their valuable feedback.

Conflicts of Interest: The authors declare no conflict of interest.

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