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Assessing Aquatic Mammal Welfare While Assessing Differing Values and Imperfect Tradeoffs

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Abstract

Assessments of animal welfare can be complex and controversial, including where captive and free-ranging aquatic mammal welfare are of concern. An assessor's value preferences, attitudes, personal experience, and societal values are examples of factors that inform how animal welfare is evaluated. While there is not a single measure of animal welfare that is universally accepted, assessments of the welfare of aquatic mammals can be fruitful if informed by tried and true standards and indicators. Animal welfare is best viewed within context and relative to opportunities for improvement, although some animal welfare concerns may clearly be dichotomized as "good" or "bad" via animal welfare assessment tools. Tools used for assessing animal welfare can be grouped into general categories, including behavioral indicators, physiological indicators, engineering standards, and performance standards. Mellor's *Five Domains Model* provides a framework for integrating multiple indicators and standards; however, while there are generally agreed upon concepts of animal welfare, such as sufficient quality and quantity of food, assessors' values (belief systems) impact their perceptions of animal welfare. This can cause intractable disagreements that can be understood through Fraser's *Three Orientations Model* in which function-, feeling-, and natural lives-based values of animal welfare are distinguished.

Still, discordance among these values can remain and can be amplified by differences in desired outcomes and how to achieve these outcomes. Tension between values confounds the resolution of tradeoffs that inevitably exist between differing animal management options such as resolution of the tension between captive individual and population-level welfare concerns for social species. Additional contextual challenges for addressing aquatic mammal welfare include assessment of welfare in different captive settings, increased attention to the affective states of animals, and the welfare of free-ranging aquatic mammals. Resolution of aquatic mammal welfare challenges ultimately depends upon stakeholders' personal relationships and a willingness to engage in constructive dialogue. This dialogue must be focused on optimally addressing animal needs for a particular set of circumstances by using animal-based measures based on the animal's perspective rather than the advancement of a set viewpoint.

Key Words: aquatic mammals, animal welfare, behavioral indicators, physiological indicators, engineering standards, performance standards, *Five Domains Model*, *Three Orientations Model*, value system

Introduction

Two individuals are at water's edge. Both are concurrently looking at the same aquatic mammal in the same setting yet vigorously disagreeing about whether "good" or "bad" animal welfare is present in the animal. How can this be? Which individual is "right"?

This brief scenario is indicative of what many who study animal welfare already know—namely, that animal welfare is a complex concept with numerous definitions and perspectives (Hewson, 2003; Fraser, 2009). While there are science-based indicators of welfare, the concept itself is inherently normative since whether an individual is faring well or poorly (i.e., the shape of its quality of life) is riddled with both subjective and objective elements (Appleby & Sandøe, 2002; Croney & Anthony, 2010).

Our view of animals, their moral status, and welfare is influenced by numerous factors. Included are traditional customs that reinforce particular ways of *valuing* and interacting with animals that shape our sense of what matters to them. There is a need to emphasize that underlying values, or beliefs, shape the conclusions of animal welfare assessments. Thus, animals used for food, clothing, and labor may be perceived to have a different value and receive

different welfare assessments under similar conditions than those who are our companions (Fraser, 2008). In cases in which animals are afforded the status of "near-persons," such as companion animals, the animals may be viewed just like a family member, and welfare assessments may use standards expected for family members (Varner, 2012). The welfare of near-persons, generally speaking, may be considered something that matters inherently to the animal, whereas the welfare of animals considered as mere resources (e.g., production animals) may be valued mainly for instrumental ends other than those which matter to the animals themselves. In other cases, the value of certain animals is associated with spiritual inspiration, threats, myths, environmental interests, and property. These differing values and attitudes shape the perspectives that guide how animal welfare is assessed (Fraser, 2008).

Traditional uses and social customs regarding the moral status of animals and their welfare continue to be challenged. Today, there is much interest in the ethical standing of animals, their welfare, and the corresponding obligations that human beings owe to them (Anderson, 2004; Broom, 2011). Thus, it is no surprise then that the welfare of aquatic mammals has also gained currency.

A landmark animal welfare document was the publication of the *Five Freedoms* in 1965 (Brambell, 1965). These guidelines indicate that animals under human control should be managed so that they are (1) free from hunger and thirst; (2) free from discomfort; (3) free from pain, injury, or disease; (4) free to express normal behavior; and (5) free from fear and distress.

While these guidelines were developed for livestock, they have served as a solid foundation for basing animal welfare assessments of other domestic and nondomestic species. The *Five Freedoms* are also a foundation for many regulatory requirements. However, it has been argued that we can and should surpass the *Five Freedoms* by surpassing basic husbandry expectations and provide opportunities for captive animals to thrive, flourish, achieve positive affective states ("good" feelings or emotions), and have "lives worth living" (Melfi, 2009; Mellor, 2014a, 2016; Vicino, 2015). Today, animal welfare is more than just about preventing animal cruelty. The concept encourages understanding of an animal's constitutive nature for (re)creating suitable husbandry conditions or minimizing adverse impacts upon free-ranging animals (Anthony, 2012). These higher standards are consistent with the expectations of large segments of human society (Cornish et al., 2016).

While many animal welfare debates are often centered on domestic animals, there has been increased publicity regarding the welfare of nondomestic animals. Some of the most publicized and polarizing debates center on aquatic mammal welfare due to differing inter- and intrasocietal perceptions. Highly publicized aquatic mammal welfare concerns include whaling activities, incidental fishery injuries and mortality, the welfare of cetaceans in captivity, the population status of polar bears (*Ursus maritimus*) and other endangered species in the wild, boating trauma to manatees (*Trichechus manatus*) and other species, harvest of fur bearing animals such as harp seals (*Pagophilus groenlandicus*) and mink (*Neovison vison*), California sea lion (*Zalophus californianus*) and Stellar sea lion (*Eumetopias jubatus*) predation on endangered and threatened salmon stock (*Oncorhynchus* spp.), and pest control where animals such as beaver (*Castor canadensis*) and nutria (*Myocastor coypus*) have damaged human property or the environment (Hovelsrud et al., 2008; The Northeast Furbearer Resources Technical Committee, 2015; Edwards et al., 2016; U.S. Army Corps of Engineers, 2016; Wang et al., 2017).

Animal welfare is viewed through the lens of societal norms, and society has multiple competing interests (Fraser, 2008; Ohl & van der Staay, 2012). Consequently, those with an interest in aquatic mammal welfare (termed "stakeholders" or "assessors" for the purposes of this article) may disagree about the welfare of these animals depending on their views regarding the moral status of animals or how they judge whether life is going well or poorly for these animals. Thus, dialogue among stakeholders is often hindered by differing perspectives, communication styles, objectives, and levels of trust, as well as fixed agendas and unwillingness to engage in constructive dialogue (Public Conversations Project, 2015). The type, amount of, and exposure to or interactions with aquatic mammals can also shape one's view of what welfare means to aquatic animals (Cornish et al., 2016). Therefore, stakeholders can range from those with limited knowledge of aquatic mammals to "experts" with varying views shaped by differing personal and professional experiences.

The aim of this article is to review the underlying values/attitudes and associated tradeoffs that may influence how the welfare of various aquatic mammals are considered. By shedding light on the relationship between how we value aquatic mammals and how we assess what matters to them, we hope to facilitate much needed reflection on the effect of our own biases on animal welfare assessments and how those biases serve as the basis, at least in part, of disagreement among stakeholders. Ultimately, recognizing the underlying values that motivate welfare assessments can ensure that captive and free-ranging aquatic mammals receive

quality care commensurate with their needs and adaptations.

Tools for Assessing Animal Welfare

What tools are available for evaluating aquatic mammal welfare? While some animal welfare assessment tools are common to both captive and wild animals, others are different. How can we be flexible enough to account for animals' situational needs without compromising animal welfare?

In an ideal world, there should be a framework that can provide an easily understood indicator of animal welfare such as a number on a scale of one to 10, with 10 being perfect. However, in the real world, there is not a single straightforward animal welfare assessment tool that is universally serviceable and accepted for animals housed by humans (Fraser, 2009; Broom, 2011). In addition, beyond not adversely affecting animals' habitat or unnecessarily causing pain or distress, the welfare needs of free-ranging animals are incompletely defined (Paterson, 2006). Multiple approaches have been used to address different aspects of animal welfare, and there is not necessarily concordance among these approaches. These approaches tend to correspond to the basic assumptions of the assessors regarding what they think matters to animals as well as their own preferences and interests (Fraser, 2003, 2009). In addition, the potential for spatial and temporal variation in animal welfare adds a dynamic element that will be interpreted differently at different time points (Petersen et al., 2001). Furthermore, what is "best" for an animal can vary by context such as where an individual animal is socially compatible with one group of animals but not another (Ohl & van der Staay, 2012; Mellor, 2016). These contextual interpretations are subject to the ethics and values of the assessor. Thus, four key ethical questions have been proposed for revealing the values underlying welfare assessments, to improve communication between assessors of animal welfare (e.g., animal scientists or veterinarians) and the public, and to encourage assessors to have "a greater awareness" of their own biases and "value assumptions":

- What is the baseline standard for morally acceptable animal welfare?
- What is a good animal life?
- What animal use or purposes are legitimate?
- What kinds of compromise are acceptable in a less-than-perfect world? (Sandøe et al., 2003)

As the reader can surmise, animal welfare is a nuanced concept and should not be simplified as either "good" or "bad" (Fraser, 2009; Broom, 2011; Ohl & van der Staay, 2012; Mellor, 2014b). Animal welfare is a perspectival notion. Judgements about welfare are typically made according to a particular framework which is laden with value assumptions and specific interests/preferences that reflect the assessor's aims. There may be instances where an animal's welfare can be clearly categorized or where choosing "good" or "bad" is required for legal or other purposes. This should be understood as a particular kind of shorthand. The dichotomization of welfare assessment into the very simplistic "good" versus "bad" risks polarization and misses opportunities for those truly concerned about animals to understand and improve an animal's welfare. If an animal's welfare is judged as "bad," why is it "bad" and how can deficiencies be improved to where welfare becomes "good"? Similarly, if an animal's welfare is judged as "good," why is it "good" and what opportunities are there to further improve the animal's welfare? Using the simplistic notions of "good" or "bad," welfare sidesteps important opportunities to make concrete improvements to their welfare and does not go to the heart of the matter—namely, do animals have access to what they need, and are they in a state of being that allows them to flourish.

How can the ambiguities associated with animal welfare assessment be addressed? For the purposes of this discussion, we will briefly review several categories of animal welfare assessments for animals under human care. These categories are not mutually exclusive and may differ from how they are addressed elsewhere. Behavioral and physiological indicators are tools for assessing the animal welfare of individuals and populations. Because assessor subjectivity is a component of behavioral and physiological indicators, and there is not a single indicator that addresses all aspects of animal welfare, use and interpretation of these indicators is subject to disagreement. In practice, engineering (prescriptive standards such as size of housing or acceptable environmental conditions) and performance (based on desired outcomes such as desirable behaviors or body condition) standards may be used to address animal welfare deficits and opportunities for improvement. A strategy for integrating multiple animal welfare categories is the *Five Domains Model*. However, each of these approaches have their strengths and weaknesses.

Indicators

Behavioral Indicators—Behavioral indicators of animal welfare are generally based on direct observations of animals, and many are low cost,

can be non-intrusive, use low or no technology, and are reproducible (Altmann, 1974; Dawkins, 2004). Behavior can represent insight into an animal's mental state such as when behavior associated with pain or hunger is evident or a given behavior is the outcome of an animal's decision-making processes. Behavioral indicators of animal welfare can include ethograms, characterization of activity, summaries of interactions with conspecifics and other species, and similar indices (Xian et al., 2010; Meagher et al., 2014; Wierucka et al., 2016). The baseline for these indices can be in comparison with wild conspecifics or what is subjectively considered normal.

Behaviors that can be quantified or clearly defined are ideal for assessing animal welfare. Examples of quantifiable behaviors for aquatic mammals include feeding behavior, the occurrence and types of social interactions, swimming activity, cooperative behavior, and preference studies (Smith & Litchfield, 2010; Campbell-Palmer & Rosell, 2015; Clegg et al., 2017; Nakahara et al., 2017). Preference or choice studies that are appropriately designed for the question at hand can also be useful for guiding proactive or corrective management activities that can improve animal welfare (Gonyou, 1994; Hunter et al., 2002; Ross, 2006b; Melfi, 2009; Fabienne & Helen, 2012; Ward & Melfi, 2015; Clegg et al., 2017). However, subjectivity for some behaviors can result in disagreement among observers, particularly where animals' affective states are of interest.

Limitations to behavioral indicators of animal welfare include the challenge of defining what is normal, especially with acknowledgment of the need to account for individual variation (Gonyou, 1994; Bracke, 2006). Identification of abnormal behaviors is sometimes more straightforward than identification of some normal behaviors or a range of normal behaviors. Abnormal behaviors that could represent compromised animal welfare include stereotypic behavior (although stereotypies are not necessarily abnormal), self-mutilation, or "excessive" agonism within social groups (Broom, 1991). In addition, because observation periods are finite, significant animal welfare concerns can be missed. Finite observation times may not capture situations that intermittently compromise animal welfare such as unnecessarily rough restraint and handling by humans or transient exposure to other noxious stimuli. Inter-observer variation is a particular challenge for which qualitative behavioral outcomes are recorded, and standardization of data collection methodology is warranted for quantitative and qualitative behaviors (Altmann, 1974; Weary et al., 2009). Behavioral observations can also fail to detect an animal's internal responses to external stimuli. This is classically evident in the behavior of rabbits that behaviorally appear to be non-responsive to stimuli (tonic immobility), yet have altered heart rates and rhythms and elevated corticosteroid ("stress hormone") levels (Farabollini et al., 1990; Giannico et al., 2014). Similar "stress responses" may be evident in aquatic mammals (Mormede et al., 2007; Kershaw & Hall, 2016; Lyamin et al., 2016). There is also the challenge of defining how much deviation from "normal" would be considered abnormal, particularly with respect to "normal" inter-individual variation (Hill & Broom, 2009). Resolution of these considerations is a subjective activity that is prone to being interpreted differently by different assessors or external stakeholders.

Physiological Indicators—Physiological indicators can provide objective measures of an animal's affective state or response to stimuli because number values are often associated with these indicators. Physiological indicators of animal welfare are diverse and can include external appearance (such as body condition and skin/fur appearance), measures of health (such as morbidity and mortality—in many cases, measures of health are actually the absence of disease), nutrition (such as assessed by biological sampling or indirectly via diet composition analysis), reproductive indices (such as fecundity), measures of organ function (such as heart rate or the results of routine blood biochemistries), and hormone levels (such as hormones associated with the sympathetic-adrenal medullary system) (Dawkins, 2008; Fraser, 2009; Hill & Broom, 2009; Blache et al., 2011; Mellor, 2017; Richard et al., 2017). Some physiological indicators have the potential for non-invasive measurements such as hormone levels in feces, urine, or cetacean blow (respiratory vapor) (Queyras & Carosi, 2004; Keay et al., 2006; Cook, 2012; Richard et al., 2017; Wasser et al., 2017). Non-invasive measures have the potential advantage of providing information without confounding results by disturbing animals.

In contrast, some physiological indicators require manual or chemical restraint for surgical implantation of telemetry devices and are, therefore, invasive activities that can potentially serve as confounders (Øritsland et al., 1977; Horning et al., 2017). However, animals can sometimes be acclimated to some physiological sampling with minimal disturbance such as when animals are trained and acclimated to voluntarily sampling (Houser et al., 2016). Additional practical concerns include the standardization and validation of methods (e.g., including quality assurance), and when an animal's behavior serves as reference for interpretation (e.g., whether the animal is playing, exhibiting reproductive behavior, or other relevant behaviors) (Keay et al., 2006; Hill & Broom, 2009; Cook, 2012). Development of

reference ranges ("normals") can be difficult when there are small animal population study sizes or study designs that do not completely address the question(s) at hand (e.g., application of reference values from one population to another without corroboration of the validity of doing so; Friedrichs et al., 2012). Appropriate handling of biological samples prior to analysis is also needed to ensure valid results (Keay et al., 2006; Friedrichs et al., 2012). Thus, while physiological indicators generally provide a number that can be used as a part of animal welfare assessments, they do not provide the certitude that would be ideal for such assessments.

Corticosteroids are physiological indicators that are commonly used as measures of animals' levels of distress (commonly referred to as "stress") in response to various stimuli (Keay et al., 2006; Dawkins, 2008; Hill & Broom, 2009). Corticosteroids can be non-invasively measured in feces, urine, saliva, and potentially other bodily fluids (Queyras & Carosi, 2004). However, there is the need for laboratory validation to ensure correlation with blood levels and accuracy under specified collection protocols (Hunt & Wasser, 2003; Queyras & Carosi, 2004). Corticosteroids must also be validated to document relevance to biological activities of interest. While elevated corticosteroid levels can be an indication of distress, they can also rise in response to normal activities that are presumed to be "good" such as eating, play, and copulation (Bloom et al., 1975; Dawkins, 2004). Thus, interpretations of corticosteroid levels must be considered in the context of behavioral or other indices of an animal's affective state or with the assumption that certain stimuli are painful or otherwise adverse. Corticosteroids must also be considered as averages over time because they signify responses to stimuli that occur over hours or longer, thereby potentially confounding distinction between acute (which could be "good") and chronic (of concern for deleterious effects) stressors. In contrast, catecholamines (e.g., epinephrine or norepinephrine) signify responses over seconds or minutes and, therefore, can potentially identify acute stressors. Nevertheless, measurement of catecholamine levels is subject to many of the same validation and interpretation challenges as corticosteroids and also cannot be sampled non-invasively (Bicker et al., 2013). Consequently, interpretation of corticosteroid and catecholamine levels can be influenced by assessor value systems, and there is a need for caution when drawing conclusions about what animals are experiencing and the impact of management practices on animals' experiences.

Data on morbidity, mortality, and reproduction would appear to be straightforward measures of animal welfare; however, context is required for these measures as well (Whitham & Wielebnowski, 2013). Such data are actually population-level indices that do not address the welfare of specific individuals. In addition, these data must often be collected over prolonged periods of time that do not account for current conditions. Furthermore, debate over whether a given value for morbidity, mortality, or reproduction is "good" or "bad" may be based on differing preferences among evaluators (Fraser, 2009; Hill & Broom, 2009; Melfi, 2009). Assessment of these population-level characteristics can also be influenced by assumptions about what matters to the animal and why such as whether an animal is frustrated if it is not reproducing and the degree to which this compromises the animal's welfare. Thus, it should be acknowledged that the use of physiological indicators to assess animal welfare may be contingent upon contextual factors, including the subjective interpretation of the assessor.

Standards

Engineering Standards—Engineering standards specify the methods, technologies, techniques, or facility characteristics needed for acceptable animal welfare and introduce a suite of considerations extrinsic to the animal under assessment. Examples of engineering standards that are applied to captive aquatic mammals include environmentally related details that specify housing size, temperature, water quality, nutrition, and requirements for veterinary care (Animal and Plant Health Inspection Service [APHIS], 2013). These standards are easy to apply and interpret in comparison with many behavioral and physiological indicators of animal welfare. Therefore, they are useful as the basis for regulatory or other oversight. However, engineering standards are prescriptive and do not account for the need to adapt to particular circumstances (Gluck, 2014). They also do not address many social and other means of improving an animal's affective state. Moreover, there is often little or no data supporting engineering standards for aquatic mammals; these standards are based largely on subjective opinions and experiences. Nonetheless, engineering standards can provide minimal standards for addressing the welfare of aquatic mammals.

Performance Standards—Performance standards specify a desired animal welfare outcome. They were introduced into the laboratory animal community as a means of achieving animal welfare objectives while maintaining flexibility in the way these objectives are achieved (Office of Laboratory Animal Welfare [OLAW], 2002). An example of a performance standard for aquatic mammals is requiring that a given body condition be maintained without specifying what is fed and at what frequency. Performance standards require clearly defined outcomes, the input of

knowledgeable professionals with sound judgment and teamwork skills, employment of sophisticated decision-making processes, and regular assessments for ensuring that outcomes are being achieved (Gettayacamin & Retnam, 2017). Performance standards permit the use of flexible management strategies that account for individual animal's needs, staff expertise, facility characteristics, and the occurrence of novel events. Ideally, performance standards can be balanced with engineering standards and incorporate behavioral and physiological indicators to comprehensively assess animal welfare. Still, regardless of how performance standards are applied, there is a level of subjectivity that allows for different interpretations by different assessors.

The Five Domains Model: A Broad Animal Welfare Assessment Strategy

Animal welfare assessment tools that are more comprehensive than the general indicators or standards discussed above are preferable for completely assessing animal welfare. The *Five Domains Model* of animal welfare (which is distinct from the *Five Freedoms*) provides a systematic framework for integrating multiple animal welfare considerations and clarifying animal welfare assessments (Mellor, 2017). It is useful for identifying impacts resulting from different management strategies, possible interactions among domains, potential mitigation strategies for which more information is needed, and the opportunity to rank different mitigation strategies (Mellor, 2017). The *Five Domains Model* has four functional or physical domains—(1) nutrition, (2) environment, (3) health, and (4) behavior—that can be characterized using behavioral, physiological, and other changes in an animal's status. The fifth domain characterizes the mental or affective state that an animal is experiencing, and it incorporates the status of the other four domains. For example, stressors in the environment (Domain 2) can result in fear, distress, or other negative emotional states in Domain 5. The *Five Domains Model* also incorporates concepts such as the quality, intensity, and period of time an animal experiences a given state ("good" or "bad"). Additional merits of the *Five Domains Model* include identification of negative welfare states, clarification of why animal welfare is being compromised, and indications of where additional information is needed. Furthermore, quantitative measures or qualitative scores for a domain(s) can be incorporated into the model to describe an animal's welfare status or clarify the accessibility and quality of available data. The latter can serve as an index of confidence in the overall assessment. There is also sufficient flexibility to modify a welfare assessment so that new information can be incorporated or to acknowledge the specifics of a given situation. For instance, if an animal's awareness is limited because it is not conscious or the animal is deceased, some data, such as involuntary physical movements, are not relevant. Most importantly, the *Five Domains Model* permits a focus on how an animal's welfare can be improved rather than dichotomized into "good" or "bad." Thus, the *Five Domains Model* offers the potential to comprehensively rank different scenarios and identify where negative impacts on the animals can be mitigated. However, the subjective elements previously discussed, differences in the ease of identifying impacts among domains, imprecision in the ranking of outcomes, and the challenge of matching assessment tools to the characteristics of a domain are among the model's limitations.

Specific Aquatic Mammal Welfare Considerations

There are considerations of aquatic mammal welfare that extend beyond and supplement the *Five Domains Model* or for which incomplete information is available for resolving challenges (see Supplementary Appendix, which is available on the *Aquatic Mammals* website in the "Supplementary Materials" section: www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Most notable are the need to address aquatic mammal affective states with the use of training, enrichment, play, and other means; confirm institutional support for ensuring continual internal and external individual animal and program assessment(s); continual efforts for improvement; characterization of the impact of humans on animals; and the need for research to clarify basic husbandry needs. Training has been an important part of many marine mammal programs and has served as a model for domestic animal and captive wildlife management programs (Ramirez, 2012). This is because it offers a pragmatic opportunity to reduce animal distress (anxiety, fear, and helplessness as listed in the *Five Domains Model*) associated with husbandry and veterinary programs, and it may be useful for addressing aquatic mammals' social, mental stimulation, and other needs for achieving a positive affective state.

In contrast to these pragmatic views, from a value-based viewpoint, there are values that are opposed to human intervention and that are skeptical of the impact of human–animal bonds upon aquatic mammals. Regardless, as assessors become more accustomed to considering the cognitive experiences or feelings dimension of aquatic mammal welfare, there will be an ongoing need to document whether and how caretaker–animal interactions can benefit or compromise the animals' affective states, and similar research on the positive and negative impacts of public interactions is warranted (Davey, 2007; Carlstead, 2009; Whitham & Wielebnowski, 2009, 2013). Similarly, strategies for providing

enrichment have been incompletely documented, and functionally characterizing play is challenging, although strategies for optimizing these programs continue to evolve (Hunter et al., 2002; Meagher et al., 2014; Mellor, 2014a; Clegg et al., 2017). These strategies for addressing animal welfare concerns are dependent upon institutional cultures that support continuous animal assessment and continual efforts for improvement. Similar ongoing assessment of animals and processes are needed for free-ranging populations, although desired outcomes are often less defined, and significant practical challenges exist for achieving these outcomes.

Overall, there is a need for increased peer-reviewed, published documentation of practical means for addressing and improving aquatic mammal welfare, especially for research that can contribute to ensuring positive mental and emotional states (Goulart et al., 2009; Hill & Broom, 2009; Melfi, 2009; Whitham & Wielebnowski, 2013; Mellor, 2014b). These are outcomes that are prioritized in many value systems, including value systems ascribed to by many in society at large (Broom, 2011). There is also a pressing need for interests in aquatic mammal welfare to recognize that there are tradeoffs for all management strategies and a need to adapt strategies by context (Fraser, 2009; Ohl & van der Staay, 2012; Mellor, 2017).

Animal Welfare Assessment Dilemmas

Social Group Dilemmas—A general principle is that social animals in captivity should be housed in social groups (Campbell-Palmer & Rosell, 2015; Hemsworth et al., 2015; Guarino et al., 2017). Assessing the welfare of animals in "normal" social groups presents the challenge of how to balance the welfare of animals at the top of social hierarchies versus those at the bottom. Stakeholders can forget that the term *pecking order* originated from chickens for which pecking is a normal behavior that is used to establish social dominance hierarchies (Forkman & Haskell, 2004). The downside of being at the bottom of the pecking order is the negative physical (and, presumably, emotional) impact on animals in that situation. Similar physical means of enforcing social hierarchies are also seen in dolphins for which tooth-rake marks are present in wild and captive animals as evidence of normal inter-individual interactions for establishing dominance (although rake marks can also occur as a part of play and courtship behavior; Samuels & Gifford, 1997; Scott et al., 2005).

In extreme circumstances, individual cetaceans can suffer serious injury or death as a part of apparent inter- or intraspecific conflicts (Dunn et al., 2002; Barnett et al., 2009). Thus, as a general consideration for all social animals, there is the potential for tension between the animal welfare concerns of a population of cetaceans housed in species' typical social groupings with the welfare of individuals at the bottom of social hierarchies. Management strategies exist for reducing the degree of adverse impacts on low hierarchy animals under captive settings such as use of visual barriers or active social management by human caretakers (Renner & Kelly, 2006; Herrelko et al., 2015; Ward & Melfi, 2015). However, there remain tradeoffs for population versus individual animal welfare concerns, and assessments of these tradeoffs remain subjective.

*Wildlife Dilemmas—*The categories of animal welfare indicators and standards that we addressed above were largely developed for domestic animals under human care. To apply these frameworks and approaches to nondomestic (i.e., wild) animals in captivity is to introduce less certitude in their efficacy. To then apply these categories to free-ranging wildlife challenges their value yet further. However, there is value in using these approaches for assessing the welfare of nondomestic animals in free-ranging settings, particularly in environments heavily impacted by human activities. Still, practical challenges exist for assessing and resolving the welfare concerns of free-ranging animals, particularly in aquatic environments (Harrington et al., 2013; Castle et al., 2016). The degree to which humans should be responsible for the welfare of free-ranging aquatic mammals and be expected to institute corrective action when poor welfare is perceived is also a contextual, subjective, and dynamic perception.

Summary of Animal Welfare Assessment Tools

The various strategies for assessing animal welfare all have pros and cons. This ambiguity is further complicated by human social considerations, even when science-based information is available. Thus, while new research and methodology have an important role in identifying strategies for improving animal welfare, they may be mistakenly viewed as "the answer" for resolving animal welfare disagreements for two reasons. First, there are well-established elements of bias in research design, conduct, and investigator interpretation (Sackett, 1979; Higgins, 2008); the beliefs of a researcher and their reason for undertaking research on an animal welfare indicator cannot be fully divested from their interpretation of the results and its implications. Second, stakeholders' strongly held beliefs or agendas will influence how new research information is interpreted in the "outside world"; information that is not consistent with a particular value system may not be accepted, and those who do accept discordant information are delegitimized (Bar-Tal, 1990a, 1990b). Therefore, wide acceptance of animal welfare assessments is subject to the beliefs of groups of people and society at large. As a consequence,

some of the more intractable aquatic mammal welfare debates, such as whether cetaceans can be "humanely" kept in captivity and whether trapping "pest" nutria and beaver is "humane," are unlikely to be resolved with more biological research. These debates actually represent the sociological challenge of resolving differing values and beliefs.

Addressing Intractable Animal Welfare Debates? The Three Orientations Model for Assessing Animal Welfare

> There ain't no good guy, there ain't no bad guy.
>
> There's only you and me and we just disagree.
>
> –Jim Krueger, as sung by Dave Mason

The first step in addressing intractable animal welfare debates and equivocal interpretations of animal welfare assessment tools is to identify why there can be disagreement even when stakeholders are using the same information. There are clearly instances of "good" and "bad" welfare, but where is the boundary between "good" and "bad"? And how do we address the subjectivity of this boundary for animal welfare assessments?

Fraser's *Three Orientations Model* is a tool that has value in highlighting why stakeholders may disagree about an individual's or group of animals' welfare (Fraser et al., 1997). This model sheds light on how stakeholders can have differing values and is a forum for understanding how stakeholders can "talk past" each other. While this model does not resolve differing viewpoints, recognition of stakeholder's differing values—even where not explicitly stated—is the starting point for entering into true dialogue and potentially arriving at a consensus.

The *Three Orientations Model* of animal welfare recognizes *function-*, *feeling-*, and *natural lives-*based components of animal welfare assessments, although these components are not necessarily mutually exclusive (Table 1). The *function*-based component of animal welfare is concerned with whether an animal's biological and behavioral systems are working appropriately within a given environment. Blood biochemistry values, body condition, skin or hair appearance, heart and respiration rates, growth, seeking warmth when cold, and indices of reproductive health are some examples of function-based measures. The downside of overemphasizing this approach or using it to the exclusion of the model's other components is that it incompletely accounts for an animal's ability to express "normal" behavior or the animal's affective state.

The *feeling*-based component of an animal's welfare is concerned with an animal's access to positive affective experiences while being free of negative affective experiences. While free-ranging animals are not free of negative affective experiences, feeling-based assessments assume that humans have a responsibility for minimizing negative affective states for animals under their control. Feeling-based assessments are challenged by our need to interpret the observable responses of animals to determine how it feels rather than being able to ask the animal directly. Thus, human-based perceptions, rather than the animal's actual experience, can potentially skew feeling-based assessments.

The *natural lives*-based component of animal welfare is concerned with whether an animal is able to express evolutionarily important behaviors, such as swimming for aquatic mammals, and has access to elements in the animal's typical environment to flourish. This component reflects the animal's *telos* (i.e., the "dolphinness" of a dolphin; Rollin, 2015). How well an animal's "nature" is satisfied can be difficult to determine to an untrained observer.

Ideally, an assessor will use a balanced approach and incorporate function-, feeling-, and natural lives-based components in their evaluation (Fraser, 2009). While there may be situations in which favoring one of these components is warranted, an over-emphasis on one component has the potential to result in compromised animal welfare when viewed from the perspectives of the other two components (Figure 1). This results in an imbalanced animal welfare assessment. An inability to recognize imbalances and the values that underlie these imbalances can result in individuals "talking past" each other without resolution of differing opinions.

Values and Viewpoints

How values (belief or attitudinal systems for this discussion) affect animal welfare assessments can be further understood by considering how an assessor values and balances relationships among humans, animals, and the environment and whether he or she considers what matters to the individual in subjective or objective terms. The breadth or narrowness of an assessor's worldview, her or his self-awareness, and her or his ability to recognize inconsistencies and tradeoffs affect how rigidly these views are applied. These characteristics influence how animal welfare is characterized and shapes debates between differing viewpoints.

We propose that assessors have values that shape their view of desirable animal welfare outcomes, and shape how these outcomes are achieved. There can be discordance between these values within an individual, as well as among individuals and groups. The general ethical framework underlying desired

Table 1. A summary of Fraser's *Three Orientations Model* of function-, feeling-, and natural lives-based components of animal welfare assessments (Fraser, 2009)

Animal welfare philosophy	Characteristics	Strengths	Weaknesses
Function-based	Animal can adapt to its environment. Animal's biological systems are working appropriately.	Measurable outcomes	These may not account for INDIVIDUAL animal's emotional well-being.
Feeling-based	Free of negative experiences (i.e., pain, fear, and hunger) Ability to experience positive experiences (i.e., through social companionship)	Strives to minimize an animal's potential for emotional distress	Open to subjective interpretation; negative experiences are present in "natural" settings. These ideals can be unrealistic to achieve in human-controlled settings AND MAY CONFLICT WITH POPULATION WELFARE.
Natural lives-based	Ability to live normal life Ability to express normal behavior	Consideration of the animal's full range of existence	Definitions of normality are not fixed and can be difficult to define.

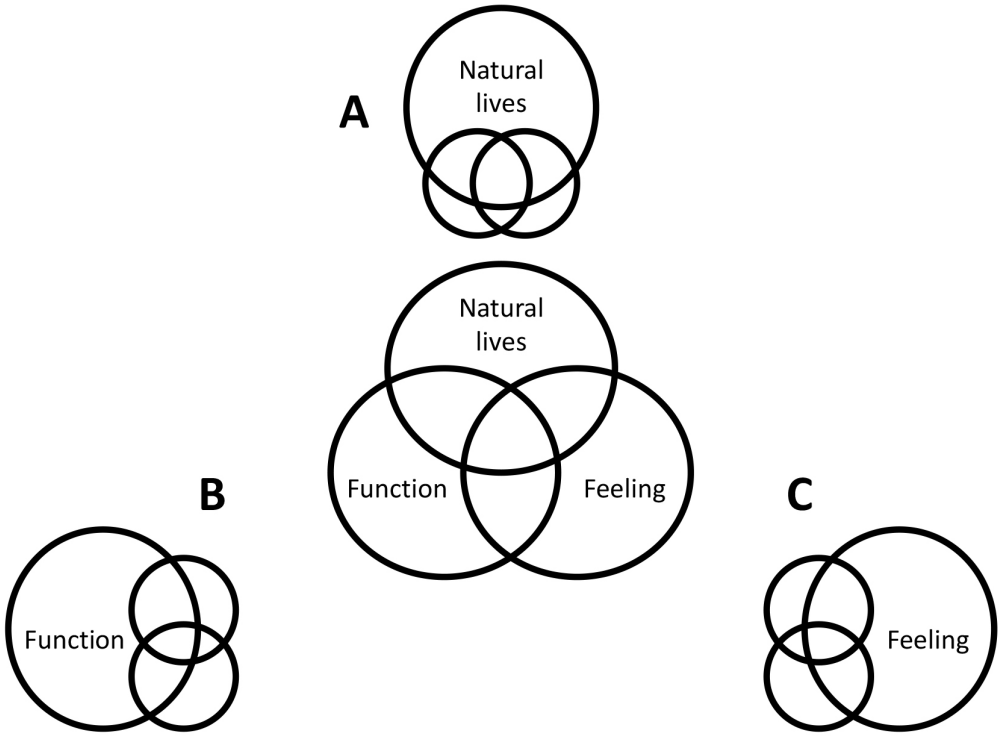

Figure 1. The central image depicts a balanced approach of natural lives-, function-, and feeling-based considerations when evaluating individual animal welfare concerns. Imbalances are depicted by (A) emphasis on natural lives, (B) emphasis on function, and (C) emphasis on feelings (Fraser, 1997).

welfare outcomes can be categorized as values that are either (1) instrumentalism, (2) focused on the interests of individual aquatic mammals, (3) focused on the interests of populations of aquatic mammals, and (4) focused on general ecosystem or ecological interests.

Instrumentalists value aquatic mammals as sources of food, fur, or work. This viewpoint is linked to the view that animals are resources/commodities to be used for human interests and that humans are entitled to determine the fate of aquatic mammals—that these animals are under human dominion. This is in contrast to whether the welfare of individuals matters to the animal in question (as perceived by the assessor), either because of a dislike of human dominion or the ethical belief that an individual aquatic mammal's welfare interests have intrinsic merit. A range of views can underlie this focus on individual animal welfare, including those who believe that animals should have legal rights and/or the autonomy to make choices about their life; those who believe in responsible human stewardship; and those who interpret animal lives in terms of human values and experiences (anthropocentrism). Those who primarily value aquatic mammal populations may do so out of a sense of responsibility for human actions (e.g., injuries due to boats or environmental degradation caused by humans); for purely aesthetic or spiritual reasons due to a conservation or ecological ethos; or for other reasons. Those with a broad environmental perspective will have values similar to those who prioritize aquatic mammal populations, but this broader perspective also acknowledges the interests of other species and general environmental concerns. In addition, this broader perspective generally implicitly recognizes the need to balance competing interests. These simplified categories are not mutually exclusive but serve as a basis for considering some of the more intractable aquatic mammal welfare challenges.

Values for how to achieve desired animal welfare states can be discordant with values for desired outcomes. Several ethical constructs illuminate how these discordances can arise (Palmer et al., 2014). One ethical construct focuses on outcomes for which "the ends justify the means" (consequentialism). An extreme example of this would be a situation in which a long-term management objective is to keep a collection of aquatic mammals alive without regard for (or without compelling justification of) how management methods would affect the animals' affective state. Alternatively, how desired outcomes are achieved may be prioritized, meaning that trying to do the "right" things is what counts (duty-based). An example of this would be when protocols for rescuing a stranded cetacean are strictly followed rather than accounting for and adapting to extenuating circumstances such as working under storm conditions that might compromise animal or human health. Furthermore, pragmatism, or achieving desired animal welfare states based on a practical approach to problems, is a third construct that may be relevant for some assessments. An example of this would be feeding a captive aquatic mammal a diet that is not identical to what it would receive in the wild but that is cost-effective and meets or exceeds the animal's nutritional needs. Each of these three value systems may be situational, vary temporally within an individual or among a group of assessors, or differ for other reasons. However, the underlying values can be discordant and result in vastly differing views of animal welfare. For instance, a duty-based assessor who adheres to a guideline that a captive animal's diet must match what it receives in the wild will contest feeding an alternate diet promoted by a pragmatist.

Values influencing desired animal welfare states and how to achieve these objectives are also shaped by personal experiences and societal expectations or priorities. On a personal level, a history of positive personal relationships can be the basis for open and productive dialogue, whereas negative interactions can lead to turf battles and the absence of a shared mission to optimize aquatic mammal welfare. The latter is a particular problem when popularized interactions that favor polarization and an absence of civility are adopted as norms (Bar-Tal, 1990a). On a broader scale, general societal perceptions of conspiracies and distrust of "experts" can undermine the credibility of professionals with extensive knowledge of aquatic mammals (Hansson, 2004). These various narratives can result in animal welfare regulatory environments that are shaped by community politics rather than what animals actually experience.

Settings and Tradeoffs

In the spirit of providing a path for understanding and conscientious dialogue, we will address aquatic mammal welfare tradeoffs and conflicts that exist in various settings. While many discussions center on aquatic mammal welfare under human control in captive settings (including large, naturalistic enclosures labeled as "semi-captive"), the welfare of free-ranging aquatic mammals has also received newsworthy attention and can present vexing challenges. As a point of clarification, our discussion focuses on value systems rather than characterization of individuals because labeling individuals can serve as a barrier to resolving differing welfare assessments.

Captive Animals

Holding animals in captivity requires a value system that permits humans to decide that captivity is appropriate, and this value system may be applied differently for domestic and nondomestic animals. Holding animals in captivity is difficult to resolve with values that are fundamentally opposed to human dominion over animals under any circumstances (e.g., a strong rights-based view that chides curtailing animals' freedom). Similarly, value systems that prioritize nondomestic animals' autonomy or freedom to range in the wild are difficult to reconcile with captivity as prioritization of animals being in the wild may result in welfare assessments that all captive animals experience compromised welfare.

Other value systems are compatible with holding aquatic mammals and other nondomestic species in captivity. For instance, in response to natural lives-based concerns that aquatic mammals must range over large areas to have an acceptable level of animal welfare, a function-based approach would assert that wild animals are forced to range because of the need to access temporally and spatially variable food sources. Consequently, function-based valuations would prioritize provision of reliable sources of nutrition, space, and opportunities for activity as a means of meeting aquatic mammal welfare needs in captivity. A balanced approach to welfare would also incorporate feeling-based management strategies that fulfill an animal's affective state (specifically, needs for emotional "happiness" and mental activity) using management activities such as enrichment, opportunities for self-choice and play, and housing in compatible social groupings. An important point is recognition that these management activities substitute, in part, for mental activities that would be devoted to avoiding predators, accessing uncertain sources of food, and other life-and-death activities. Effective use of these strategies can allay boredom and maladaptive behaviors (such as some stereotypies).

However, these function- and feeling-based management strategies may not be considered acceptable by those who distrust the expertise of professionals due to societal narratives or personal experiences. There is some basis for this distrust as humans are inherently imperfect, and the assertion that captive aquatic mammal management is continually improving implicitly incorporates recognition that previous management strategies were not optimal. Thus, depending on the starting point of the stakeholder (e.g., underlying values and experiential influences), perceptions of aquatic mammal welfare will be (1) locked in as unacceptable under all or most circumstances, (2) viewed as "good" and improving, or (3) in some intermediate level of acceptance.

Settings where aquatic mammals are held captive present different challenges, and stereotypes of these settings can influence assessments of animal welfare. There are common animal welfare considerations for all settings such as the need to address nutrition, water quality, and health care. However, perceptions of how to balance different animal welfare needs will vary among settings and assessors' value systems.

Exhibit/Show Animals

Exhibit and show animals include aquatic mammals in conventional zoo and aquarium settings as well as nonconventional settings or in enclosures with open water flow to natural systems. These may include facilities where varying degrees of contact with the public are permitted. These facilities are often sources of publicity and contention, generally with what appear to be concerns about an individual animal's affective state or due to a general opposition to aquatic mammals being kept in captivity (Kyngdon et al., 2003). In addition, the capture of wild animals for placement in captive settings is discordant with values that prioritize the existence of animals in free-ranging settings. Opposition to the capture of free-ranging animals includes welfare concerns for captured individuals, the social stability of groups from which animals are removed, and impacts on populations (Marino & Frohoff, 2011). Captive breeding programs are an acceptable alternative to wild capture for some value systems, particularly for those for which there are conservation objectives; whereas other value systems see captive reproduction as perpetuating a status quo with which they do not agree (Wang et al., 2005; O'Brien et al., 2009; Marino & Frohoff, 2011). Concerns about aquatic mammals are generally based on perceptions of cetaceans' high levels of cognition and self-awareness or objections to how show animals are presented to the public (Marino & Frohoff, 2011). There is support for high levels of cognition, although levels of cognition and self-awareness approaching that of humans has been debated (Gregg, 2013; Harley, 2013). This debate is in part due to research that does not have rigorous levels of experimental design and has not been replicated. Those who perceive cetaceans' mental and emotional capacities as being similar to those of humans may not reach consensus with those whose values allow for aquatic mammals to be held in captivity.

General objections to use of animals in entertainment venues include concerns that these animals' conservation status or true nature is being misrepresented and debased (Cataldi, 2002; Schroepfer et al., 2011). In response to these concerns, some facilities have altered their show programs to be more education oriented with the use of conservation messaging or demonstrations of husbandry

behaviors (Miller et al., 2013). However, show behaviors requested of the animals can be similar, regardless of the verbal narrative provided to the public. Thus, objections to these shows may be based on the "story" that is told rather than true animal welfare concerns. The common use of positive reinforcement training for behaviors that aquatic mammals perform in the wild, particularly for which food reinforcements represent a minor portion of the diet, would seem to address many welfare concerns pertaining to the animals' affective state (Perelberg & Schuster, 2009). In addition, representations of an animal's "dignity" may be considered a human construct that is not directly associated with animal welfare (Broom, 2011). There is evidence that educational programs can have an impact on visitors' conservation knowledge, attitudes, and behavior (Miller et al., 2013). Less clear is whether different messaging for shows changes perceptions of animal welfare, particularly for shows that explain management activities that are intended to demonstrate what staff are doing to ensure that animals have a high level of welfare.

A starting point for assessing exhibit/show aquatic animal welfare can be engineering standards (APHIS, 2013). Nutritional, temperature, record keeping, and lighting standards, as well as resting areas for some species, are examples of accepted requirements for many regulations and external party audits. Recent discussions and some facilities' monitoring have also recognized the need to minimize noxious auditory stimuli, although tolerance levels have yet to be established (Quadros et al., 2014). Water quality is also an accepted regulatory and external party audit engineering standard, especially for cetaceans. However, these standards are not uniformly applied—for example, in locations where hippopotamuses (*Hippopotamus amphibious* and *Choeropsis liberiensis*) are housed in dump-and-fill water systems (D. Miller, pers. obs., 2016). Whether acceptance for lower standards for some species is due to tradition, differential valuation of species, or other reasons is uncertain. Complicating engineering standards for water quality further, there is recent discussion that historic efforts to minimize water microbial communities may be misguided and that managed microbial communities may be beneficial for aquatic mammal health (Van Bonn et al., 2015).

Conventional exhibits have traditionally emphasized visibility of animals for the public and ease of cleaning (Melfi et al., 2004; Fàbregas et al., 2012). While the public may perceive that the increasing use of naturalistic exhibits corresponds to optimal animal welfare, this perception may not be accurate in some instances (Melfi et al., 2004). Thus, some increasingly discussed engineering standards for improving animal welfare include expectations for structural diversity to address the aquatic mammals' need for variety and to provide visual barriers in social groups (and from the public); whether use of substrates other than concrete can improve animal welfare; and whether elimination of bright blue substrates and addition of shade can decrease eye lesions (Gage, 2008).

While ensuring that animals are not required to look into the sun while being fed (which would be uncommon in free-ranging settings) and provision of shade to conventional exhibits are management strategies that some facilities employ to optimize animal welfare, data that can be used to base engineering standards is scant, and animal welfare assessments of many of these concerns is subjective. Similarly, while engineering standards addressing enclosure size exist, the basis for these standards is subjective and not optimized (APHIS, 2013). This raises the question of how big is big enough for an enclosure. No enclosure will be big enough for value systems that prioritize a free-roaming state. Since regulatory standards are minimal standards, there is the question of whether management strategies such as enrichment, training, or other active human management can compensate for limitations in enclosure size, diversity, or similar physical characteristics. A domestic animal analogy would be when a social animal has access to a large enclosure or pasture yet primarily uses a small area in proximity to humans in anticipation of interactions with humans. In other words, can performance standards address aquatic mammals' needs for mental stimulation and affective states under captive conditions when enclosure size or other circumstances are limiting?

Performance standards may include expectations for addressing animal health, mental stimulation, or affective states (Gettayacamin & Retnam, 2017). A high level of veterinary care is available to many captive aquatic mammals, and veterinary care is a component of many regulatory and industry standards. But what health outcomes are adequate? Is it reasonable to expect that all captive animals be trained to permit the conduct of low stress diagnostic and medical procedures? Should the baseline for comparison be morbidity and mortality rates in the wild where animals become sick and die without medical intervention? Given advances in medical and veterinary care, there is the potential for some individuals to forget that animals do not live indefinitely (Jessup & Scott, 2011). However, even in comparison to humans, valuing this outcome is inconsistent with biological realities as mortality, disease outbreaks, and sporadic occurrences of infectious and noninfectious diseases occur in wild animal populations. Which of these sporadic occurrences is acceptable and at what frequency? The response to these questions will vary according to the values and experiences of assessors.

Integration of multiple historic, individual animal, social group, and multidisciplinary inputs is most likely to result in optimal animal welfare, but subjective application of this information is required (Whitham & Wielebnowski, 2013). Consequently, use of historic records of mortality, morbidity, and fecundity may not resolve some animal welfare disagreements, particularly those for which records do not reflect recent improvements in animal management and care.

Some performance standards are in response to practical management or publicity concerns. The recent use of sperm sorting to reduce the parturition of males that are in excess of management needs is a practical management tool that could meet some publicized concerns (O'Brien et al., 2009). Moratoriums on breeding, particularly for cetaceans, are generally in response to publicity concerns (Association of Zoos and Aquariums [AZA], 2017). However, in contrast to sperm sorting, moratoriums on breeding can result in outcomes that are discordant with some species' normal social structure. While a breeding moratorium meets the objectives of value systems opposed to aquatic mammals in captivity, detrimental impacts on social structure due to breeding moratoriums are an animal welfare tradeoff that is less recognized and discussed.

Another controversial topic is assessments of swim-with-the-dolphins, pinniped feeding, and other programs that permit interactions between the public and captive aquatic mammals (Kyngdon et al., 2003; Trone et al., 2005; Miller et al., 2011). Some value systems will not support these programs under any conditions. For value systems that conditionally accept that animal welfare may not be compromised by such programs, a first-level assessment is whether these programs ensure that the basic husbandry, social, and other needs of these animals are met. A second-level assessment is how interactions with humans are handled. Central to interactions with the public, assuming that the public is supervised to ensure that they are not responsible for trauma, inducing fear responses, or transmission of disease (likely minimal due to dilution in water bodies and short duration, in most instances), is whether the animal has the choice to interact with the public. Evidence that aquatic mammals have a choice of whether or not to interact with the public include situations in which staff ensure that the animals are not surrounded and can escape, and animals receive full diets based upon a predetermined and comprehensive animal and veterinary approach that is not linked to whether animals choose to participate in programs or other real-time animal performance indices. An additional consideration is ensuring that interactions with the public do not disrupt social interactions or cause intraspecific aggression among the animals.

Under ideal circumstances, it is possible that interactions with humans could constitute enrichment that favors an improved affective state, although this outcome is dependent upon physical facilities, how humans manage the interactions, and perhaps other factors (Kyngdon et al., 2003; Trone et al., 2005). The literature and anecdotal observations suggest that while there are facilities that are attentive to meeting aquatic mammals' welfare needs, there are others that do not. For facilities that clearly do not meet aquatic mammals' welfare needs, some value systems will favor development of strategies for raising facility standards, whereas others will favor abolishment of all such facilities.

Previous sections of this article have weighed concerns about aquatic mammal welfare that have been publicized and have acknowledged the ambiguities of animal welfare assessments. Herein, we suggest that the perspectives of many professionals who work closely with aquatic mammals in captivity in post-industrial and other countries should be recognized. There is also the need to recognize that many of the leading marine mammal facilities have established a level of individual animal care and welfare that exceeds levels of care seen in other captive animal facilities and those provided for many domestic animals (Ramirez, 2012). Examples supporting this view include the extensive activities and equipment for maintaining water quality; standards for ensuring feeding of high-quality (human-grade) food; the development of positive reinforcement training methods for eliciting voluntary behaviors that reduce animal distress associated with husbandry and medical activities; daily and throughout the day assessments of animal health, attitude, and compatibility within social groups; frequent medical checkups and monitoring of weight/body condition; and attention to the animal's affective state and how it can be improved using enrichment, training, and other strategies (Kyngdon et al., 2003; Joseph & Antrim, 2010; Miller et al., 2011).

Close and frequent interactions between marine mammals and staff in many of these facilities include prioritization of strategies for ensuring the animals' overall health (such as ensuring good body condition and physical fitness), need for mental stimulation (independently, such as with provision of enrichment, or in response to human requests for behaviors), "down" time and play time, and positive social interactions with humans and conspecifics (Kyngdon et al., 2003; Brando, 2010; Miller et al., 2011). Observations of animals responding to visitors or staff behavioral requests in exchange for positive social interactions with staff, rather than solely food rewards, is consistent with viewpoints that these animals may enjoy and benefit from interactions with humans

(Trone et al., 2005; Perelberg & Schuster, 2009). Observations of similar behaviors in similar frequencies between captive and wild aquatic mammals are consistent with perceptions that captive animals can experience affective states similar or superior to those of free-ranging conspecifics (Dudzinski et al., 2010; Greene et al., 2011; Dudzinski & Ribic, 2017).

There are experienced professionals with value systems or professional experiences that contrast with mainstream captive aquatic mammal conventions, specifically for cetaceans (Marino & Frohoff, 2011). Some of these professionals have values that are discordant with keeping aquatic mammals in captivity under all circumstances. Others have had professional experiences in facilities where aquatic mammal welfare was truly substandard, whose starting or evolved values are incompatible with keeping aquatic mammals in captivity, and/or who encountered negative personal interactions with other professionals. Fully assessing specific concerns raised by these individuals can be difficult. Rather than delve into the details of these concerns, it is more productive to consider how captive aquatic mammal welfare can be improved by these criticisms, whether globally or for specific facilities. In addition, since these criticisms have been part of the basis of efforts to eliminate captive marine mammal facilities, there is a need to fully discuss how these measures truly benefit or compromise animal welfare. In particular, there is a need to more fully consider the negative effects of breeding bans on normal groups of social marine mammals, effects on conservation efforts, how to manage the last solitary individuals if marine mammal populations are managed to extinction, and other impacts of regulatory actions that are based on limited value-driven perspectives.

Working/Research/Production Settings

Aquatic mammals may be kept in settings where they are work animals (e.g., military working animals), raised for commercial production (e.g., fur bearing), or used for research (Reddy et al., 2001; Meagher et al., 2014). Many of the same management strategies (e.g., assurance of quality nutrition, maintenance of water quality and temperature ranges, training for voluntary husbandry behaviors, and provision of enrichment) that are used for ensuring the welfare of aquatic mammals in exhibit and show settings can be used for work and research animals. Failure to consider natural lives- and function-based values in management strategies or enclosure characteristics may be justified when the end result is valued more than individual animal welfare concerns.

Invasive research on aquatic mammals requires appropriate use of analgesic and anesthetic agents by most nations and, particularly for cetaceans, may meet resistance during project review processes due to concerns about negative external perceptions and publicity (Hartung, 2010; Gettayacamin & Retnam, 2017). No less of a concern are noninvasive research projects that would compromise an animal's affective state. Most challenging to many value systems are work animals (such as in the military) that are trained to address situations in which the animal could lose its life or be injured, or when they are raised for production purposes such as American mink. Frustration due to lack of access to water is an example of an animal welfare concern associated with farmed mink (Mason, 2001). Value systems that favor human interests over the interests of these animals, and in relative comparison with alternatives, may justify the use of these animals in these settings. As a consequence of the true and perceived impacts on animal welfare, the use of aquatic mammals in many work and invasive research settings is discordant with many value systems in the absence of substantial benefits to human interests. Note that in addition to work settings, research can also be done with display animals, which is often not invasive and is integrated into their regular training sessions.

Captive "Sanctuary" Settings

There is increasing popular support for transferring animals from captive settings where animal welfare is perceived to be compromised into captive settings that are labeled as "sanctuaries" (Donaldson & Kymlicka, 2015). The transfer of domestic animal species, research laboratory great apes (primarily chimpanzees [*Pan troglodytes*]), and zoo or performance elephants (*Loxodonta africana* and *Elephas maximus*) into facilities labeled as "sanctuaries" are examples of this trend. Underlying this movement is the belief that animals in a given setting (e.g., laboratory, exhibit, or performance) inherently experience compromised welfare because of the setting. While the original settings may warrant changes for improved animal welfare, labeling a facility as a "sanctuary" may address human value-based concerns without substantively addressing animal welfare concerns. The term *sanctuary* elicits idyllic perceptions of positive affective states even though human control of these settings requires attention to the same animal welfare considerations as exist for more traditional settings (Mountain, 2017). In particular, continued funding to support facility function and animal needs is a general, practical concern for captive sanctuary or rescue/animal shelter management systems (Messer, 2012). An additional practical concern is the dichotomy and tradeoffs between active human and noninterventionist (minimal human interactions) management approaches. The latter does not support the close monitoring of animals or the use of low-stress health and

husbandry methods that are possible with trained animals in more conventional housing.

Depending on the degree to which "normal" social management is approached with noninterventionist approaches, reproduction can occur. While reproduction is a normal part of an animal's existence and may be considered an important component of animal welfare, especially for social species, perpetuating captive populations contrasts with value systems that favor elimination of these populations.

An additional concern that has occurred for some species' sanctuaries has been the absence of external oversight for identifying instances of compromised animal welfare (Associated Press, 2009; Turner et al., 2012). Thus, for value systems that believe in human responsibility for optimizing the welfare of captive aquatic mammals, captive sanctuaries and traditional facilities may employ similar management approaches to ensure animal welfare. This can result in the application of similar performance and engineering standards (environmental/enclosure characteristics) for captive sanctuaries and more conventional facilities. Therefore, publicized values can be the primary distinction between captive sanctuaries and more traditional exhibit and show settings rather than representative of true differences in animal welfare.

Within the context of trends that favor captive sanctuaries (as opposed to natural protected areas), there are values that favor the creation of sanctuaries for cetaceans. The motivation for these discussions are value-based objections to cetaceans in exhibit, show, work, production, and research settings (Mountain, 2017). These proposed captive sanctuaries include natural bodies of water that are enclosed with nets for housing marine mammals. Housing in captive sanctuaries can be viewed as superior to releasing captive aquatic mammals into wild settings where animals are unlikely to remain alive, let alone thrive, due to an absence of survival skills in wild environments. However, as mentioned above, there is a need to address the same animal welfare concerns as expected in conventional settings, and this will require using many of the same strategies as employed for conventional management.

Rehabilitation Facilities

Wildlife rehabilitation is an activity based on prioritization of the welfare of individual animals or a sense of responsibility for human activities that result in injuries to animals (Kirkwood & Sainsbury, 1996). However, there is a need to consider the welfare of animals during the rehabilitation process, at release, and in the context of the impact on other animals (Kirkwood & Sainsbury, 1996; Rollin, 2002). Wildlife rehabilitation programs for aquatic mammals have been established (Moore et al., 2007). In addition to trauma due to human activities, reasons for aquatic mammals' admittance to rehabilitation facilities include debility due to infectious or noninfectious agents that could be due to natural or anthropogenic processes. From a pragmatic standpoint, there is tension between the goal of not habituating rehabilitation animals to humans (e.g., the goal of keeping wild animals wild and less likely to interact with humans when released) and the goal of minimizing distress and exposure to humans during typically needed medical interventions.

Because priority is generally given to the release of healthy aquatic mammals to the environment, short-term stressors that would be minimal or nonexistent for exhibit animals trained for voluntary procedures are justified as transient activities that are required to achieve a healthy status in these animals. This does not mean to imply that analgesics, sedatives, anesthetic agents, good manual restraint techniques and/or equipment, and other management efforts are not used to minimize pain or distress in aquatic mammals in rehabilitation facilities (Stringer et al., 2012; Rosenberg et al., 2017). However, while animals in rehabilitation facilities share similar food, water quality, and other animal welfare considerations with conspecifics in other captive settings, smaller enclosure size, animal handling, and other considerations may be justified as acceptable, pragmatic, short-term measures that are required to reach the objective of releasing healthy animals. The opportunity to monitor the health risks of free-ranging aquatic mammal populations when individual animals are admitted to rehabilitation facilities is an additional justification for many value systems that support aquatic mammal rehabilitation (Greig et al., 2005; Zagzebski et al., 2006; Adimey et al., 2012).

A concern for all wildlife rehabilitation activities is whether animals experience a normal existence following release to the wild (Moore et al., 2007; Mullineaux, 2014). Survival and positive affective states are not guaranteed for released animals, even if they appear to be "normal" and healthy. Animals that are returned to degraded habitats will potentially experience compromised welfare. Mortality, failure to breed, and similar adverse individual animal outcomes also naturally occur for wild animals that never enter rehabilitation facilities, and this may be an acceptable baseline for comparison for rehabilitated animals. This raises questions of what indices of animal welfare and levels of failure are acceptable for rehabilitated aquatic mammals. Selection of these indices and tolerance for failure will vary among evaluators with different value systems. Similarly, decisions on use of long-term care or euthanasia for animals that are not releasable presents a conundrum that can pit some value systems against practical realities (Moore et al., 2007).

Free-Ranging Animals

Free-ranging aquatic mammals and other wildlife species have animal welfare concerns that often differ from those of captive conspecifics, although loss of habitat and conservation interests may result in increasingly blurred boundaries between the two populations in the future (Harte, 2001; Paquet & Darimont, 2010). Notable challenges for addressing free-ranging aquatic mammal welfare include the difficulty of imposing human interests on animals that are not under human control and the question of whether humans have an ethical responsibility for free-ranging animals' welfare. Physical trauma, sonar and other anthropogenic noise (e.g., from shipping, construction, etc.) that compromises biological functioning, harassment, and other anthropogenic sources harmful to aquatic mammals are considered by many value systems to be a part of humanity's ethical responsibility (Kelly et al., 2004; Zirbel et al., 2011; Adimey et al., 2012). However, natural processes can also result in morbidity, mortality, and poor affective states for free-ranging aquatic mammals. Because these are natural processes, interventions such as wildlife rehabilitation are a relatively recent consideration as adverse animal welfare states are historically accepted as being out of human control and ethical consideration. But what if human activities affect the rate and/or degree of processes that adversely affect aquatic mammals? Trauma to aquatic mammals due to boats, fishing, or other activities is commonly accepted as justification for engaging in aquatic mammal rehabilitation. Less obvious are the impacts of anthropogenic activities on infectious disease transmission such as sea otter deaths due to protozoa, low prey populations due to overfishing, or high body burdens of toxicants due to pollution as seen in some cetacean populations (DeMaster et al., 2001; Ross, 2006a; Shapiro et al., 2012; Reif et al., 2017). Even less directly associated with humans are algal blooms and warming climate temperatures that alter Arctic environments (Van Dolah, 2000; Gilg et al., 2012). Many value systems may favor human acceptance of responsibility for these impacts on free-ranging animal welfare, but what is acceptable or practical to accomplish? Furthermore, how can conflicting value systems be reconciled for the benefit of free-ranging aquatic mammals' welfare (AZA, 2017)?

Incompatible Animal Welfare Objectives for Free-Ranging Populations—As many as 37% of all marine mammal species are at risk of extinction, largely due to anthropogenic impacts such as pollution, overfishing, development, and climate change (Davidson et al., 2012). While most people value these species and their persistence, there is generally higher valuation of the anthropogenic activities that are risking these species' persistence. Activities that can compromise the welfare of free-ranging aquatic mammal species include construction, drilling, ecotours, swim programs, boat traffic, and oil spills (Constantine, 2001; Gordon et al., 2003; Peterson et al., 2003; Romano et al., 2004; Neumann & Orams, 2006; Adimey et al., 2012). Some of these activities depend upon the presence, health, and welfare of free-ranging aquatic mammals yet may adversely affect these animals. Other activities are of such great economic importance that accommodations for animal welfare are not politically accepted by decisionmakers. While some activities may have minimal impact on aquatic mammals, documentation of the impacts of these activities, at varying levels, on the welfare of aquatic mammals, as well as strategies for minimizing or preventing compromised animal welfare, is incomplete. Establishment and enforcement of effective regulations intended to protect aquatic mammal welfare are incomplete.

Free-Ranging Populations and Captive Breeding Programs—While field conservation measures can be viewed as part of a strategy for meeting the animal welfare interests of free-ranging aquatic mammal populations, avoidance of circumstances that risk aquatic mammal welfare and persistence is often not sufficiently valued until populations reach critically low numbers. At this point, drastic *in situ* programs or captive facilities that breed or rehabilitate the threatened or endangered species are options for species recovery efforts (Moore et al., 2007; Seiffert et al., 2012; AZA, 2017). While both options can be justified under some value systems, both options are hampered by the need to resolve the factors that contributed to the population's decline before animals can be released. Whooping cranes (*Grus americana*), black-footed ferrets (*Mustela nigripes*), California condors (*Gymnogyps californianus*), and Arabian oryx (*Oryx leucoryx*) are examples of species whose successful population recovery programs included the use of captive breeding programs (Snyder et al., 1996). However, whether captive facilities are developed for rehabilitation (e.g., Hawaiian monk seal [*Neomonachus schauinslandi*]) or captive breeding, the above-mentioned value-based concerns for captive facilities exist. Therefore, the practical challenges for ensuring captive animal welfare remain, including the potential for long-term captive management for individuals that cannot be released due to the absence of suitable habitat, concerns about the individual's ability to survive in the wild, or for other reasons.

Some countries and jurisdictions have banned housing or breeding of captive cetaceans, largely based on previously discussed values concerned with holding animals in captivity (Hugo, 2016; AZA, 2017; Phys. Org, 2017). These bans have the practical impact of limiting the number of facilities

available for rehabilitation or captive breeding, as well as a diminishment of personnel numbers and level of expertise available to aquatic mammal conservation programs. This reduction in facilities and personnel poses potential concerns for threatened and endangered species in a world where declining wildlife habitat often requires active management of small and semi-wild populations. For instance, vaquitas (*Phocoena sinus*) have declined to less than 30 individuals in the Gulf of California (Mexico) due to human activities and recently became the object of an intensive captive recovery program (Nordlund, 2017). This captive program is inconsistent with the values driving the proposed ban on breeding cetaceans in Mexico and the ban on captive marine mammals in Mexico City (Cronin, 2014; AZA, 2017). On a broad scale, if a sufficient number of bans are enacted, the resources available to address the welfare needs of vaquitas and other endangered cetaceans in captivity are compromised. This creates a paradox of values that prioritize persistence of wild populations of aquatic mammals while failing to eliminate anthropogenic threats and potentially limiting the expertise and other resources available to address the welfare needs of animals in rehabilitation and captive breeding programs.

Vexing Options for Individual Free-Ranging Animals—The circumstances associated with free-ranging animals also create practical animal welfare challenges for individuals such as situations that occur with whale strandings. Whales may strand on land due to natural causes, exposure to anthropogenic low-frequency sonar in marine environments, or for other reasons (Walsh et al., 2001; Zirbel et al., 2011). One or multiple animals may strand at a given time. While some animals can be redirected into navigable waters and some can be rehabilitated in captive facilities (or housed permanently when they cannot be released), the lives of many cannot be saved. Several days may pass until stranded whales die of dehydration, drowning (when high tides cover the blowhole), or other causes (Harms et al., 2014). Individual animal welfare is clearly compromised under these conditions, but what is humanity's responsibility to prevent suffering? Does it make a difference whether the cause of the stranding is natural or man-made? How can euthanasia (humane termination of life) be accomplished for these species?

Some value systems will favor euthanasia as a means of preventing the suffering of stranded whales, while other value systems are opposed to euthanasia of animals (Matibag et al., 2009; American Veterinary Medical Association [AVMA], 2013). When euthanasia is elected, there are several methods of achieving this endpoint (American Association of Zoo Veterinarians [AAZV], 2006; AVMA, 2013). However, there are substantive challenges associated with each of these methods. The large body size of many whale species poses a risk to humans who are in close proximity, particularly in high wave environments (Harms et al., 2014). Thus, administration of chemical euthanasia agents to stranded whales poses a safety risk to humans and is a secondary toxicity risk for animal scavengers that feed on the carcass. Succinyl choline is a drug that likely has minimal risk of secondary toxicity but acts by paralyzing respiration while not affecting consciousness or perceptions of pain (AAZV, 2006; AVMA, 2013). This is generally regarded as an unacceptable means of euthanizing animals under most circumstances (AVMA, 2013). However, is it acceptable if it reduces marine mammal death processes from days to minutes or hours? Is succinyl choline justifiable when humans who administer the agent risk death if they are accidentally exposed?

While firearms are a possible alternative to administration of drugs for small marine mammals, personnel must be familiar with the exact anatomical landmarks to target and shoot accurately to ensure that stranded whales do not suffer. Firearms also pose an aesthetic concern and physical risk to humans (AVMA, 2013). Explosives have been explored as an approach for euthanizing large marine mammals, but the targeting, aesthetic, and human safety concerns are magnified compared to firearms (Barco et al., 2012). Thus, for those who value mitigating the suffering of stranded whales with euthanasia, there are substantial practical challenges as none of the currently available options is ideal for many situations. Thus, this is another situation in which value systems can be challenged by pragmatic realities.

Instrumental Values and Aquatic Mammals

Instrumental values of aquatic mammals can diverge markedly from values that prioritize aquatic mammal individuals or populations. Whaling and harvest of smaller cetaceans are well-publicized sources of conflict between value systems (Bekoff, 2007). Similarly, harvest of juvenile harp seals represents a graphic image that has been a focus of animal welfare campaigns (Daoust et al., 2002). These uses of charismatic marine mammals represent clashes between cultures that have historically viewed these species as natural resources and those that do not. This raises the question of the suitability of imposing one culture's norms on others. Actual animal welfare concerns, beyond the impact on populations and species, include the challenge of causing a rapid death in large-bodied whales for whom death may take minutes to hours to occur after harpooning (Gales et al., 2008). In contrast, 98% of harp seal juveniles are killed in what is judged to be an acceptably humane manner (Daoust et al., 2002).

These two cases pose the question of what percentage of animals must be killed instantaneously to be acceptable. They also raise a comparison with standards of acceptability for domestic animal slaughter for food when less than 100% of animals may be instantly dispatched with a given method (AVMA, 2016). There is also the potential for confusing the aesthetics of the method with the outcome such as when clubbing juvenile harp seals results in nearly 100% dying instantly, although the use of clubbing presents aesthetic challenges (Daoust et al., 2002; AVMA, 2013). Do these assessments differ if the harvest occurs as a part of traditional aboriginal harvest and subsistence, or if the harvest is sustainable (population persistence is not threatened)? These contextual issues and potentially labile conclusions illustrate the tension between socially modified perceptions and what animals actually experience. The tension inherent when there are discordant value systems can result in polarized responses as well as failure to recognize opportunities to improve animal welfare.

Circumstances in which commercial (e.g., tours that intentionally set up interactions between aquatic mammals and the public), incidental (e.g., aquatic mammal consumption of fishery harvests), or opportunistic (e.g., chance encounters) interactions occur between humans and wild aquatic mammals have many of the same concerns as previously mentioned for captive aquatic mammal–public interactions such as animal distress as a consequence of human activities (Constantine, 2001; Stokes et al., 2002; Pont et al., 2016). An added concern for free-ranging aquatic mammals is the habituation of these aquatic mammals to humans. Whether or not these mammals come to depend on humans as sources of food, these interactions can lead to situations wherein the aquatic mammals are judged to have crossed acceptable boundaries and become a threat to human health and safety (Dyck, 2006). At this point, individual animals may be classified as pests, thereby justifying termination of their lives under some value systems.

The decision to terminate animal lives and the selection of "humane" methods used to do so can be affected by whether an animal is labeled as a pest, whether they are a charismatic species, or other contextual factors. For instance, while wearing of furs may be perceived *a priori* to represent compromised animal welfare, taxonomic considerations may increase the acceptability of terminating the lives of nutria (*Myocastor coypus*) (a rodent species) for fur apparel compared to more charismatic species (Herzog et al., 2001; Grossman, 2010). Because nutria are also labeled as a pest species due to their adverse environmental impacts when outside of their native range, the methods used to terminate their lives may also be assessed differently than for more charismatic species (Jojola et al., 2005). These contextual factors have the potential to influence the complicated tradeoffs that are inherent when striving to balance animal welfare with the practical realities of managing animals under free-ranging, field conditions (Reynolds, 2004). For instance, beavers (*Castor canadensis*) may be distressed if captured in terrestrially placed traps as compared with submerged traps. However, how does one balance this distress versus the distress of drowning in submerged traps when drowning is not generally considered an acceptable means of terminating life (Association of Fish & Wildlife Agencies [AFWA], 2006; AVMA, 2013)? Does the animal welfare assessment of the trapping methods used vary if the beaver(s) is (are) causing damage that jeopardizes vital (or for that matter peripheral) human interests? Expectations for acceptable animal welfare may also be modified when addressing animals that are a direct threat to human life (e.g., polar bear) or a threat to the existence of other valued species (e.g., sea lion predation on endangered salmon species) (Dyck, 2006; Pont et al., 2016).

Contrasting value systems may disagree with terminating animal lives under any conditions, or under specific conditions, and may also have dissenting perceptions of the "humaneness" of the methods used. Nevertheless, there must be ongoing efforts to identify strategies for improved animal welfare for free-ranging aquatic mammals whether or not existing options are considered undesirable. While many value systems cannot be reconciled, practical considerations will often be the basis for addressing the animal welfare concerns of free-ranging aquatic mammals.

Conclusion

Assessors' value preferences, attitudes, and personal experiences with animals shape their assessments of animal welfare. Assessors' assessments are also shaped by societal values. Increased attention to aquatic mammal welfare and animal welfare in general have led to improved management of captive individuals, offered modifications for human activity affecting free-ranging animals, and have altered societal perceptions of captive and free-ranging individuals and populations. There are instances of aquatic mammal welfare that may be clearly assessed as adequate or excellent based on most value systems. There are also practical limitations to addressing some welfare concerns and a need to recognize biological and practical realities. In particular, the tradeoffs that must be addressed for a given context must be transparently

communicated, evaluated, and debated. This is particularly true when dissonant concerns, such as individual and population-level animal welfare interests, must be balanced. The *Five Domains Model* provides a framework for transparent evaluation of tradeoffs, while the *Three Orientations Model* provides a framework for identifying the value-driven perceptions that can lead to dissonant animal welfare assessments. Research can provide a basis for addressing biological and social animal welfare concerns, although it can also be used as a distraction from addressing the tough discussions that are needed to resolve differing value systems. However, where there is a true interest in addressing animal welfare, rather than advancement of an ideology or "winning," transparent dialogue that clearly identifies points of contention can potentially identify areas of agreement and lead to creative solutions to aquatic mammal welfare dilemmas. Aquatic mammal welfare is most likely to benefit from the presence of stakeholders with firsthand knowledge of the animals in question who are open to self-reflection and self-critique; are in possession of a genuine interest in comprehensive animal welfare assessment; and are interested in seeking good outcomes for humans, animals and the environments that constitute their homes.

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